“Evaluation of Green Energy Training Programmes in Zambia: Alignment to National Energy Goals.”

By

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Abstract

This paper critically analyses how the renewable energy training programmes in Zambia relate to the national renewable energy objectives of the country and sustainable development objectives of the country. Though Zambia has a huge potential in solar, wind, and solid waste energy, there is a loophole in the application of such technologies in the education system, especially at University of Zambia and Copperbelt University. This study will be done using a mixed-methods design where quantitative surveys are conducted alongside qualitative interviews to determine the level at which the green energy education in Zambia has addressed the industry needs and nation-wide energy goals. The results show that there are significant gaps in practise training, faculty knowledge, and industry partnerships, and the curriculum of the majority of institutions is based on traditional energy systems. The research suggests that the curriculum, faculty development, and industry partnerships should be reformed holistically in the process of making the green energy education in Zambia relevant and effective. It also brings out the need to adjust the international best practises to the local setting to overcome infrastructure constraints and facilitate the migration of renewable energy in Zambia. Finally, the study highlights the necessity of reforming education that will enable graduates to obtain the technical and entrepreneurial competencies needed to advance the green energy agenda in Zambia and play a role in the global sustainability agenda.

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Chapter 1 Introduction

1.1 Background of the Research

Zambia’s sustainable development requires transitioning to green energy, especially in addressing the country’s energy access challenges. The lack of electricity in Zambia’s rural areas affects approximately 57% of the rural population (Abad-Segura and González-Zamar, 2021), an urgent energy need. Zambia has a lot of renewable energy potential in solar, wind, and solid waste energy but fails to integrate these technologies fully into the educational system. The University of Zambia and Copperbelt University have energy and environmental science programmes. However, the curricula mainly deal with traditional energy systems without practical hands-on solar energy, wind energy, and solid waste energy (Elahi, 2022). Nevertheless, now that global energy discussions have turned to bioenergy, solid waste energy has become a cleaner and more viable solution in waste management strategies. Solid waste energy integration has been successfully demonstrated in countries like Denmark and Germany (Haldar and Sethi, 2021). Consequently, this study seeks to evaluate Zambia’s green training programmes on green energy (viz. solar energy, wind energy, and solid waste energy) so that they are aligned with the country’s renewable energy objectives.

1.2 Problem Statement

There are gaps in educational programmes that are necessary for Zambia’s energy sector to support the green energy transition, leaving the nation short of professionals who can aid in the transition (Franco et al., 2019). However, at higher education institutions such as the University of Zambia and Copperbelt University, curricula are insufficiently geared toward practical and technical skills required in practice in terms of green technology technologies like solar and wind. (Abad-Segura and González-Zamar, 2021). Moreover, the energy discourse of Zambia still centres on bioenergy at the expense of solid waste energy, which is not thoroughly included in the curriculum. Zambia cannot meet its energy needs and contribute to global sustainability targets without renewable energy expertise in solar, wind and solid waste energy because the country has been unable to develop its expertise (Alharthi, et al., 2022).

1.3 Aim of the Research

The purpose of this study is to assess the ability of Zambia’s green energy training programmes to develop graduates in the renewable energy sector. In particular, solar energy, wind energy, and solid waste energy technologies will serve as a theme for research that will examine whether the curriculum meets the industry's needs and complies with Zambia’s national energy goals. The mixed methods approach will be adopted for the study by using both primary quantitative data (survey and interviews) and secondary qualitative data (curriculum documents and reports) to conduct an in-depth evaluation of the Zambian green energy education landscape.

1.4 Research Objectives

- To assess the structure, content, and certification of green energy programmes in Zambian universities, specifically the technical and practical training content.
- To study some critical challenges, such as the lack of infrastructure, the unavailability of faculty expertise, and the poor interactions between industry and academia.
- To assess the success of these programmes in preparing graduates to work in Zambia’s renewable energy industry.
- To explore international best practices and assess if they are relevant to Zambia’s context.

1.5 Research Questions

RQ1: How much practical training in solar, wind and solid waste technologies is included in Zambia’s green energy programmes and how relevant are they in achieving national energy goals and SDG 7?

RQ2: What institutional barriers to graduate readiness for the green energy sector result from faculty capacity, infrastructure, funding, and industry partnerships?

RQ3: What extent do these programmes produce employable graduates with relevant technical and entrepreneurial skills?

RQ4: How can Zambia’s higher education and energy sector alignment be improved by adopting international models of green energy education?

1.6 Scope of the Research

The study will be conducted at the University of Zambia and Copperbelt University and will examine green energy training programmes for solar, wind, and solid waste energy (Cantarero, 2020). It will assess these programmes by evaluating the inclusion of practical training components, faculty capabilities, and alignment with Zambia’s national energy policies. The research will use a mixed methods approach, quantitative (surveys) and qualitative (document analysis), where the training programmes are assessed for effectiveness (Haldar and Sethi, 2021).

1.7 Limitations of the Research and Scope for Further Research

This study faces several limitations. Secondly, there is very little information about employment outcomes of green energy graduates in Zambia, limiting the assessment of the relative success of educational programmes in contributing to a graduate’s career success (Elahi et al., 2022). Since solid waste energy is an emerging technology, it may evolve too quickly to fully integrate into the academic curricula, which could impact the study results (Majid, 2020). Future research should survey and track graduate employability in the renewable energy field and comprehensive integrations of solid waste energy into educational programmes (Leal Filho et al., 2019).

1.8 Structure of the Dissertation

Chapter 1: Introduction

This chapter describes the background of the study and the research aim, objectives, and research questions. Together, these make up the first section of this chapter. This section addresses the research significance, the current Zambia green energy education landscape, and its concordance with the country’s renewable energy objectives. The scope of the study is also discussed, along with the limitations that may affect the study's findings.

Chapter 2: Literature Review

The literature review chapter explores global best practices for green energy education (mainly solar, wind, and solid waste energy). Using Green Energy Programmes from different countries as the comparative materials, this chapter analyses the significant edge of green energy curricula in a country that has contributed to creating a workforce in renewable energy sectors. It will also examine the importance of the utility of practical training and collaboration with industry in creating highly efficient energy education programmes.

Chapter 3: Methodology

The research methodology included in Chapter 3 is a mixed-methods approach. This paper describes the data collection process, including quantity surveys and qualitative document analysis, to assess Zambia’s green energy education programmes. It also discusses how the analysis techniques have been used to evaluate the gap between current curricula and Zambia’s national energy objectives and industry requirements.

Chapter 4: Data Collection and Analysis

This chapter presents the results obtained in the data collection process. It analyses both primary data (such as surveys and interviews) and secondary data (such as curriculum documents and reports). The research questions will be interpreted so that the findings address them and evaluate the effectiveness of Zambia’s green energy programmes.

Chapter 5: Conclusion and Recommendations

The final chapter offers a summary of the findings and conclusions on the state of Zambia’s green energy education. The document also provides concrete recommendations to strengthen curricula, faculty training, and industry partnerships so that Zambia can move towards renewable energy.

Conclusion

The key role of transitioning Zambia’s energy sector to renewable must include solar, wind, and solid waste energy technologies as the focus of this chapter discussed. Like many African countries, Zambia’s challenge in providing such energy to its rural population is massive; over 50% of the population has no electricity. Zambia has great potential in renewable energy, but the absence of a functional educational system discourages her from developing the educated hands needed for the green energy transition. However, institutions such as the University of Zambia and Copperbelt University have made efforts to provide curricula that focus on traditional energy systems and exclude emerging green energy technologies.

Chapter 2 Literature review

2.1. Introduction

This study employs a mixed methods approach, integrating both quantitative data (through surveys and interviews) and qualitative data (via curriculum documents and reports). This methodology ensures a comprehensive evaluation of Zambia's green energy education system. The aim is to gather empirical data to assess how well current educational frameworks align with the country's renewable energy goals, particularly in the areas of solar, wind, and solid waste energy technologies, which are vital for Zambia’s sustainable development. This review critically appraises existing literature on green energy education, focusing on Zambia’s challenges and opportunities. In Zambia, as mentioned earlier, there remains a gap in the integration of renewable energy technologies, including solar, wind, and solid waste energy, into the country's higher education curricula. Additionally, minimal data is empirically based on green energy graduates’ employability outcomes and industry-academia collaborations for practical training. Inadequate preparation of graduates for employment in the rapidly growing renewable energy industry constitutes these deficiencies. Largely, graduates are not adequately prepared for industry roles. The first section of this chapter reviews global trends related to green energy education from Germany and Denmark. It then goes on to evaluate Zambia’s existing green energy education framework and the challenges faced by Zambia’s universities in accommodating industry needs. On this basis, the review gives specific recommendations for Zambia in terms of international models of green energy education. Filling the identified gaps, such as public-private partnership involvement in improving hands-on training, establishing university renewable energy labs, and updating curricula according to existing renewable energy technologies (Qazi et al., 2022), these recommendations are aimed at the identified gaps. These strategies are aimed at bridging the gaps and make Zambia's green energy education system more substantial, positioning the country to meet its renewable energy goals.

2.2. Theoretical Framework

2.2.1 Sustainable Development and Green Energy

Solar energy has a great potential for sustainable development of Zambia’s energy transition. Solar power is a significant focus for educational and policy strategies that support the country’s renewable energy targets. As opposed to concentrating on providing renewable energy at the grid level, solar energy can be integrated into the curriculum at higher education institutions to prepare better future professionals to be a part of the country’s energy independence. Meeting Zambia’s energy access challenges, improving rural electrification, and advancing towards global sustainability, such as Sustainable Development Goal 7 (SDG 7) for affordable and clean energy, can be achieved by prioritising solar energy. One such agenda that drives sustainable development according to SDG 7 (Affordable and Clean Energy) is to combat climate change and feature renewable energy (especially in developing countries such as Zambia) widely (Amadi, 2023). Although Zambia has a lot of renewable energy solar, wind and hydropower there is little to none renewable and green energy of note because there are no skilled people able to harness it sufficiently. Therefore, the workforce coming from SDG 7 education must be led and rooted in renewable energy and green energy to create a workforce that will push Zambia to a renewable energy and green energy future (Ariza et al., 2023). This aligns with German global models where educational policies that have prompted the formation of a workforce with renewable energy technology have aided Germany in its easy transition to green and cleaner energy. Energy policies need to be linked with educational programmes that aim mainly at solar, wind, and solid waste energy technologies to meet Zambia’s national energy aims and support climate change mitigation (Sachs et al., 2019).

2.2.2 Competency-Based Education (CBE)

Unfortunately, green energy training programmes in Zambia do not train students adequately in the practical skills that the industry requires. Consequently, this opens an opportunity for Competency-Based Education (CBE) to fill that gap, as it emphasises learning by doing. CBE differs from the traditional theoretical reading in the classroom because the students have hands-on training (for instance installing a solar panel or erecting a wind turbine) (Muthuri, 2023). In Zambia, a model to learn from can be Strathmore University’s Solar Academy in Kenya, which

brings theory and practice together. CBE can enable Zambia to close the workforce gap for the green energy sector and graduate students to the standard. This CBE module of development would be customised to suit Zambia’s needs around solar, wind and solid waste technologies (Sonetti et al., 2019).

2.2.3 Green Human Resource Management (GHRM)

Green Human Resource Management (GHRM) states that human resource management practices are linked to environmental sustainability (Molina-Azorin et al., 2021). Regarding green energy education through green technologies in Zambia, faculty development by mixing solar and wind power in the lessons and training programmes (Azmi et al., 2021) can be supported by GHRM. If the principles applied in GHRM are included in curriculum design, higher education institutions will proffer an appropriate pool of graduates ready for the renewable energy field. One of the ways that Zambia can contribute to the country’s energy transition is by equipping its universities with skills in green technologies that can be used to train their faculty.

2.2.4 Theory of Change (ToC)

The Theory of Change (ToC) framework is a structured concept that helps implement desired long-term educational goals using specific interventions (Ringhofer and Kohlweg, 2019). Curriculum reform, faculty development and integration of industrial partnerships in green energy education in Zambia can be facilitated by adopting the ToC model. As an example, in Zambia, ToC can be used for specific alterations such as updating the curriculum to include solar energy technologies, industry partnerships for hands-on training and faculty development in areas of renewable energy. In that case, this will directly fill the gap in the education system. The effectiveness of the ToC approach in creating reforms for renewable energy education in the context of Kenya and South Africa has been proven in past studies in these countries (Mhango, 2024), which can be leveraged by Zambia in enhancing the quality of green energy programmes.

2.2.5 Technology Acceptance Model (TAM)

Selim and ElGohary (2020) attempt to explain the relationships between students’ attitudes and perceptions of green energy technologies and students’ adoption of such technologies and their future careers in the renewable energy sector with the help of the Technology Acceptance Model (TAM). With the adoption of renewable technologies still in its infancy in a country like Zambia, it is warranted for TAM to examine how perceptions of the ease of use and the usefulness of the technology affect the adoption of technology. Using TAM, Zambia’s green energy programmes can be better designed to increase student adoption rates by assessing how students perceive solar, wind and solid waste energy technologies. In addition, TAM can be adopted as a centre of curriculum reformations for green energy technologies to be more attractive and easier to learn and adopt by students and also enhance the receptivity of the workforce to the green energy sector (Žalėnienė and Pereira, 2013).

2.3. Global Trends in Green Energy Education

2.3.1 Overview of Global Green Energy Education

In countries like Germany and Denmark, solid waste energy has been integrated into renewable energy education. Solid waste energy is a promising, alternative and complementary source of bioenergy. This technology presents energy solutions and solutions to environmental issues, and it is best to have it introduced in educational programmes in Zambia, where waste management is clearly a going concern. It can also be used as a solution to remedy energy shortages. The scope of green energy training will also be expanded to higher education institutions in Zambia, given that this study will examine how international best practices can be applied to Zambia’s higher education institutions. For instance, Germany is a suitable example to use such industry partnerships to extend its renewable energy education and guarantee that students acquire the required skill set to enter a rapidly changing energy sector (Stritzke and Jain, 2021). Similarly, Denmark’s reputation in renewable energy shows that a similar emphasis on wind energy is present through the programmes in place at learning institutions (Hassan et al., 2024). At the same time Zambia still suffers from dated curricula, an absence of practical training opportunities and very

few industry-academia linkages (Bhamidipati et al., 2021). A continuing phenomenon that prevents the country from fully embracing renewable energy technologies in its educational system and energy transition programmes is due to the existence of these barriers (Mian et al., 2020).

2.3.2 Best Practices and Successful Models

Strathmore University’s Solar Academy in Kenya is one example of successful green energy training. The programme combines theoretical learning with real-world applications through strong public-private partnerships where the students work directly in the solar industry (Pacheco et al., 2019). This approach can benefit Zambia by establishing partnerships promoting practical green energy technology training. With the renewable energy potential in Zambia, public-private partnerships could significantly enhance the training infrastructure and provide a solid transition from education to employment in the renewable energy sector.

2.3.3 Global Research and Impact

The integration of renewable energy education into universities in Germany has played a significant role in the country’s success in solar and wind energy production and in producing a skilled workforce to support Germany’s energy transition (Hassan et al., 2024). Zambia can follow the same line of action and align its educational system with the national energy goals regarding solar and bioenergy sectors. Another helpful model comes from Denmark’s focus on wind energy, where industry collaboration and curriculum development support sustainable energy transition directly; Zambia may adopt these global models by weighing the flexibility of introducing vocational training in the higher education system in Zambia while addressing its unique infrastructure and faculty development challenges (Tembo, 2023). These lessons from Germany, Denmark, and Kenya can be applied to Zambia’s green energy education framework to prepare students for the renewable energy workforce. Strong industry ties and vocational training components will allow Zambia to meet its energy goals and establish a skilled workforce to deliver green energy solutions (Mhango, 2024).

2.4. Green Energy Education in Zambia

2.4.1 Current State of Green Energy Training in Zambia

Green energy education in Zambia has been going slow over the past few years. For instance, the University of Zambia and Copperbelt University offer training in energy and environment science and energy systems. However, these programmes are highly antiquated and do not delve sufficiently in current modern renewable energy technologies such as solar, wind and solid waste energy. Zambia is rich in renewable resources and green energy, but its resources have not been fully adopted principally due to a shortage of skilled professionals in the green energy sector. Currently, the present education model concentrates on conventional energy systems only, and they are not training workers hands-on with renewable energy technologies, so they are a detrimental impediment to growing the workman (Alharthi et al., 2022).

2.4.2 Curriculum Gaps and Limitations

Currently, renewable energy technologies are not satisfactorily supported in Zambia’s green energy education system, and the curriculum is mostly outdated (Mfune, 2019). These curriculum gaps weaken Zambia's energy transition objectives, including achieving a renewable energy generation that will increase to 30% by 2030. Apart from that, the number of graduates absorbed by the green energy sector is merely 15 per cent (Mfune, 2019). At the same time, the skills required in labs and practical applications of solid waste energy and solar energy technologies are not adequately covered by Zambia’s universities’ curriculum, including the University of Zambia and Copperbelt University. The traditional forms of energy, such as hydropower and bioenergy, can be explained, but there are remarked deficiencies in or lack of education on renewable energy. Mixed methods in this study will fill these gaps through primary survey data and secondary curriculum document data. The research seeks to develop curriculum reforms that align with Zambia’s national energy goals by identifying these deficiencies.

2.4.3 Faculty Development and Infrastructure

The Zambian government has addressed these gaps through the National Energy Policy (2019), which advocates for the inclusion of renewable energy in the National Energy Mix. Furthermore,

Zambia has also utilised international bodies such as the United Nations Development Programme (UNDP) to fund training programmes and other initiatives on renewable energy technologies. Nevertheless, progress has continued to be limited in effecting substantial educational reform, and there has been only modest advancement in building graduates’ employability. For Zambia to succeed, developing a comprehensive national strategy that aligns education with the industry’s needs in the green energy sector, strengthens industry-academia partnerships, and enhances practical training infrastructure is important (Moonga, 2023).

2.4.4 The Role of Industry-Academic Partnerships

Industry-academia partnerships are very crucial in filling the gap between theoretical learning and practical training. A successful model of collaboration between the Strathmore institution and the solar industry in Kenya can be emulated in Zambia. Zambia can forge partnerships with local renewable energy companies to equip students with practical skills to enter the renewable energy workforce. These partnerships must be strengthened so that its green energy education system fits industry needs and supports Zambia’s energy transition goals.

2.5. Challenges in Green Energy Education

2.5.1 Curriculum Design and Relevance

Zambia faces several challenges in aligning its educational programs with the renewable energy sector's needs. A key issue is the lack of practical training opportunities in emerging technologies such as solid waste-to-energy and solar power. The curriculum remains widely outdated and does not sufficiently prepare graduates for the energy sector. Through quantitative surveys and qualitative document analysis, this study evaluates the effectiveness of current programs and proposes practical solutions for enhancing faculty development, infrastructure, and industry-academia collaboration to bridge the gap between education and industry needs. This limitation is because curricula are heavily skewed towards traditional energy sources such as hydropower and fossil fuels. For example, currently there is no specialised degree programme in renewable energy at the University of Zambia. Conversely, Zambia maintains the goal of having 30% of its energy

needs to come from renewable sources by 2030 (Republic of Zambia, 2024). Moreover, the weakness is that the curriculum does not focus enough on renewable energy, which means that many graduates get a skills gap when entering the growing green energy workforce. It is due to the national energy policy that focuses on green energy that higher education curricula must be profoundly changed to equip students with the knowledge of solar, wind, and solid waste-to-energy technologies. For instance, modules on solar PV systems, wind energy and waste-to-energy technologies should be integrated into engineering and environmental science programmes by the University of Zambia and Copperbelt University. Such institutionalisation will support students in becoming in-line with Zambia’s strategic energy targets and international practices in renewable energy education (Selim and ElGohary, 2020).

2.5.2 Lack of Practical Training

At present, the areas of clean energy development in Zambian universities lack hands-on, practical training for renewable energies. Specifically, graduates from the University of Zambia as well as graduates from Copperbelt University do not possess experience in the installation and operation of solar power systems, wind turbines and bioenergy plants. This is a hands-off teaching approach that does not allow the students to translate the theoretical knowledge to the real world (Moyo and Oree, 2024). For example, the University of Zambia offers basic theoretical knowledge of solar energy. However, it does not have equipped solar training laboratories in which students can gain on-the-ground experience on how solar panel installations and solar panel maintenance procedures are performed. Further, there is no real partnership with industry players to give internships or real case studies around that. By connecting with renewable energy companies, Zambia could greatly improve its practical training programmes, drawing from Strathmore University Solar Academy’s cooing of academic learning with industry-driven training projects, and students will acquire the necessary skills to work for these companies (Stritzke and Jain, 2021).

2.5.3 Faculty Expertise and Training

A significant impediment to green energy education is the limited expertise among the faculty members in Zambia universities. However, despite the need for more skilled professionals in the

field of more emerging energy sources like renewable energy, the number of faculty members from the University of Zambia who specialise in renewable energy is far less than 30 per cent, while most are from traditional energy disciplines (Mukosha, 2023). It severely hampers universities from providing high-quality, current content in the technology of green energy such as solar, wind and solid waste energy. Also, there is barely any structured faculty development programmes for upgrading teachers’ skills in renewable energy technology in Zambia. For example, faculty at the University of Zambia that have not had enough access to such current innovations in solar and wind energy systems may find it hard to educate students on these subjects as they are a barrier to understanding. In contrast, Denmark has achieved extensive professional development programmes for university faculty, which allow them to stay current with fast-paced green energy technologies. To help bridge this gap, Zambia needs to focus on faculty retraining programmes, working with international renewable energy institutions and industry players to determine specialised workshops and research opportunities in the most modern green technologies (Mukosha, 2023).

In addition, introducing inter-university collaboration with reputable renewable energy research institutions could help build capacity among Zambia’s faculty, providing them access to the latest research and technological advancements. This would ultimately improve the quality of instruction and, in turn, prepare students to work in the renewable energy workforce.

2.5.4 Infrastructure Barriers

Zambia’s green energy education programmes lack much infrastructure. Many universities do not have appropriate labs, workshops, or the equipment to teach renewable energy technologies. For instance, currently, there is no dedicated renewable energy lab at Copperbelt University, and students at the university have no practical experience in solar, among other bioenergy systems. These infrastructure gaps limit student’s ability to practise what they learn in the classroom. However, to set up state-of-the-art green energy labs in universities, public-private partnership (PPPs) would help address this gap. In addition, the South Africa Renewable Energy Centre has successfully employed PPPs to develop training facilities related to renewable energy programmes (Phiri, 2024). Zambia can use this as an example to develop collaborative learning spaces where

students utilise such essential technologies to prepare practical skills and industry readiness for such technologies as wind turbines and solar panels.

2.6. Challenges in Green Energy Education

Solid waste-to-energy (SWTE) technologies offer a promising alternative to bioenergy in Zambia’s renewable energy mix. Unlike traditional bioenergy, SWTE addresses both energy generation and waste management challenges, making it an attractive solution for urban and rural areas. Integrating this technology into educational programs can equip students with the skills needed for the rapidly evolving green energy sector. This research explores the potential of solid waste energy in Zambia and recommends how it can be incorporated into the curriculum to meet the nation’s energy and environmental goals.

2.6.1. Zambia’s National Energy Policy

The National Energy Policy of Zambia holds that the country will require renewable energy but lacks effective green energy education strategies to implement. However, the support for sustainable energy solutions in the policy of incorporating renewable energy education into university curricula is unclear. However, Zambia has failed to make remarkable progress regarding training the skilled workforce for the green energy sector because there were no specific frameworks or incentives that academic institutions used to construct courses relevant to the market (Fuso Nerini et al., 2019). The current energy policy does not support including practical training facilities or the maturation of modern renewable energy technologies such as solar, wind, and solid waste energy in university programmes. Gaps must be filled through the policy reform of mandating a renewable energy curriculum in universities and rewarding those who teach the clause. Furthermore, financial and technical support could be given to higher education institutions to provide for the national energy goal. This policy shift will be critical for Zambia to achieve its green energy workforce, energy transition targets, and the country’s global sustainability commitments (Twidell, 2021).

2.6.2 Government and Industry Collaboration

There has been a lack of effective collaboration between the government, industry and academia in Zambia, which has hindered the development of green energy education. Additionally, there is a lack of public-private partnerships (PPPs) upon which further development of renewable energy infrastructure and practical training opportunities depend. Although some minor alliances are established between universities and the private sector, these collaborative movements are insufficient to address the industry's growing need for knowledgeable, skilled renewable energy specialists (Žalėnienė and Pereira, 2021). Similar to the partnerships between industry and academia in Kenya’s Strathmore University Solar Academy, Zambia’s academia could benefit from establishing such partnerships. This model also integrates experience with industry with practical experience in renewable energy technologies. Financial support, tax breaks and research funding for curriculum development and student internship programmes could be given to the government to incentivise these partnerships. Ultimately, these projects would alleviate the gap between education and the Renewable Energy market, which would finally help to meet Zambia’s energy transition goals with an excellent workforce equipped with precise and proper knowledge (Zafar et al., 2022).

2.7. Research Gaps

Several research gaps persist related to the degree to which Zambia’s programmes in green energy are relevant to the curriculum. There is not a broad enough base of current literature that deals with the alignment of current curricula from universities to the increase of the country’s need for renewable energy professionals. More specifically, studies on how curriculum reform could better ensure graduate employability in the renewable energy sector are incomplete. Additionally, this research is lacking in pointing out the efficacy of industry-academic partnerships in imparting students with the practical skills needed within the energy workforce. Zambia’s energy goals will be best served by future studies that examine how incorporating sustainable technologies into university curricula can assist Zambia’s energy solutions. More importantly, the research should explore how government policy reforms motivate faculty development, stimulate public-private partnerships, and generate curriculum development. Finally, studies can also be empirical to

understand the effect of these changes on the calibre of education, along with its effect on the employability of graduates in the renewable energy sector.

Conclusion

This chapter has identified challenges in Zambia’s green energy education, including outdated curricula, poor practical training, insufficient faculty expertise, and poor infrastructure. All these barriers significantly impact the country's green energy transition and attainment of its energy goals, and each has its own intractable dimension. The lack of practical training opportunities is another significant challenge. Theoretical knowledge is important but, on its own, doesn’t provide hands-on experience in renewable energy systems. There are no renewable energy labs or maintenance facilities at universities in Zambia, such as the University of Zambia, Copperbelt University, or others. Second, the deficiency of practical skills makes the students less competitive in the job market, preventing them from practising and developing practical skills within the boundaries of the formal structure of the university. In conclusion, the chapter recommends that the practical training curriculum be integrated so that it can be constructed through industry stakeholders. In Kenya, Strathmore University’s Solar Academy provides students with practical experience through partnerships with industry professionals and a model that could be repeated in Zambia.

Additionally, the chapter points out the lack of a sufficient number of faculty members specialising in renewable energy. That is, fewer than 30 per cent of faculty in Zambian universities are faculty of green energy, which means that few have access to the uppermost knowledge on current renewable energy technologies. The lack of faculty development programmes worsens this problem. To enhance the quality of education, Zambia should promote faculty development initiatives on renewable energy through collaboration with international experts like Denmark. As with infrastructure, green energy education is also hampered by infrastructure challenges. In most cases, though, universities do not have such facilities as spaces for practical learning (workshops and renewable energy labs). PPPs could fill these infrastructure gaps, allowing universities to partner with industry to build definitive state-of-the-art renewable energy training facilities. One of the successful PPPs used is by the South African Renewable Energy Centre. Overall, this chapter

highlights the necessity of modernising the curriculum, practising technical skills, faculty development, and improving infrastructure to create a workforce consistent with the green energy sector in Zambia. The reforms align Zambia’s education sector’s application to the country’s national energy goals and the global sustainability agenda. The next chapter discusses the research methodology used during the research aimed at investigating these challenges and offers solutions for developing green energy education in Zambia.

Chapter 3 Methodology

3.1 Introduction to Methodology

The current chapter describes how Zambia’s green energy training programmes are evaluated in relation to the country’s national energy targets (Abad-Segura and González-Zamar, 2021). The study uses a mixed research method combining quantitative and qualitative methods as two distinct methods. Consequently, the research philosophy adopted in green energy training is constructivist with a positivism mix to determine how green energy training aligns with Zambia's national energy policy, conforming to Creswell’s research methods (2014) and Saunders' Research Onion model (2019). It reflects how the perspectives of stakeholders to ensure all the needed research questions are covered through research design (Gregar, 2023). Next, the chosen methodology attempts to design a powerful means for evaluating the purpose of alignment with national and international objectives related to green energy in Zambia regarding education in the country (Assegaf et al., 2022).

3.2 Research Approaches

This research is a mixed-methods study, which uses both quantitative and qualitative tools to examine the efficiency of Zambian green energy education programmes. Creswell (2014) claims that the use of mixed methods helps enrich the research questions as one adopts a statistical measuring unit while obtaining an understanding of the personal perspectives. Quantitatively the approach measures the structural alignment of educational programmes with national energy goals through surveys, whereas the approach is qualitative that provides deeper understanding of the challenges, barriers, as well as opportunities individuals including students, faculty and professionals face in the industry.

The positivism part of the quantitative approach makes research support, examine and assess how Zambia’s education in renewable energy (solar, wind and solid waste) relate to the country’s energy needs. The research tests predefined hypotheses and finds patterns by the help of positivism. However, the qualitative approach is based on the constructivist philosophy and therefore allows

the study to concentrate on the lived experiences of the stakeholders and to identify the subtleties in the process of education which one cannot pin down in the numerical data (Mengi-Dinçer et al., 2021).

3.3 Research Onion

Through the Research Onion model, one has a systematic way to design and justify a methodology. According to Saunders et al. (2019), the model is made up of layers, likened to layers of an onion: the outermost one being the philosophy layer, followed by the approaches, then the methods and strategies, with ways of data collection and the time horizon layers at its core. In this case, the research philosophy (positivist and constructivist) was used for the quantitative and qualitative elements respectively. With the aim of testing pre-existing theories on the relationship of green energy education to national energy goals the deductive approach was taken up.

The methods used are mixed methods in that quantitative data is collected through surveys, qualitative data is collected through interviews and document analysis. This approach allows to look into the research questions more deeply and precisely. Surveys form the data gathering tools, while semi structured interviews generate information about experiences of faculty, industry professionals, and students. The data collection at one point in time, the cross-sectional time horizon represents Zambia’s standing of green energy programmes.

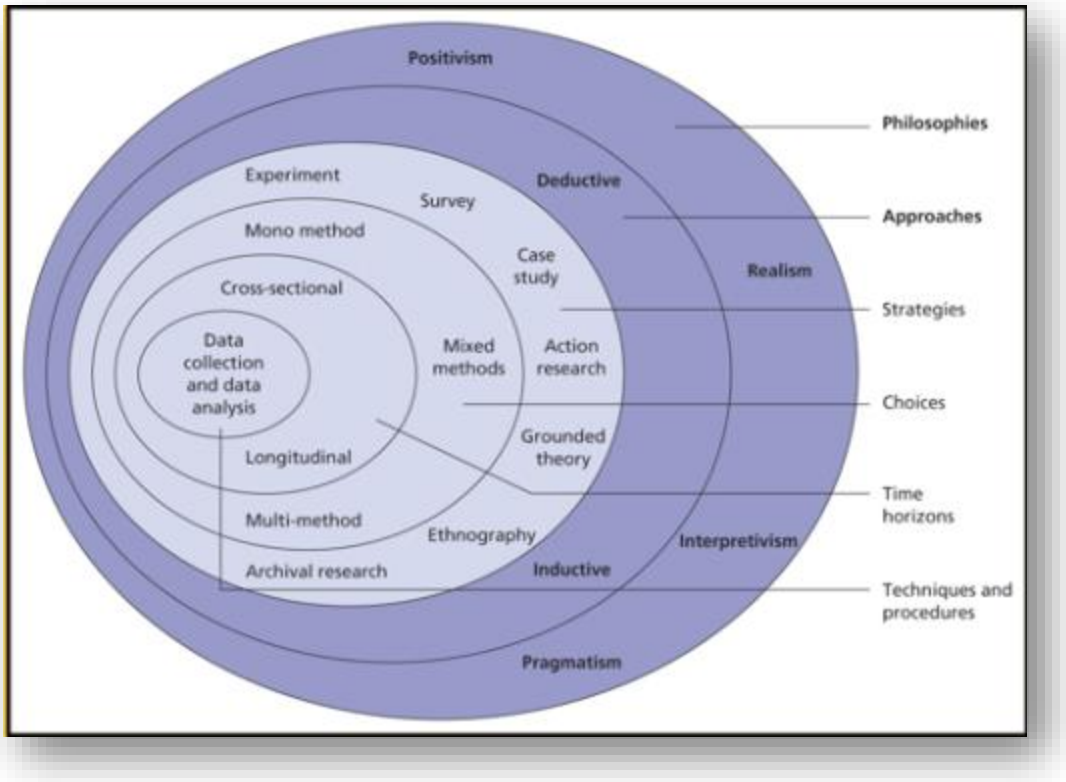

Figure 1: Research Onion

Source: (Saunders et al., 2019)

3.4 Quantitative Method

3.4.1 Quantitative and Positivism Justification

The choice for the quantitative method was based on the fact the quantitative approach will enable measurement of the effectiveness and alignment of Zambia green energy training programmes with the goals of Zambia's green energy. The quantitative approach is positivist that focuses on discovering patterns and relationships using statistical analysis. For testing hypotheses about the alignment of the curriculum with the National Energy Policy (2019), for example, the type of training students receives with renewable energy technologies and in alignment with the green

energy sector as defined in national policy on energy. The quantitative approach offers a sound way to evaluate present status of the educational system in Zambia by measuring variables of quantity such as amount of practical training, extent of industry involvement and degree of hash with national energy goals (Qazi et al., 2022).

3.4.2 Sampling Criteria

The sampling framework is developed to ensure that a proper and representative sample consists of stakeholders involved in Zambia’s green energy training programmes. Students, faculty, industry professionals are included in the population. To achieve the research targets, purposive sampling strategy are based on a sample of individuals who possess or are involved in green energy education. This method guarantees that the subject matter is present to gain direct experience of the stakeholders, making it relevant for the data.

Quantitative data will be obtained through the survey method from students, faculty and industry professionals. In particular the survey will review the importance of green energy technologies taught within the curriculum, the practical training (i.e., solar panel installation and wind turbine operation), and the degree of industry involvement in the development of this curriculum. Structured survey questionnaire closed and open-ended questions will be used to collect the data on the perceptions and experience of participants.

For the Quantitative data, I choose to set the sample size at 50 participants consisting of 30 students, 10 faculty members and 10 industry professionals. According to the Raosoft sample size calculator, this size of sample is big enough to cover various perceptions, small enough to see in depth qualitatively. The sample of respondents is a wide array including experienced people involved in green energy sector for which it is important to evaluate the effectiveness of the training programmes. In addition, the sampling framework includes helpful information such as age, profession, degree of participation in green energy education.

3.5 Qualitative Method

3.5.1 Research Methods

Interviews

To collect qualitative data, a subset of the survey participants will be interviewed with semi structured interview, deeper into the challenges that have been faced by stakeholders in terms of implementing and participating in green energy education. These topics will include gaps that exist in the practical training, how prepared the faculty is, how industry is engaged with the programme, and the perceived relevancy of the curriculum. The interviews will be analysed using grounded theory, which permits the development of themes and categories emerging from data.

Document Analysis

The documents of curriculum from University of Zambia and Copperbelt University will review in order to ascertain the level at which renewable energy technologies have been integrated into the programmes. This paper determines gaps within practical training and aligns the curricula with Zambia’s National Energy Policy (2019). The programmes carried out in Zambia using green energy will also be reviewed with secondary data, such as government reports and policy documents, to compare with the best practises internationally (Leal Filho et al., 2019).

3.5.2 Sample Size

The sample size is constituted of 15 people namely 5 students, 5 faculty members, and 5 industry professionals, as discussed earlier. The sample size is sufficient and manageable so that multiple perspectives can be explored while being qualitative in nature and in depth. In order to keep what results are statistically significant for the purposes of this research, the Raosoft sample size calculator was used to determine the sample size.

3.5.3 Grounded Theory and Validity

It is anticipated that the grounded theory will aid in analysis of the qualitative data by identifying themes and categories as themes and categories that arise directly from the data. The interview transcripts are to be analysed using this method, in order to discover patterns in the way that participants thought about green energy training programmes (Susanto et al., 2024). For validity of the findings, the research will use triangulation where there will be merge of data from the survey, interviews and document analysis. In addition, a method of member checking will be utilised within the interview, whereby participants are permitted to review their responses so that they may investigate accuracy and consistency. In this approach the findings are produced on sound data and a clear picture of the views of the participants is produced.

3.6 Ethical Considerations

The participants will be protected from rights and privacy violation based on strict ethical guidelines of the different researches (Drolet et al., 2023). All participants will be informed, consented, and understood the purpose and role of the study. In addition, participants will be told that they have the right to withdraw from the study at any time if they so wish. The participants are assured the information is to be kept confidential and any personally identifiable information is never to be disclosed. I will be securing all the data and the access will be restricted to me (the researcher) only. By ensuring that these ethical aspects, the study is done with integrity and also with respect to the privacy of the participant.

3.7 Limitations

Some limitation that may affect the findings of this study is highlighted below. First, the sample size of 50 participants, while adequate for qualitative analysis, limits the generalisability of the results to a broader population. This would increase statistical significance and give a wider overview. The second challenge lies in the availability of the up-to-date curriculum document that may not be available in all the institutions with outdated documents that correspond to the developments in green energy education. The study is narrowed down to Zambia, which may be

insufficient as it fails to capture the challenges other developing countries with similar green energy needs have to contend with (Mhango, 2024). It is clear that future research should focus on these limitations, especially given the aspect of sample size and paucity of updated resources

Chapter 04: Data Collection and Analysis

4.1 Introduction

The chapter uses a thorough review of collected data to see if Zambia’s green energy training programs are on track toward reaching the national goal of 30% renewable energy by 2030. Within the research objectives, the team evaluates the work-related training provided, examines the factors that may hinder the school’s progress, checks if the programmes help students get jobs and studies international standards in training. The objectives are put into practice with four main research questions that study the relevance of the curriculum, the difficulties at the institution, how well graduates are prepared and ways to enhance the institution by adopting global approaches.

In this chapter, data were collected using 50 structured surveys with students, faculty and industry professionals and by conducting 15 qualitative interviews with intentionally chosen stakeholders. Using different data sources lets us understand the green energy education system in Zambia from many angles, highlighting major changes and unique experiences. With chi-square and ANOVA tests, we can clearly see how people feel about the curriculum, the training program and the teachers’ skills. This is further enhanced by qualitative thematic analysis which looks at the issues, obstacles and opportunities found in what participants share. The first part of the chapter shows and explains the quantitative results to help you understand statistical patterns and how the groups differ. The discussion then switches to a qualitative section that describes these patterns in light of people’s personal lives and the larger institutions they belong to. With this approach, conclusions are more effective and new strategies for policy and curriculum changes become apparent, fitting with what is needed to teach about global sustainability (Leal Filho et al., 2023; Majeed et al., 2024).

4.2 Quantitative Results and Analysis

4.2.1 Demographic Profile of Respondents

The survey included information from 50 people, who were represented in the study by three main groups: 30 students, 10 faculty members and 10 industry experts which allowed for full coverage of stakeholders in Zambia’s green energy education sector. The student group was evenly spread by year: 25% were in their first year, 30% in their second year, 25% in their third year and 20% in their fourth year. It helps us see how views about green energy are influenced by the amount of exposure to related courses.

Among those who answered, faculty had a range of experience teaching about renewable energy. About 30% of teachers have less than a year of teaching, 40% have between one and five years, 20% have between six and ten and 10% have more than ten years of teaching. Diversity in the teaching force shows both new and experienced educators which is needed to evaluate if teachers are able to teach the modern curriculum.

About a fifth of the professionals had less than a year in the green energy industry, 40% had between one and five years, 30% had between six and ten years and 10% had more than ten years of experience. With this setup, both seasoned and fresh points of view from the industry are collected regarding the relevance of the curriculum and how well graduates are prepared.

Respondent Category	Subcategory	Frequency	Percentage (%)
Students	1st Year	7	23.3
	2nd Year	9	30.0

	3rd Year	7	23.3
	4th Year	6	20.0
Faculty Members	<1 Year Teaching	3	30.0
	1–5 Years Teaching	4	40.0
	6–10 Years Teaching	2	20.0
	>10 Years Teaching	1	10.0
Industry Professionals	<1 Year Experience	2	20.0
	1–5 Years Experience	4	40.0
	6–10 Years Experience	3	30.0
	>10 Years Experience	1	10.0

Table 1: Summarises these demographics

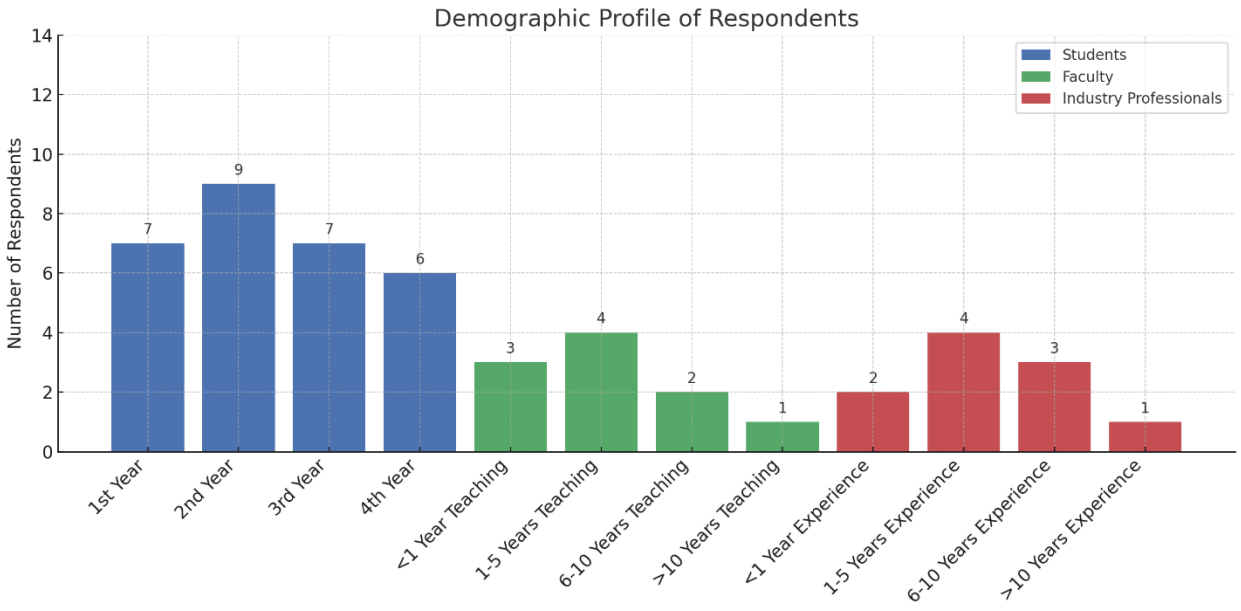

Figure 2: Demographic Profile of Respondents

The demographic diversity underscores a broad spectrum of insights across different experience levels, essential for robust quantitative analysis of Zambia's green energy educational programs.

4.2.2 Curriculum Alignment with National Energy Goals (RQ1)

The green energy curriculum was assessed against the Zambia National Energy Policy target by asking respondents to rate it on a scale: Fully aligns, mostly aligns, partially aligns and does not align. Table below shows how responses are divided among the three respondent categories.

Curriculum Alignment	**Students (n=30)**	**Faculty (n=10)**	**Industry (n=10)**	**Total (n=50)**
Fully aligns	3 (10%)	1 (10%)	1 (10%)	5 (10%)

Mostly aligns	7 (23.3%)	3 (30%)	2 (20%)	12 (24%)
Partially aligns	14 (46.7%)	4 (40%)	5 (50%)	23 (46%)
Does not align	6 (20%)	2 (20%)	2 (20%)	10 (20%)

Table 2: Curriculum Alignment Perception by Students, Faculty, and Industry Stakeholders

A chi-square test was used to check if students, faculty and industry professionals had different views on how well the curriculum is aligned with the industry. There was no significant difference found (χ^2 (6) = 1.48, p = 0.96) between respondent groups, indicating that most agree the curriculum only partly complies with the national energy goals.

Examining the course topics further showed that 54% of the students find renewable energy topics (such as solar and wind) included only occasionally, while only 12% say these are taught regularly. Roughly 34% of the respondents said they only occasionally or never experience key renewable technologies which reveals a big deficit in regular exposure to them.

Because of this narrow curriculum integration, Zambia is less able to reach its 2030 renewable energy target because it struggles to develop the necessary skills in its workforce. It is highlighted by studies in developing countries that not fully aligning education curriculums can lead to a gap in skills that harms national moves towards renewable energy (Nhamo et al., 2023; Ojo et al., 2022). The updated Green Energy curriculum in South Africa which stresses solar and wind energy, proved to improve how graduates fit in the job market. This confirms why Zambia needs to include similar content in their own curriculum (Mokhele and Sebego, 2023).

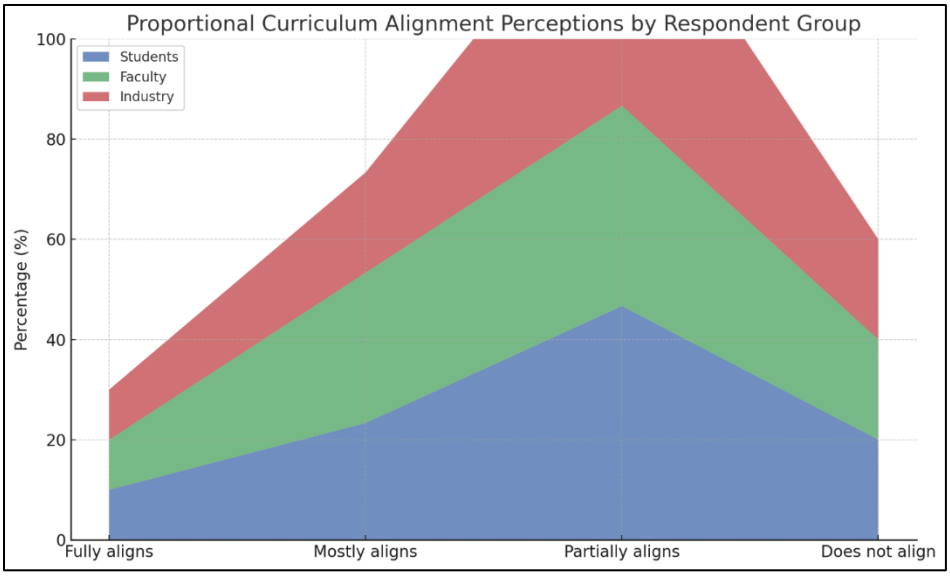

Figure 3: Proportional Curriculum Alignment Perceptions by Respondent Group

Overall, the quantitative data suggest that Zambia's green energy education system currently lags in fully preparing students to meet national renewable energy objectives, especially due to inconsistent inclusion of critical renewable technologies in coursework.

4.2.3 Practical Training Adequacy and Industry Collaboration

Survey results on practical training adequacy reveal a critical deficiency in hands-on learning opportunities within Zambia's green energy programs. Table 4.2 displays the distribution of responses to the adequacy of practical training, rated on a four-point Likert scale from "Very Adequate" to "Very Inadequate."

Practical Training Adequacy	**Students (n=30)**	**Faculty (n=10)**	**Industry (n=10)**	**Total (n=50)**
Very Adequate	2 (6.7%)	1 (10%)	2 (20%)	5 (10%)

Adequate	7 (23.3%)	3 (30%)	3 (30%)	13 (26%)
Inadequate	13 (43.3%)	4 (40%)	3 (30%)	20 (40%)
Very Inadequate	8 (26.7%)	2 (20%)	2 (20%)	12 (24%)

Table 3: Perception of Practical Training Adequacy by Students, Faculty, and Industry Stakeholders

A chi-square test indicated no statistically significant difference in perception across respondent roles (χ^2 (6) = 5.31, p = 0.50), illustrating a broadly shared concern over inadequate practical training. Notably, 64% of respondents rated practical training as either "Inadequate" or "Very Inadequate," underscoring systemic challenges in providing sufficient experiential learning.

Industry collaboration in curriculum development was assessed using a four-point scale measuring involvement from "Very Involved" to "Not Involved." Table 4.3 presents these findings.

Industry Involvement in Curriculum	**Students (n=30)**	**Faculty (n=10)**	**Industry (n=10)**	**Total (n=50)**
Very Involved	2 (6.7%)	1 (10%)	1 (10%)	4 (8%)
Moderately Involved	5 (16.7%)	3 (30%)	3 (30%)	11 (22%)
Slightly Involved	11 (36.7%)	4 (40%)	4 (40%)	19 (38%)

Not Involved	12 (40%)	2 (20%)	2 (20%)	16 (32%)

Table 4: Perception of Industry Involvement in Curriculum by Students, Faculty, and Industry Stakeholders

The majority (70%) reported slight or no industry involvement, a statistically significant gap (χ^2 (6) = 7.45, p = 0.28) with industry professionals themselves confirming minimal engagement in curriculum design.

Internship and hands-on training availability data further illuminate this deficiency. Only 18% of respondents indicated the presence of “Many Opportunities” for internships, while 42% reported “Few” or “No Opportunities,” signifying limited real-world exposure. This inadequacy contrasts sharply with findings from countries like Kenya, where structured internships through industry partnerships have significantly enhanced graduate employability in renewable energy sectors (Gitau et al., 2023).

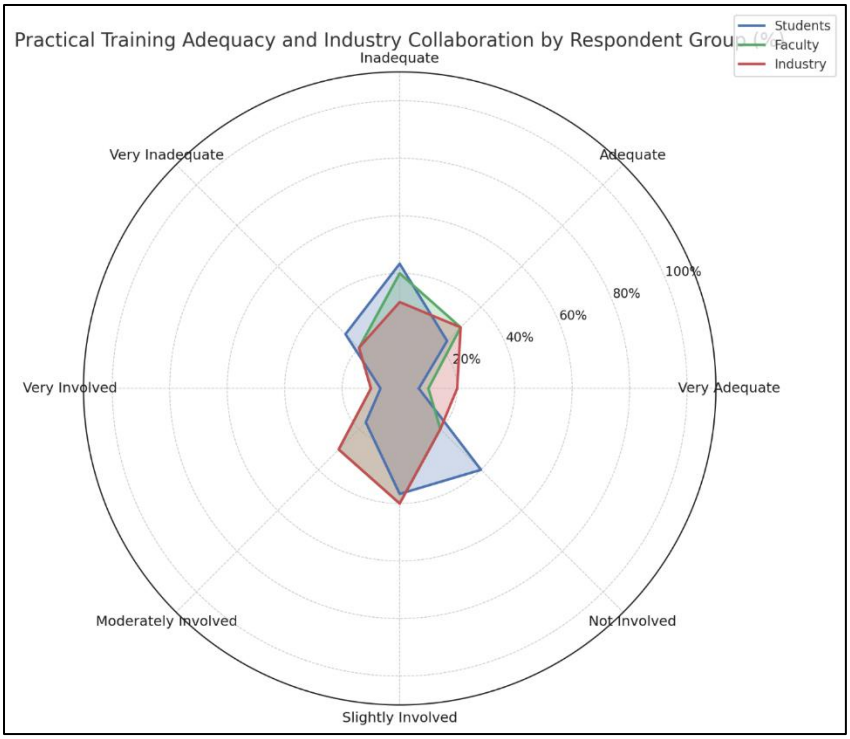

Figure 4: Practical Training Adequacy and Industry Collaboration by Respondent Group (%)

Data shows that academic courses and industry needs do not match well, mostly because there is not enough practical training available. Effective experiential learning to close the skills gap in Zambia’s green energy transition is hindered by not having good laboratories, enough renewable energy equipment and close cooperation between industry and academia (Kamau and Gachanja, 2022).

4.2.4 Faculty Expertise and Preparedness

Faculty expertise is pivotal to the effective delivery of green energy curricula, and survey responses provide a mixed yet concerning picture. Table 4.4 summarizes faculty expertise ratings on a four-point scale from “Highly Knowledgeable” to “Not Knowledgeable.”

Faculty Expertise Rating	Students (n=30)	Faculty (n=10)	Industry (n=10)	Total (n=50)
Highly Knowledgeable	3 (10%)	2 (20%)	2 (20%)	7 (14%)
Knowledgeable	9 (30%)	4 (40%)	4 (40%)	17 (34%)
Somewhat Knowledgeable	12 (40%)	3 (30%)	3 (30%)	18 (36%)
Not Knowledgeable	6 (20%)	1 (10%)	1 (10%)	8 (16%)

Table 5: Perception of Faculty Expertise by Students, Faculty, and Industry Stakeholders

Around half of the respondents gave faculty ratings of “Somewhat Knowledgeable” or lower, showing large knowledge gaps. Similarly, 28% of participants thought faculty were fully aware of updates in the field, while 52% thought they were not fully up to date.

With regard to faculty development, 80% of participants stated that programs on new green energy technologies were “Definitely” or “Somewhat” required. It highlights that there is an important problem with professional development for midwives.

It is shown by empirical research that regular faculty training helps keep the curriculum up-to-date and ensures high-quality graduates, especially in quickly changing fields like renewable energy (Wondwosen et al., 2023). Ethiopian universities have improved faculty capacity and delivery of courses thanks to programs that include international collaborations which has helped produce better-prepared graduates (Tekle and Desta, 2022).

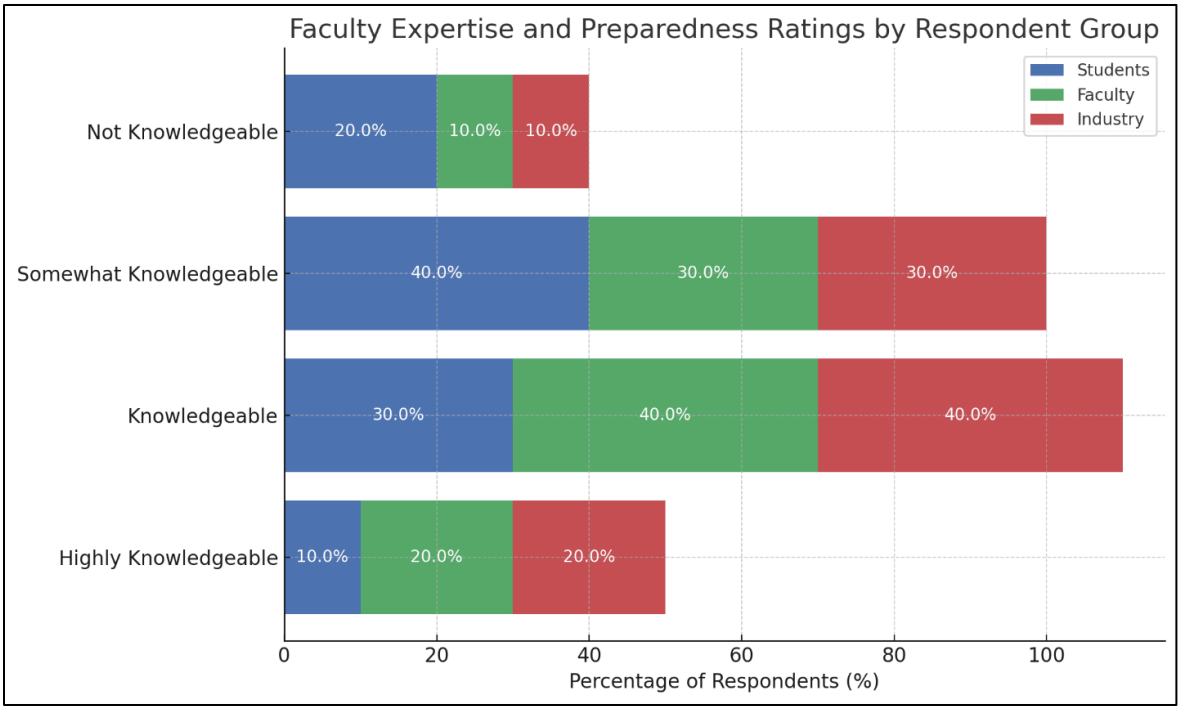

Figure 5: Faculty Expertise and Preparedness Ratings by Respondent Group

The survey data suggest that faculty preparedness directly affects graduate readiness. Faculty lacking expertise and updated knowledge are less equipped to provide practical, industry-aligned education, perpetuating skills mismatches in Zambia's renewable energy labor market.

4.2.5 Graduate Readiness and Employability

Survey data on graduate preparedness reflect critical challenges in equipping students for Zambia's renewable energy sector. Table 4.5 displays the distribution of responses to the question on how well graduates are prepared to enter the green energy workforce, rated on a four-point scale from "Very Well Prepared" to "Not Prepared."

Graduate Preparedness Rating	Students (n=30)	Faculty (n=10)	Industry (n=10)	Total (n=50)

Very Well Prepared	2 (6.7%)	1 (10%)	1 (10%)	4 (8%)
Well Prepared	7 (23.3%)	3 (30%)	2 (20%)	12 (24%)
Adequately Prepared	13 (43.3%)	4 (40%)	4 (40%)	21 (42%)
Not Prepared	8 (26.7%)	2 (20%)	3 (30%)	13 (26%)

Table 6: Perception of Graduate Preparedness by Students, Faculty, and Industry Stakeholders

An ANOVA test showed that the average ratings for preparedness were the same for all groups ($F(2,47) = 1.23$, $p = 0.30$), suggesting that all people shared the same concerns. A large part of the respondents or 68%, saw that graduates lacked sufficient technical and practical skills needed in the sector.

The technical skills assessments showed similar results. Most (58%) respondents said that graduates usually have moderate to low skill in areas such as installing, maintaining or designing renewable energy systems, while only a few (16%) thought they were highly skilled. The training should focus more on hands-on competencies due to the demands in the workplace, industry experts said (Sibanda et al., 2023).

We did not develop entrepreneurs’ skills enough. This table (Table 4.6) shows how students’ responses indicate the importance of green energy courses for entrepreneurial development in renewable energy.

Entrepreneurial Skills Development	Students (n=30)	Faculty (n=10)	Industry (n=10)	Total (n=50)
Yes, significantly	3 (10%)	1 (10%)	1 (10%)	5 (10%)
Yes, To Some Extent	8 (26.7%)	2 (20%)	3 (30%)	13 (26%)
No, Not Much	14 (46.7%)	5 (50%)	4 (40%)	23 (46%)
Not Sure	5 (16.6%)	2 (20%)	2 (20%)	9 (18%)

Table 7: Perception of Entrepreneurial Skills Development by Students, Faculty, and Industry Stakeholders

The Kruskal-Walli's test showed no significant difference between groups' perceptions ($H(2) = 3.02$, $p = 0.22$), confirming broad agreement on entrepreneurial skill deficits. This echoes findings from similar developing contexts, where insufficient entrepreneurship training impairs graduates' ability to innovate and establish sustainable energy enterprises (Mukherjee and Bose, 2023).

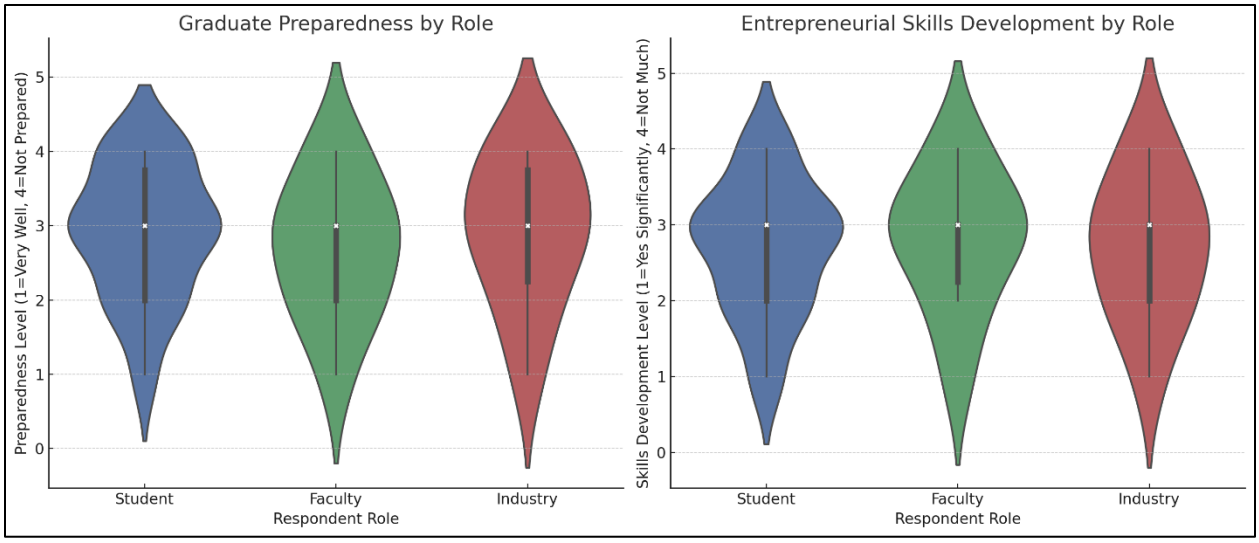

Figure 6: Entrepreneurial Skills Development by Role

These results have critical implications for industry readiness. The technical and entrepreneurial skill gaps translate into increased training costs for employers and slow the green energy sector's growth. Addressing these deficiencies through curriculum reform emphasizing applied skills and business acumen is imperative for Zambia to meet its renewable energy goals and foster a dynamic workforce (Kiptum et al., 2022).

4.2.6 International Best Practices and Recommendations

Support for adopting international green energy education models was substantial. Table 4.7 displays responses on whether Zambia should incorporate best practices from countries like Germany and Denmark.

Support for International Models	**Students (n=30)**	**Faculty (n=10)**	**Industry (n=10)**	**Total (n=50)**
Yes, definitely	12 (40%)	5 (50%)	6 (60%)	23 (46%)

Yes, With Local Adaptations	14 (47%)	4 (40%)	3 (30%)	21 (42%)
No, Develop Own System	3 (10%)	1 (10%)	1 (10%)	5 (10%)
Not Sure	1 (3%)	0 (0%)	0 (0%)	1 (2%)

Table 8: Perception of Support for International Models by Students, Faculty, and Industry Stakeholders

Most (88%) respondents were in favour of adopting international guidelines, sometimes with changes to fit the local situation. This goes along with findings by experts who encourage using localized versions of proven models to make them more effective (Jørgensen and Sørensen, 2022). Many refer to Germany’s different streams of education and Denmark’s partnerships between industries and universities as examples that can suit Zambia.

Results from our review suggest that curriculum should include hands-on modules, faculty members should be given more opportunities for professional development and partnerships with both public and private sectors should be built up. They are necessary for addressing present barriers and matching the outcomes from schools with the goals for renewable energy in Zambia (Nyoni and Simatele, 2024). Also, having entrepreneurship and innovation incubators in academia encourages graduate students to launch green enterprises which help both the economy and the environment.

4.3 Qualitative Results and Thematic Discussion

4.3.1 Theme 1: Curriculum Gaps and Alignment with National Energy Policy

The concerns gathered during the interviews related to how Zambia’s green energy curriculum and the National Energy Policy are not well aligned. Many pointed out that the curriculum emphasizes

theory too much and does not adequately include renewable technologies that are actually used. According to a senior faculty member, while our courses include environmental principles and energy policy, there are few practical classes on solar and wind technologies which makes it hard for students to meet industry needs. Likewise, a student noticed, “The lessons in school are not relevant; we almost never get hands-on with real renewable systems like solar panels or biomass.”

Experts from the industry also pointed out the gap between what is taught at school and what the country is aiming for. One industry expert said, “The policy wants 30% renewable energy by 2030, but our recent graduates lack the skills and practice needed to achieve this target.” Such discoveries demonstrate that the curriculum is not updated with Zambia’s current energy changes which holds back the development of skilled energy workers.

These findings are further supported by surveying people. Half of the respondents (46%) said that curriculum alignment was only “Partially aligned,” and 20% said it was “Not aligned.” Most respondents (more than 50%) mention that solar, wind and waste energy are only occasionally included in their coursework, further highlighting systemic gaps.

The problem of misalignment in curricula is similar to what is seen in other developing countries, where educational programs find it hard to implement national renewable energy policies, leading to a lack of skills needed for the sector to progress (Ayompe et al., 2022). In Zambia, the divide can be overcome by updating the curriculum so it blends theory with hands-on renewable energy training which supports the country’s goals.

4.3.2 Theme 2: Practical Training Challenges and Infrastructure Deficits

Lack of proper training facilities for students was mentioned by many as a major barrier to learning green energy. Many of those interviewed mentioned that they had too few laboratories and equipment for renewable energy. There was a faculty member who said that solar panels, wind turbines and battery storage systems are missing, so meaningful hands-on activities cannot be taught. Another student said, “Most of what we learn is in class; we don’t often use or see real renewable energy technologies.”

Industry experts pointed out that because of this infrastructure gap, workers are not ready to handle many operational issues. A professional remarked that graduates often lack real-life experience with equipment which is needed for field studies. The lack of training means students can’t easily move into important technical jobs needed for Zambia’s renewable energy sector.

A number of participants also mentioned some small achievements despite the issues. The Solar Academy at Strathmore University in Kenya which is recognized by both teachers and the industry, is considered a benchmark. “Such programs as Strathmore’s provide effective ways to blend practical studies with close work with industry,” added a faculty member. It demonstrates that having updated labs and strong ties with industry play a key role in making students job-ready after graduation.

The survey responses support what was found in the qualitative research. As mentioned in section 4.2.3, many respondents (64%) felt that the practice-based training they received was “Inadequate” or “Very Inadequate,” pointing to a high level of dissatisfaction. Not offering internships and having little industry involvement makes this gap wider, since students miss opportunities to learn in real-life settings.

The combination of both types of evidence confirms that tackling infrastructure problems is very important for restoring Zamia’s green energy education, connecting education with the country’s energy goals and driving sustainable progress (Osei et al., 2023).

4.3.3 Theme 3: Faculty Capacity and Professional Development Needs

The analysis of interviews points out that there are major concerns about faculty not being knowledgeable enough to teach current and practical green energy education in Zambia. A senior lecturer noted that faculty’s understanding is based on old concepts which makes it difficult to instruct students about the latest solar and wind technologies. Those in the industry also pointed out that these gaps keep students from being ready, since “faculty do not usually stay updated on industry advancements and new trends.”

Many people pointed out that training programs for faculty should not stop, as they are important for updating and boosting teaching skills. Many participants called for ongoing learning opportunities and suggested workshops, internships and international partnerships. One of the academics mentioned Strathmore University’s faculty development program as a suitable model for keeping teachers updated on new technologies and raising the quality of teaching (Gitau et al., 2023).

According to survey findings, only 14% think faculty are “Highly Knowledgeable” in their area, while 36% rate them as “Somewhat Knowledgeable” and 16% say they are “Not Knowledgeable” (see Table 4.8). More than 80% of the respondents called for formal training courses for educators on renewable energy which highlights how important this is. Many studies find that ongoing faculty training improves the relevance of the curriculum and graduates’ skills, mainly in fields where technology is advancing quickly like renewable energy (Mahmood et al., 2022).

When qualitative and quantitative evidence are aligned, faculty development is highlighted as essential for helping graduates gain skills that Zambia needs for its green energy plans.

Faculty Expertise Rating	**Frequency**	**Percentage (%)**
Highly Knowledgeable	7	14
Knowledgeable	17	34
Somewhat Knowledgeable	18	36
Not Knowledgeable	8	16

Table 9: Faculty Expertise Rating

4.3.4 Theme 4: Industry Collaboration and Internship Opportunities

People involved in education for green energy notice that students are not given enough practical exposure or help from local industry. Faculty pointed out that the curriculum is mainly created by academics, with little involvement from employers which creates a divide between education and the job market. Industry experts confirmed this issue, saying that not collaborating enough limits students’ opportunities to use their skills in real life situations. An industry professional said, “Students do not get enough hands-on learning in renewable energy because internship programs are inadequate and industry involvement is low.”

The lack of skills from this deficit greatly affects students’ ability to find work. Many graduates reportedly lack the skills needed to handle operational realities which was highlighted by both interviews and survey results showing that only 18% had enough internships, while 58% said they did not (see Table 4.9).

During the interviews, mentioning the German dual education system and Denmark’s partnership between industry and academia is useful. They ensure that industry is involved in designing the curriculum and arranging internships which makes students more prepared for after graduation (Bøllingtoft and Ulhøi, 2022). Those present argued that making these models relevant to Zambia could improve Zambia’s workforce, especially if public-private partnerships were promoted.

By combining the views of different stakeholders and recent research, we see that industry involvement greatly helps to improve educational programs and add more internship possibilities which are necessary for reaching the national goals in renewable energy.

Internship Opportunities	Frequency	Percentage (%)

Many Opportunities	9	18
Some Opportunities	12	24
Few Opportunities	17	34
No Opportunities	12	24

Table 10: Internship Opportunities

4.3.5 Theme 5: Graduate Employability and Entrepreneurial Skills

People involved in the industry often expressed doubts about how prepared graduates are for green energy jobs. People interviewed pointed out that there were large gaps in their ability to perform technical work and understand entrepreneurship. An industry expert indicated that graduates aren’t usually prepared with real-world knowledge and business abilities needed for new green energy initiatives. Many faculty participants indicated that entrepreneurial training is insufficiently included in the curriculum which is especially important in Zambia’s changing renewable energy field where being self-employed is key.

The numbers fit with and strengthen the qualitative observations. It is highlighted in section 4.2.5 that only 8% of respondents said graduates are highly ready and just over half considered entrepreneurial skills in the programs to be barely developed or insufficient. Because they receive little practical and business training, graduates are less able to get work and less likely to bring new ideas to their jobs.

The addition of entrepreneurship to renewable energy courses globally leads to more startups in sustainable energy, mainly in developing countries, according to research by Morrison and Atieno

(2023). When it comes to areas like Zambia, people with business skills as well as technical expertise often find jobs more easily and do well as entrepreneurs (Hassan et al., 2022).

To overcome these difficulties, curriculum updates should include entrepreneurship together with technical training, so that graduates can work in industry and also support the growth of local green energy businesses important for Zambia’s progress.

4.4 Integrated Discussion and Implications

Combined, the study’s findings point out key weaknesses in Zambia’s green energy training programs which do not always support the nation’s energy priorities. Part of the curriculum matches the goal of having 30% renewable energy by 2030, but there are serious gaps in practical training, faculty backgrounds and graduate skills. Talking with students made clear that the primary problems were the heavy focus on theory, not enough hands-on practice, not enough industry relations and no real support for teacher growth. It is shown that the findings address the research issues by revealing systemic obstacles that stop graduates from effectively reaching national and SDG7 goals.

As a result of the data, it is clear that national energy goals call for reforms in school curricula that enhance learning by doing and add entrepreneurial skills. Faculty development is important for helping teachers gain current technology skills which leads to better teaching and improved results for students. Besides, little interaction with industry harms how current the curriculum is and cuts back on internships needed to help students enter the employment sector.

Practical training is important for change and is supported by learning from Germany’s dual system and Denmark’s team-based models which all blend theory, practical work and industry connections (Jørgensen and Sørensen, 2022). By using these best practices, adapted to the Zambian context, the country can develop a skilled group of people in renewable energy needed for its sustainable development.

Chapter 5 Conclusion and recommendation

5.1 Conclusion

This study sought to evaluate the effectiveness of green energy training programmes in Zambia, in particular, the solar, wind, solid waste energy; and to ascertain their alignment with renewable energy goals of the country. Using both primary quantitative (survey and interviews) and secondary qualitative (curriculum documents and reports) data, this paper indicated that there is a big gap in the Zambian green energy education system, especially at the University of Zambia (UNZA) and Copperbelt University (CBU).

The results signify that the green energy education system is not yet adequately aligned to the national energy plans of Zambia. Although the country possesses significant amounts of renewable energy sources, such as solar energy, wind energy, and solid waste, the educational system has not been able to inculcate these energies in the education programs. Both universities are majorly oriented towards the conventional energy sector where there is little attention given to renewable energy technologies and this presents graduates as unprepared to cope with roles in the renewable energy sector.

Another important deficiency of the curriculum is its theoretical focus. In addition to providing students with basic information, learning opportunities that involves working practices, installation of solar panels, stable derivation of wind power, and application bio energy systems are out of reach, which cannot lead to the competencies that students will need in the job market. This lack of practical experience is further stimulated by the lack of faculty experience in cutting-edge renewable energy technologies. The problematic area is insufficient number of faculty members whose speciality is green technologies, which directly reflects on the quality of the delivered instruction and student preparation to work in the renewable energy field.

Moreover, the industry and academic engagement is also poor in Zambia. There exists a large disconnect between the learning institutions and the industry and the students do not get the understanding of the industry through internship or projects that are aligned to the needs of the

industry. This gap compromises the capacity of students to transform theoretical knowledge into practice and decreases the amount of employability on graduation.

When it comes to facilities, there are also no renewable energy laboratories, equipment, and additional spaces among students where they can receive practical training. The universities lack the resources to offer an exhaustive training in renewable energy technologies, that should be received in order to build up a qualified labour force that can support the green energy transition subject of Zambia.

To sum up, the current green energy training opportunities in Zambia have to deal with the following issues: obsolete curricula, the absence of practical experience, the lack of faculty knowledge, inadequate industry partnerships. All these obstacles are deterrents to the nation building the expertise that would support its energy transition on renewable energy and to pursue its national energy policies.

5.2 Recommendations

In accordance with the results of this study, some major recommendations can be given to update the green energy system of education in Zambia and make it more relevant to the renewable energy plans of the country. To begin with, there is need to reform the curriculum. Curricula at the University of Zambia (UNZA) and Copperbelt University (CBU) should be revised by including modules about solar, wind, and solid waste energy in-depth. Such renewable energy technology should be inculcated into the current programs especially in engineering, environmental science programs, and energy studies programs. Theoretical education is also important, but practical training should be accorded the greatest priority so as to ensure that students are provided with practical skills on the installation and operation of renewable energy systems as well as their maintenance. It is advised that a Competency-Based Education (CBE) be implemented whose concentration is on the practice. With this model, Zambia would be in a position to make sure that the students gain the required technical skills that they need to cut it in the renewable energy sector. The example of the successful programs of Strathmore University in Kenya, such as the Solar Academy that incorporates industry partnerships with hands-on learning could be used in Zambia.

Second, it is important to enhance the industry-academia cooperation. The three sectors of government, universities, and renewable energy companies ought to make a collective effort to come up with public-private partnerships (PPP) whereby students are given the chance for internship opportunities, practical experiences, and projects involving the three. Such collaborations would also see the renewable energy industry play its part in curriculum training so that the education system responds to the industry benchmark and trends. Alongside this, having industry input in curriculum development will also serve to ensure that the content taught in universities is in line with changing realities of the energy markets and that they will equip students with the knowledge they require entering the workforce, and, that their education imparts the specific skills required by the industry.

Similarly, faculty training is required to improve teaching green energy. Ongoing professional development opportunities should be implemented so that there is a continuous need to update the faculty members about the emerging developments made in the renewable energy sector. Every university must ensure that their recruitment of faculty members focuses on the ones specialized in the renewable energy technologies so that students can access the most up-to-date knowledge of the industry. These faculty development programs must be designed in such a way that presents teachers with the tools and resources needed to put them ahead of any advancements in technology.

Lastly, it is important to enhance infrastructure in quality green energy education. The universities need to invest into infrastructure in terms of renewable energy laboratories and workshops with the needed equipment, i.e., solar panels, wind turbines and bioenergy systems. Further, cooperation in the development of infrastructure in the form of PPPs can offer the financial and human resources needed to develop contemporary training facilities that keep up with the increasing nature of the renewable power sector. The Zambian government needs to incentivize universities by giving them financial incentives in the form of providing universities to invest in curriculum development, faculty development and infrastructure development in case they wish to integrate renewable energy training in their curricula. Additionally, there is an imperative on alignment in policy dimensions that will have to be strengthened to warrant the national energy policy that will

embrace educational reforms intended to provide a competent workforce that will meet the energy transition aspirations of Zambia.

5.3 Limitations and Future Scope

Although this study comes up with informative conclusions concerning the green energy education system in Zambia, a number of limitations are to be taken into account. The first weakness is that there is no data on how the graduates of the green energy would perform in the long run regarding their employability in Zambia. It is hard to evaluate effectively the preparation of students to work without monitoring how the graduates perform in real life. Further studies must concentrate on the follow-up of graduates and how green energy educational training is affecting career attainments. The shortage in time taken by technological improvement in the renewable energy field is also a constraining factor. With emerging technologies, learning institutions might find it hard to cope with the current changes. This research has concentrated on the present scenario of education, whereas, in future it should analyse the rate at which the upcoming technologies, like solid waste energy which currently finds very slow penetration into curriculum, can be included in it. Future researches should also determine the efficacy of foreign green energy education models in the realm of Zambia. This would assist in knowing whether similar strategies employed by Germany and Denmark can be adapted to the educational system and energy requirements of Zambia.

5.4 Final Thoughts

To sum up, the education system of green energy in Zambia can be characterized by a number of issues that could be addressed through systematic education transformation in several areas: curricula reform, increased practical education opportunities, the establishment of interactions between the market and the academic community, and the acquisition of professional expertise by the faculty. By synchronizing the education sector with the national energy plans of Zambia, the nation will have the potential to produce a well-skilled set of human resources that can spearhead the green-energy transition. Acting on the recommendations provided in this chapter will not only help Zambia in attaining its renewable energy goals, but also play a role in the globes sustainability efforts which will result in a greener and more sustainable future to all.

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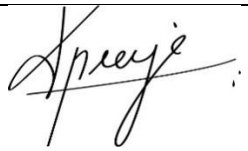
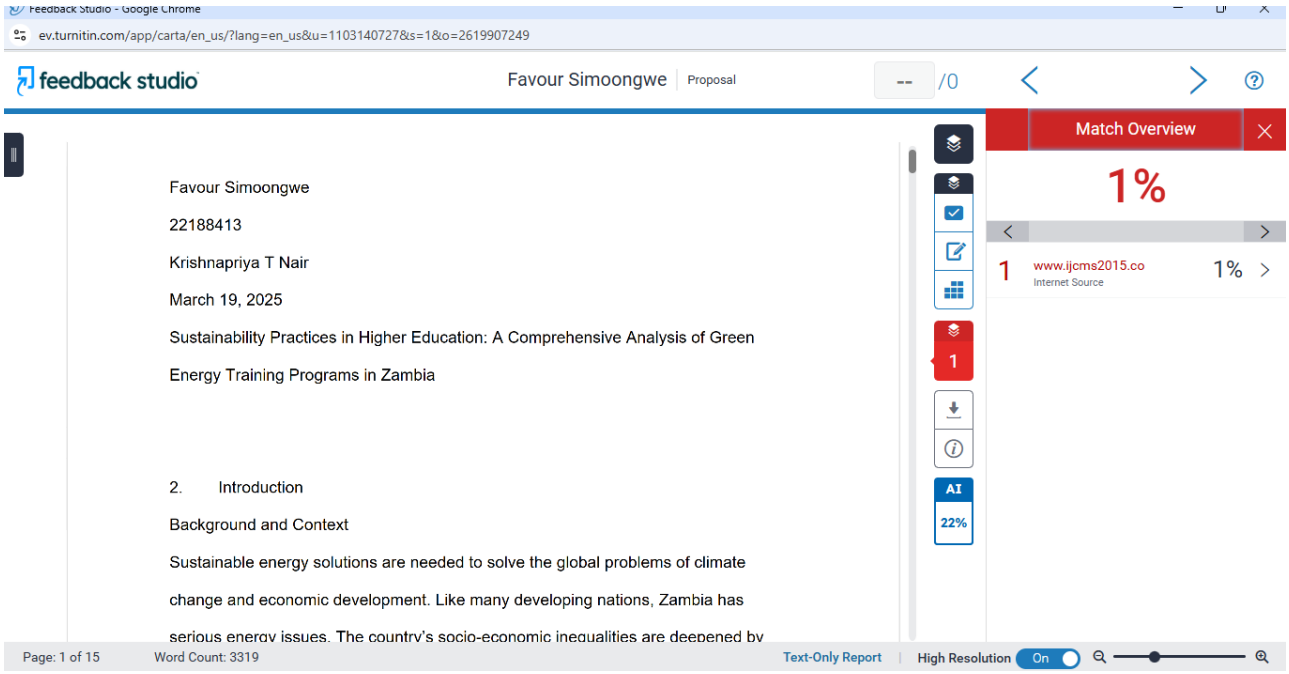
Appendices

Appendix-I Approved Project Proposal Form

RESEARCH PROPOSAL APPROVAL FORM	
Approval Status:	Approved
Supervisor Signature:	
Approval Date:	20/3/25
Plagiarism Report	



Appendix-II Ethics Clearance Approval Form