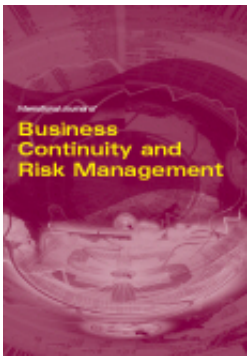

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A brief literature review of renewable energy policies in Zimbabwe

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Abstract: This article provides a comprehensive review of renewable energy policies in Zimbabwe by examining ten papers that specifically discuss this topic. The findings of this review emphasise the importance of an enabling environment to support the growth of renewable energy in Zimbabwe's energy mix. Several policy instruments are identified as a key to creating such an environment, but poor administrative and coordination arrangements, limited technical capacity, and insufficient funding hinder their full implementation. Beyond policy instruments, the review highlights the critical role of prevailing administrative and political systems, market conditions, the economic situation, and the business environment in shaping the success of renewable energy deployment in Zimbabwe. Given these challenges, a more comprehensive and integrated approach considering various factors is necessary to support successful renewable energy development in Zimbabwe.

Keywords: climate change; energy access; energy transition; electrification; renewable energy; policy; Zimbabwe.

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Biographical notes: Jeremiah Mushosho holds a PhD from the University of Zambia, where his research primarily focused on renewable energy policies and finance. His intellectual curiosity is captured in his scholarly work that critically examines these policies' efficacy and practical implementation and the development of innovative renewable energy financing models. Not only does he possess a deep understanding of the technical aspects of renewable

energy, but he also carries a profound knowledge of the financing challenges of the energy sector and the socio-economic impacts it can create. His contributions are of profound value to the green energy sector.

Abubaker Qutieshat is a renowned academic and research leader, holds dual positions at the University of Dundee and Oman Dental College. As an Associate Staff Member and Honorary Researcher in Dundee, his insightful perspectives enrich the academic community. Simultaneously, his role as the Research Head at Oman Dental College signifies his robust leadership and dedication to medical academia. A key area of his research is health economics, with a special emphasis on green health, highlighting his commitment to sustainable and economical healthcare solutions.

1 Introduction

Against climate change concerns, renewable energy deployment has become a critical global energy policy goal, which has seen many countries, adopt policy instruments to support renewable energy deployment (Lee and Seo, 2019). Renewable energy presents the most significant opportunity to accelerate climate change mitigation and the elimination of energy poverty at the same time. As a result, there is a rapid increase in the importance of deploying renewable energy technologies (RETs) globally (IRENA, 2019). Over the years, renewable energy development and deployment have significantly increased (Carley et al., 2017; Hille et al., 2020; Yang and Yang, 2017). While this is so, renewable energy deployment needs markets ready to welcome the full range of RETs (IRENA, 2018). The energy markets cannot naturally support new energy technologies without policy intervention (Fouquet, 2012). In addition, different barriers can slow down the development, deployment, and utilisation of renewable energy, including harmful subsidies on fossil fuels and nuclear power (Kaygusuz, 2012). To correct this market failure, there is a need for a sustainable and consistent policy framework to promote the development and deployment of RETs (Fouquet, 2012). Therefore, policies are critical to implementing the transition to renewable energy effectively. The rise of economic and environmental challenges associated with the burning of fuels and the fact that the related market forces cannot drive the needed transition to cleaner energy sources by themselves have led many governments to put in place renewable energy policy instruments (Pitelis et al., 2020; Thapar et al.,2016).

Policy instruments are techniques put in place by government authorities exercising their power to effect social change (Park, 2015). Some scholars believe that the development and implementation of renewable energy policies are considered effective strategies for mitigating the emission of greenhouse gases while promoting the development and deployment of RETs for energy security (Pitelis, 2018; Yaqoot, 2016). However, if government policies are poorly designed and not implemented effectively, they may create more problems than they solve, leading to a weaker case for renewable energy policy (Pitelis, 2018). Putting in place a renewable energy policy that could be effective calls for an adequate understanding of factors that have a bearing on the development and consumption of energy, including economic, social, and other factors at the local level (Nyiwul, 2016). While renewable energy policy instruments are designed to support renewable energy deployment, their effectiveness in increasing renewable

electricity generation capacity remains to be determined (Kilinc-Ata, 2016). Policies' effectiveness depends on the policy instrument type and the local market conditions. While taking into consideration the above arguments, many scholars argue that there is a need for public policies to correct the associated market failures that may hamper renewable energy development, deployment, adoption, and subsequent utilisation. One may argue that approaches with excellent potential for further investment in renewable energy development and deployment should introduce competitive practices in the electricity market, which may encourage more independent power producers (IPPs) to venture into generating energy (von der Fehr and Ropenus, 2017). On the other hand, we should warn that, depending on the local context, policies to promote investment in renewable energy may promote practices that discourage competition in the electricity market (Kayo, 2002).

This review contributes to the current literature by:

- Identifying the key policy instruments employed in Zimbabwe to support renewable energy deployment and discussing their effectiveness in increasing renewable electricity generation capacity.
- Highlighting the challenges and barriers hindering the full implementation of these policy instruments, such as poor administrative and coordination arrangements, limited technical capacity, and insufficient funding.
- Examining the broader factors that shape the success of renewable energy deployment in Zimbabwe, including the prevailing administrative and political systems, market conditions, economic situation, and the business environment.
- Offering recommendations for a more comprehensive and integrated approach that considers various factors to support successful renewable energy development in Zimbabwe.

By focusing on the specific context of Zimbabwe, this review aims to shed light on the complex interplay of factors that influence renewable energy policies' effectiveness and provide valuable insights for policymakers, researchers, and practitioners interested in promoting renewable energy in developing countries.

2 Methodology

This research aims to provide a thorough understanding of renewable energy development, policies, and challenges in Zimbabwe. To accomplish this goal, we used a systematic literature review methodology that included the following steps:

Scopus and Google Scholar were used to conduct a literature search. [TITLE ('Renewable Energy' Zimbabwe)], and [intitle: 'Renewable Energy' AND intitle: 'Zimbabwe'], respectively. was used as the search string for article extraction, along with the term 'policy' combined with the OR operator to broaden the search results and capture a broader range of studies related to renewable energy policies in Zimbabwe. The search was restricted to articles written in English.

Both search engines returned a total of 44 articles during the initial search. We began by removing duplicates before moving on to a two-step screening process. We began by reviewing the titles and abstracts of the remaining articles to determine which were

relevant to our research objectives. The selected articles ($N = 10$) were then subjected to a full-text review to ensure that they met our inclusion criteria, which were as follows:

- Zimbabwean renewable energy development, policies, or challenges.
- Studies that provide empirical or theoretical insights into renewable energy transitions, financing, or policy instruments in the Zimbabwean context.
- Peer-reviewed journals, books, and conference proceedings.

After finalising the article selection, we extracted relevant information such as the study's objectives, methodology, main findings, and recommendations. The extracted data was then synthesised to identify common themes, trends, and gaps in the existing literature on renewable energy development and policy in Zimbabwe. This synthesis guided our analysis, allowing us to provide a comprehensive overview of Zimbabwe's current state of renewable energy research and highlight potential future research directions.

We identified research gaps and areas that require further investigation while synthesising the literature. These gaps and potential research directions were identified due to the limitations and challenges discussed in the selected articles and our review of the existing body of knowledge. We hope that by identifying these research gaps, we can contribute to a better understanding of Zimbabwe's renewable energy landscape and provide guidance for future research efforts in this field.

2.1 The rationale for the review and analysis

According to Sustainable Energy for All (SE4ALL), access to clean and affordable energy remains a critical challenge for millions of people worldwide, with approximately 800 million people lacking access to electricity. Around 600 million people in Sub-Saharan Africa still lack access to electricity, accounting for 80% of the global figure. Zimbabwe has 41% energy access, leaving an estimated 6 million people without access to clean and affordable energy, with rural electrification at 20%, resulting in significant urban-rural disparities. A comprehensive set of policies promoting clean energy access is required to address this challenge.

While several countries have implemented policies to promote renewable energy development and deployment globally, most analyses have been conducted in the global north, with little research conducted in Africa, as Ge and Zhi (2016) point out. As a result, more knowledge and understanding of renewable energy policies are required in Africa and developing countries such as Zimbabwe.

This article reviews and analyses ten scholarly articles on renewable energy policies in Zimbabwe. The study's goal is to identify policy contributions and gaps and make recommendations for closing the knowledge gap. Given the growing scholarship in renewable energy policy, the findings of this study contribute to a new body of knowledge and practise in renewable energy policy, which has educational significance for academia. The study's findings will be helpful to other researchers interested in understanding Zimbabwe's renewable energy policy landscape and stimulate political and scholarly debates on Africa's energy transition. Furthermore, as Qazi et al. (2017) highlighted, this review can help promote renewable energy within the development agenda and encourage public opinion and political engagement, enabling a policy shift in favour of renewable energy.

3 Results

The following studies were included in the review:

Table 1 Studies included in the review of renewable energy policies in Zimbabwe, sorted by year of publication

Author(s)	*Year*	*Title*	*Scholarly source*
Mbohwa, C. and Siso, B.	2009	The role of renewable energy in the electricity industry in Zimbabwe	Advanced Materials Research
Makonese, T.	2016	Renewable energy in Zimbabwe	2016 International Conference on the Domestic Use of Energy (DUE)
Murombo, T.	2019	Climate change in Zimbabwe: towards a low carbon energy industry	Forthcoming in climate change law in Zimbabwe: concepts and insights (Konrad Adenauer Foundation)
Al-Ghussain, L., Samu, R., Taylan, O. and Fahrioglu, M.	2020	Techno-economic comparative analysis of renewable energy systems: a case study in Zimbabwe	Inventions
Maramura, T.C. et al.	2020	Renewable energy access challenge at the household level for people experiencing poverty in rural Zimbabwe: Is biogas energy a remedy?	International Journal of Energy Economics and Policy
Müller, F., Claar, S., Neumann, M. and Elsner, C.	2020	Is green a Pan-African colour? Mapping African renewable energy policies and transitions in 34 countries	Energy Research and Social Science
Dzvimbo, M. and Zhanda, K.	2020	Policy-making prospects and challenges of the climate change and the urban energy sector in Zimbabwe	Journal of Urban Systems and Innovations for Resilience in Zimbabwe-JUSIRZ
Carley, S., Baldwin, E., MacLean, L.M. and Brass, J.N.	2017	Global expansion of renewable energy generation: an analysis of policy instruments	Environmental and Resource Economics
Makoni, E.	2021	Renewable energy development 'an analysis of investment models' case of Zimbabwe	Master's thesis, PAUWES
Shafiullah, G.M., Masola, T., Samu, R., Elavarasan, R.M., Begum, S., Subramaniam, U. and Arif, M.T.	2021	Prospects of hybrid renewable energy-based power system: a case study, post analysis of Chipendeke Micro-Hydro, Zimbabwe	IEEE Access

3.1 Global expansion of renewable energy generation: an analysis of policy instruments

The paper by Carley et al. (2017) analysed the various policy instruments used to promote the global expansion of renewable energy generation. The study conducted by Carley et al. examined various policy instruments used to promote renewable energy generation across different countries and regions, including Zimbabwe. The authors conducted a comparative analysis of policy instruments across different countries and regions, including feed-in tariffs (FIT), renewable portfolio standards, tax incentives, and other market-based mechanisms. The study found that the effectiveness of policy instruments varied depending on the country or region in question and the specific context of the renewable energy market. The study highlights the importance of developing tailored policy instruments to support the growth of renewable energy generation. This can help accelerate the transition towards a more sustainable energy system. Some key factors influencing policy instruments' success included political will, stakeholder engagement, and institutional capacity. Overall, the study highlights the importance of developing effective policy instruments to support the growth of renewable energy generation. Policymakers can help accelerate the transition toward a more sustainable energy system by designing and implementing policies tailored to specific contexts.

The study had two dependent variables: the percentage of total electricity from renewable energy and the annual increase in each country's total renewable energy generation (Carley et al., 2017). The study focused on FIT, renewable energy portfolio standards, and policy instruments used for different purposes. While the prominent role of these two policy instruments was established, the study reveals a difference between factors that drive annual increases in renewable energy and those that cause the overall transition toward greater reliance on renewable energy. The authors believe that, for countries that have set renewable energy targets, FIT and renewable energy portfolio standards can be used to predict renewable energy market growth in a particular country. Their findings suggest that the general increase in renewable energy does not necessarily reduce the reliance on fossil fuel energy sources. They also argue that increasing renewable energy does not help countries transition to a clean or low-carbon economy. The analysis method used in the study is comparable to other methods or models as it excludes hydroelectric generation in the construct of renewable energy (Carley et al., 2017). However, the analysis method had a limitation concerning the degree of endogeneity of FIT, which the authors could not conclude.

The findings suggest that Zimbabwe's renewable energy market development may not be directly associated with any of the identified renewable energy policies. The findings of Carley et al. are consistent with the Zimbabwe situation, where several policies have been implemented. However, if placed on a time scale, there is no evidence of a noticeable increase in the share of renewable energy (total electricity from renewable energy) or an annual increase in the entire renewable energy generation in the country corresponding to the introduction of the FIT in 2016.

This analysis does not include large hydropower as renewable energy due to its potential significant adverse environmental impacts. Zimbabwe has exhibited sustained but slow renewable energy market growth from 2011 to 2019. The graph above shows that the renewable energy market development may not be directly associated with any identified renewable energy policies. Firstly, from 2011 to 2015, Zimbabwe still had

some growth in the share of renewable energy in the mix, even though the country had not introduced any specific policy on renewable energy. In 2016, there was a slight increase in the renewable energy market's growth rate. The FIT was developed but launched in a different year. The FIT is being used as a pilot and is yet to be fully implemented; therefore, it may only partially be attributed to increased renewable energy development. The observation by Carley et al. (2017) that studies on renewable energy policies and instruments suggest that policy instruments are often associated with renewable energy growth. However, sometimes the evidence needs to be more balanced, which is consistent with the findings of this review and analysis. The growth in the renewable energy market in Zimbabwe can be attributed mainly to the persistent energy deficit and load shedding, increased awareness of renewable energy, and reduction in renewable energy technology costs, which have motivated private companies and homeowners to install their power in the form of decentralised renewable energy, primarily solar PV and CSP. However, some components could be attributed to government policy, such as the mandatory elimination of electric water heaters in all new homes, which compelled all new homeowners to go for solar water geysers.

3.2 Prospects of hybrid renewable energy-based power system: a case study, post analysis of Chipendeke Micro-Hydro, Zimbabwe

It is crucial to discuss the government's efforts in funding renewable energy projects in Zimbabwe in light of the recent changes in the country's renewable energy sector. To entice IPPs to invest in renewable energy applications in Zimbabwe, the government of Zimbabwe has introduced funding mechanisms for system implementation programmes based on renewable energy. In addition, the Ministry of Energy has set up a fund to advocate for solar energy to alleviate the power shortage (Shafiullah et al., 2021).

The micro-hydro scheme in Chipendeke is an excellent example of the government's successful efforts to promote renewable energy, which have led to significant improvements in the community's socioeconomic development. This scenario illustrates the importance of public funding for electrification schemes in rural areas. It can help policymakers, and utilities plan for future initiatives to create a sustainable future for the country (Shafiullah et al., 2021).

The proposed Chipendeke community hybrid renewable energy system not only meets the current community demand but also opens up new avenues for growth in areas like healthcare, education, and commerce. Employment opportunities, cash flow, and system operational costs are all anticipated to increase due to this system's implementation. The system is eco-friendly because it uses 87.5% renewable energy, which aligns with the Zimbabwean government's goal of cutting carbon emissions by 33% by 2030 and expanding access to modern energy in remote areas (Samu et al., 2020; Shafiullah et al., 2021).

Projects like the one in Chipendeke show promise in addressing the energy deficit and reducing Zimbabwe's carbon footprint thanks to the Zimbabwean government's policies and funding mechanisms. Critical to the government's agenda is incorporating renewable energy into the energy mix, including increased investment in islanded energy systems in rural areas. An excellent illustration of the techno-economic and environmental potentialities that can be achieved with government support is the proposed hybrid renewable energy-based stand-alone power system for the Chipendeke

community (Shafiullah et al., 2021). This system would ultimately contribute to the global initiative to achieve the UN Sustainable Development Goals.

3.3 Techno-economic comparative analysis of renewable energy systems (RES): a case study in Zimbabwe

Fluctuations in fossil fuel prices significantly impact the economies of oil-importing countries such as Zimbabwe, which is why these countries are investigating increased use of renewable energy resources as a viable alternative to fossil fuels. RES, such as solar and wind, provide suitable alternatives for ensuring the country's energy security while reducing greenhouse gas emissions (Al-Ghussain et al., 2020).

In Gwanda, Zimbabwe, a techno-economic comparison of standalone wind and solar PV systems, as well as hybrid PV/wind systems, was carried out to maximise the RES fraction while keeping the levelised cost of electricity (LCOE) less than or equal to the local grid tariff (Al-Ghussain et al., 2020). The results show that the PV/wind hybrid system provides the best economic benefits in terms of NPV and PBP and the best technical performance, with a high RES fraction, competitive LCOE, short PBP, and a positive internal rate of return and NPV.

The hybridisation of RES can overcome resource intermittency and increase supply-demand harmony to a point where RES can work synergistically. Furthermore, hybridisation can increase the economic benefits of renewable energy, making them more appealing investments. In Gwanda, the hybrid PV/wind system outperformed separate systems in terms of economic and technical benefits, with solar and wind resources complementing each other synergistically (Al-Ghussain et al., 2020).

Finally, hybrid PV/wind systems can help to address the mismatch between demand and energy generation caused by resource intermittency and fluctuation, resulting in increased economic benefits and more appealing investment opportunities. Implementing similar systems in various cities throughout Zimbabwe could significantly reduce the country's energy bill and contribute to energy security. Al-Ghussain et al. (2020) demonstrated that the PV-wind hybrid system in Gwanda, Zimbabwe, outperforms separate PV and wind systems in terms of technical performance and economic benefits.

3.4 Renewable energy access challenge at the household level for people experiencing poverty in rural Zimbabwe: is biogas energy a remedy?

It is critical to empower women and female-headed households to increase the adoption of renewable technology, particularly biogas (Maramura et al., 2020). Additionally, efforts should be made to improve household head education, increase the number of livestock per household, raise income levels, expand credit access, and promote land ownership. These variables are essential determinants of biogas technology adoption in Sub-Saharan Africa and other developing regions.

Energy subsidies for the poor can help to alleviate energy poverty in rural areas. However, in many developing countries, including Zimbabwe, these subsidies disproportionately benefit the wealthier and more influential segments of society, exacerbating energy poverty. Subsidies can also distort the relative prices of energy options, resulting in the overuse of fossil fuels and increased environmental costs.

Energy poverty is frequently a symptom of more significant problems, such as income and asset poverty. As a result, focusing solely on energy poverty will not be

sustainable in addressing the root causes of poverty for rural populations. A bottom-up approach focusing on job and wealth creation would be a more effective strategy.

Biogas technology may not be viable during certain seasons, alternative energy sources may be required during the winter when energy demand rises, and biogas digesters require heat energy to maintain a consistent supply. During the rain season, gathering enough feed for the biogas plants may also be difficult. Biogas technology is seasonal, alternative energy sources may be required during the winter when energy demand rises, and biogas digesters require heat energy to maintain a consistent supply. Impoverished communities must have access to additional energy sources that operate efficiently all year.

Furthermore, socio-cultural factors can stymie rural biogas technology adoption. For example, food cooked with cow dung may be considered not culturally acceptable in some cultures. In such cases, public awareness campaigns emphasising the benefits of biogas technology are essential.

Despite the presence of biogas in the area, Maramura et al. (2020) discovered that firewood, paraffin, and charcoal were the primary sources of cooking energy at the household level. Biogas has benefited the community by providing organic fertiliser, creating jobs, reducing deforestation, reducing workload, and providing a reliable source of cooking energy. However, negative community attitudes, a lack of funds, insufficient information, and high installation costs are all barriers to biogas technology adoption. Public and private sector agents continue to promote the technology but face challenges such as high installation costs, a lack of credit, user ignorance, and a lack of awareness (Zyadin et al., 2014).

3.5 Renewable energy in Zimbabwe

In the article ‘Renewable Energy in Zimbabwe’ by Makonese (2016), the development of renewable energy in the country is explored, outlining the existing frameworks that support RETs. The paper identifies the prospects and challenges in promoting and adopting RETs and offers recommendations for their development and dissemination.

Makonese highlights four critical barriers to renewable energy adoption in Zimbabwe: policy and institutional barriers, technical barriers, financial barriers, and socio-cultural barriers.

- Policy and institutional barriers: the lack of consistent policies and regulatory frameworks to support renewable energy has hindered its development. Zimbabwe’s policies currently favour fossil fuels, but the Zimbabwe Energy Regulatory Authority (ZERA) is working on a renewable energy policy to address these gaps.
- Technical barriers include resource availability, technology design, installation, performance, and skilled labour for RETs. Zimbabwe faces uncertainty regarding wind power generation and has experienced a brain drain of skilled labour, which affects the development and maintenance of renewable energy infrastructure.
- Financial barriers: the high initial capital costs, investment costs, and transaction costs, coupled with a lack of access to capital and cheaper alternatives, have hindered the diffusion of RETs. The energy market structure in Zimbabwe favours conventional fossil fuel power plants, and the continued subsidy model for electricity acts as a barrier to renewable energy adoption.

- Socio-cultural barriers: these barriers are especially critical in disseminating cooking-related technologies. When RETs do not satisfy the perceived needs of users or integrate with the social structure, they face resistance. In Zimbabwe, rural households have been reluctant to adopt improved cookstoves due to lighting, space heating, and cultural practices.

To address these challenges and support the development and dissemination of RETs, Makonese's article recommends that government departments and agencies understand the socio-cultural factors influencing technology uptake before introducing them to communities. This approach will aid in designing renewable energy solutions better aligned with users' needs and cultural practices (Makonese, 2016).

3.6 Is green a Pan-African colour? Mapping African renewable energy policies and transitions in 34 countries

The study conducted by Müller et al. (2020) aimed to map African renewable energy policies and transitions in 34 countries. Zimbabwe is included among the countries that were mapped. The authors utilised a mixed-methods approach, combining content analysis and case studies to analyse countries' policy frameworks, governance structures, and institutional arrangements. The article reveals that RETs have gained relevance over the years as potential solutions to address the growing energy demands in Africa. The study suggests great diversity in renewable energy policies and African transitions. While some countries have made significant progress in adopting and implementing renewable energy policies, others are lagging due to inadequate financing, weak regulatory frameworks, and political instability. The study also identified several factors that support or hinder the deployment of RETs in Africa. These include political will, policy coherence, institutional capacity, public participation, and international cooperation. Overall, the study provides important insights into the state of renewable energy policies and transitions in Africa and highlights the need for more concerted efforts to accelerate the adoption of sustainable energy systems on the continent. The authors argue that policymakers must address the structural barriers and systemic challenges that impede renewable energy development to unlock the sector's full potential for economic, social, and environmental sustainability.

Their analysis considered different factors and perspectives, including the energy transition's justice dimension. It is important to note that, among the articles selected for this analysis, Müller is the only scholar who performed a deeper analysis of renewable energy policies from a justice perspective. Given Zimbabwe's rural–urban disparity in energy access, energy justice is essential when discussing energy policy. The dimensions of energy justice analysed are procedural justice, distributive justice, and recognitional justice. The analysis shows potential trade-offs between justice and market-oriented considerations that vary across countries. Just transition and energy justice are emerging issues in the global south literature, and this study's findings are discussed in this context.

In our analysis of the Zimbabwean context, we find that the energy sector in the country is mainly aligned with market orientation considerations rather than justice considerations. Where there is demand and the ability to pay for electricity, the government has made efforts to provide access to electricity, especially in urban areas and other commercial zones. Rural areas with low energy demand and limited ability to pay have remained mostly unelectrified. The rural-urban disparity is evidenced by 83%

of urban households having access to electricity compared to rural electrification, which is still around 20%, presenting a significant rural-urban disparity. This disparity shows that distributive justice considerations are not fully embedded in Zimbabwe's renewable energy transition policies and strategies. The financialisation of the energy transition results in a preference for policies that secure the bankability of renewable energy interventions, thereby side-lining the justice dimension of the transition.

The tariffs charged by the IPPs are somewhat regulated, but the energy affordability for poor rural communities remains a challenge in Zimbabwe. The non-affordability of the power seriously compromises the ability of the policies to promote recognitional justice. Recognitional justice refers to the extent to which energy policies address the needs of vulnerable groups due to energy poverty. Zimbabwe's policies recognise these vulnerable groups, for example, women, but the measures still do not address the underlying barriers to attaining energy justice. Policies mention women and their vulnerabilities. They aim to promote access to renewable energy to create opportunities for better health, employment creation, and productive use of energy to generate income equally for men and women, boys and girls. While the policies acknowledge the need for gender equality, there are limited deliberate actions to promote the same.

3.7 Policy-making prospects and challenges of the climate change and the urban energy sector in Zimbabwe

The study by Dzvimbo and Zhanda (2020) explores the challenges and prospects of policymaking regarding climate change and the urban energy sector in Zimbabwe. The challenges identified are limited financial resources, inadequate technical expertise, weak institutional frameworks, and limited stakeholder engagement. However, the authors also identify several prospects for policy-making, such as increased investment in renewable energy sources, increased public awareness and education on climate change and sustainable energy, and the adoption of innovative policy instruments like carbon pricing mechanisms. The study highlights the need for a comprehensive policy framework that considers the unique context of Zimbabwe and the specific challenges and opportunities associated with transitioning to a more sustainable energy system. The article concludes that the synergy between climate change and energy policy is critical for attaining SDGs 7 and 13. One of the significant weaknesses of Dzvimbo and Zhanda's analysis is that, while the study focused on urban areas, the renewable energy policies in Zimbabwe are national and do not only address urban or rural areas separately. Energy is a significant contributor to addressing climate change; therefore, policies in these sectors should speak to each other, and the lead ministries need to coordinate the implementation of these policies. Dzvimbo and Zhanda argue that renewable energy and climate change policies in Zimbabwe are addressed and implemented separately, creating coordination gaps and eroding the capacity of the country to address both challenges. This view by the authors may not be fully informed of the current situation regarding the linkages between the policies in these two sectors. We believe so because of the strong linkage and collaboration in implementing these policies. The institutional arrangements in Zimbabwe to address climate change and energy sector issues are complex. Several line ministries take the lead in implementing sector strategies that have a bearing on another sector. The National Renewable Energy Policy of 2019 sets renewable energy targets that will specifically help attain the nationally determined contributions (NDC) targets set by

the country under the Paris Agreement. The energy sector is also clearly identified in the NDCs, the National Climate Policy, and the low emissions development strategy as significant entry points to achieve a low-carbon economy consistent with the Paris Agreement. A cross-sectoral approach is critical for the two sectors to attain their objectives effectively. All the coordination mechanisms for NDC and climate policy implementation involve the energy sector, the primary component of climate change mitigation efforts.

3.8 Renewable energy development 'an analysis of investment models' case of Zimbabwe

Makoni's (2021) thesis on renewable energy development in Zimbabwe analyses different investment models and their potential for promoting sustainable energy systems in the country. The study identifies several investment models, including government-led initiatives, private-sector investments, and public-private partnerships. Makoni examines the advantages and disadvantages of each model, highlighting the critical role of government policies and regulations in promoting investment in renewable energy. The study concludes that combining these investment models could effectively accelerate the deployment of RETs in Zimbabwe. The findings emphasise the need for policymakers to create an enabling environment that incentivises investment in sustainable energy and promotes the adoption of RETs.

Overall, the thesis provides valuable insights into the potential of investment models for promoting sustainable energy systems in Zimbabwe. By examining the advantages and disadvantages of different investment models, the study provides policymakers with a roadmap for creating an enabling environment for investment in renewable energy. The study's findings underscore the importance of government policies and regulations in promoting investment in sustainable energy systems and accelerating the transition to a low-carbon economy. The country has experienced fluctuations in its policy formulation process, impacting renewable energy investment. This observation is critical in analysing the energy policy regime in Zimbabwe. From the year 2012, when the country put in place the National Energy Policy, which had limited scope on renewable energy, there were no new policies or significant revisions to the existing policy to set targets on renewable energy until the year 2016, when the FIT was introduced. This gap presents a missed opportunity to harness renewable energy and potential investment that could have been targeted toward the renewable energy sector. After two years of implementing the FIT, the country introduced net metering guidelines to encourage and incentivise renewable energy. However, the installed renewable energy capacity between these two instruments shows sustained, limited growth consistent with previous years, suggesting that the increase is not attributed to these two instruments. The policy environment still needs to improve to create an enabling environment for investment in renewable energy.

In addition to these so-called policy fluctuations, one could argue that implementation of the FIT and net metering was weak as they remained draft guiding principles. In 2019, the country added another policy, the National Renewable Energy Policy, and a biofuels policy. These comprehensive policies have set targets and incentives to promote the development of renewable energy in the country. However, implementation is a significant concern about these policies, which remains challenging. We observed that the sector is underfunded, and the policies only create an enabling environment. These

substantive policies require enabling policies that may come from incentives or other financial instruments and guarantees.

3.9 Climate change in Zimbabwe: towards a low carbon energy industry

The study 'Climate change in Zimbabwe: towards a low carbon energy industry' by Murombo (2019) provides insights into the challenges and opportunities for transitioning to a low-carbon energy sector in Zimbabwe. First, the author highlights the adverse impact of climate change on Zimbabwe's economy, environment, and society and emphasises the need to shift toward renewable energy sources to mitigate greenhouse gas emissions. The study analyses various policy and regulatory frameworks that govern the energy sector in Zimbabwe and identifies barriers and opportunities for enhancing the deployment of RETs. Finally, the author argues that while Zimbabwe has significant potential for renewable energy development, the lack of investment, inadequate infrastructure, and low public awareness hinder progress toward a low-carbon energy industry.

Murombo highlights that the government of Zimbabwe is vital in creating incentives for private investment in renewable energy projects. The government can create an enabling environment by formulating dynamic and flexible legal and regulatory frameworks, removing subsidies, and allowing energy utilities to charge commercial rates while cushioning people experiencing poverty. However, the regulatory framework is heavily state-centred and leaves little room for private investment. IPPs who wish to establish off-grid RETs often have to compete with the rural electrification fund, which the government fully sponsors, which may charge lower tariffs than the market rate and may not be cost-reflective. The Renewable Energy Policy and the National Climate Policy provide a good foundation for the amendment of energy policy and laws or the development of specific renewable energy and climate change legislation that can promote the twin objectives of access to clean energy and low-carbon development. The country is developing the climate bill, which is believed to become the first climate law in Zimbabwe, and stakeholders have higher expectations. Overall, the study highlights the importance of addressing the challenges and promoting opportunities for improving the resilience of Zimbabwe's energy sector to climate change. The study concludes by suggesting policy recommendations to promote a sustainable, low-carbon energy industry in Zimbabwe, such as increasing funding for renewable energy projects, strengthening regulatory frameworks, and promoting public participation in decision-making processes.

3.10 The role of renewable energy in the electricity industry in Zimbabwe

It was discovered in a 2009 paper, one of the first on the subject, that Zimbabwe's electricity supply industry faces significant challenges (Mbohwa and Siso, 2009). With an installed capacity of 2,040 MW, the country struggles to meet rising demand, while peak demand is expected to exceed 2,200 MW. Factors such as coal shortages, a lack of foreign currency for spare parts, and an unrealistic pricing regime exacerbate the situation, making it difficult for conventional power plants to operate at total capacity. Zimbabwe has been importing electricity from regional utilities to alleviate power shortages, but securing these imports has become increasingly difficult due to regional scarcity.

The potential of RETs in addressing Zimbabwe's energy crisis is investigated in this paper. Renewable energy sources such as solar, hydroelectric, biomass, wind, and waste-to-energy systems could help reduce peak demand, improve overall system load factors and performance, and relieve system planning pressure. Despite their enormous potential, RET adoption in Zimbabwe has been slow, owing primarily to barriers such as high initial costs, technical challenges, market limitations, institutional and regulatory constraints, and social and environmental factors.

The 2009 recommendations focus primarily on creating a favourable policy environment for RETs, particularly emphasising the government and the Zimbabwe Energy Regulatory Authority (ZERA). Among these suggestions are:

- Creating policies to encourage the growth of the RET market and providing incentives for demonstration projects and system installation.
- Requiring the inclusion of RETs in system development plans.
- In order to ensure cost-effective solutions, integrated resource planning needs to be implemented.
- Changing the RET pricing methodology to account for power transactions and other benefits.
- Remote areas should be prioritised for RET implementation.
- New market opportunities are being used to promote the solar industry.
- ZERC licensing frameworks enable local communities to participate in RET projects.
- Creating standards to reduce system failures.
- Encourage financial institutions to support renewable energy projects through financing mechanisms and revolving funds.

In contrast, Maramura et al.'s (2020) recommendations focus on rural biogas technology adoption, addressing socioeconomic factors and energy poverty. Among these suggestions are:

- Female empowerment and female-headed households.
- Increasing the educational attainment of household heads.
- Increasing the number of livestock per household.
- Raising the standard of living.
- Increasing credit availability and promoting land ownership.
- Energy subsidies should be re-evaluated to ensure that they benefit the intended population.
- Addressing energy poverty from the ground up, including job and wealth creation.
- Creating new energy sources to supplement seasonal fluctuations in biogas supply.
- Addressing socio-cultural issues and conducting awareness campaigns to promote the advantages of biogas technology.

The 2009 recommendations are focused on policy frameworks, regulations, and infrastructure development to promote renewable energy. In contrast, the 2020 recommendations are focused on addressing socioeconomic factors, energy poverty, and cultural issues to increase biogas technology adoption. Both recommendations aim to improve energy access in Zimbabwe, focusing on different aspects of the energy sector and requiring complementary implementation for a complete solution.

4 Conclusions

Finally, the reviewed articles highlight the multifaceted nature of renewable energy transitions and the importance of implementing context-specific policies and strategies to drive sustainable development. While there is no universal solution to promoting renewable energy growth, the findings indicate that tailored combinations of legal frameworks, investment models, and policy instruments can effectively promote renewable energy expansion in a variety of contexts, including Zimbabwe and other African countries.

The articles highlight the continent's growing interest in renewable energy development and policymaking, touching on legal frameworks, investment models, policy instruments, and challenges. These studies add valuable insights to the ongoing discussion about renewable energy transitions, emphasising the need for a comprehensive and context-specific approach that considers legal, financial, and policy factors, local conditions and challenges.

Furthermore, the identified research gaps and proposed research areas for future studies contribute to a better understanding of renewable energy development in Zimbabwe and elsewhere. By exploring these avenues, scholars can contribute to developing more effective policies and strategies that promote sustainable, equitable, and inclusive energy systems. Addressing these challenges and seizing the opportunities presented by renewable energy transitions can, in the end, pave the way for a more sustainable and resilient future for Zimbabwe, other African nations, and the global community.

The articles demonstrate Zimbabwe's and other African countries' growing interest in renewable energy development and policymaking. However, several research gaps and potential areas for future research have emerged:

- Investigate the role of local communities and indigenous knowledge in adopting and managing renewable energy, which could contribute to more inclusive and sustainable energy systems.
- Investigate the potential for energy storage solutions to integrate intermittent renewable energy sources like solar and wind into the national grid.
- Examine large-scale renewable energy projects' socioeconomic and environmental effects on local communities, including land use changes, ecosystem services, and livelihood opportunities.
- Investigate novel financing mechanisms for renewable energy development, such as public-private partnerships, green bonds, and blended finance.

- Assess the efficacy of existing renewable energy policies, regulations, and incentives in promoting renewable energy development and identify potential areas for improvement.
- Examine the role of regional cooperation and energy trading in increasing renewable energy adoption and decreasing reliance on fossil fuels.
- Analyse and develop strategies to overcome the barriers to renewable energy technology transfer and capacity building.
- Investigate the gender dynamics in the renewable energy sector, such as women's participation in decision-making, employment opportunities, and access to energy services.

Future studies can contribute to a more comprehensive understanding of renewable energy development in Zimbabwe and other African countries by addressing these research gaps and exploring the suggested research areas. This will eventually aid in developing more effective policies and strategies to promote sustainable, equitable, and inclusive energy systems across the continent.

5 Recommendations

In order to comprehensively address the development of renewable energy in Zimbabwe, we recommend the following strategies, which take into account legal, financial, and policy factors in addition to the conditions that exist locally:

- Enhance the energy policy regime by drafting legal and regulatory frameworks that are dynamic and flexible. This will help create an environment conducive to investment in renewable energy sources. This strategy should consider removing subsidies and allowing energy utilities to charge commercial rates while cushioning people experiencing poverty. This will ensure that renewable energy projects are viable and that all Zimbabweans have access to energy that is both affordable and clean.
- Immediate implementation of funding for the viability gap: In accordance with the National Renewable Energy Policy of 2019, design and carry out the funding to bridge the viability gap. This funding mechanism aims to strike a balance between the viability of the project and its affordability, thereby ensuring that all citizens have access to energy options that are both clean and affordable. The provision of funding for the viability gap will incentivise investments in renewable energy, bring down the cost of producing one kilowatt-hour of power, and make the utilisation of RETs more appealing than using conventional energy sources.
- Offer viability gap funding for community projects in off-grid areas to attract local public and private investments and foreign direct investments. In addition, the implementation of various instruments, such as guarantees, should be done in order to entice foreign direct investments. This should be done to address the challenges that IPPs, particularly those that are small to medium, face, which include the unavailability of long-term capital, high production costs, and high capital costs.

- Establish a sovereign guarantee facility to improve the investment climate and address the risks at the country level that prevent renewable energy investments from being bankable. These country-level risks include the possibility of a default by the sole energy off-taker, currency risk, and the inconvertibility of currency. If the primary obligor fails to meet their financial obligations, a sovereign guarantee offered by the government will ensure that all obligations are honoured. This guarantee will cover non-payment by the off-taker as well as currency inconvertibility, transfer restrictions, termination clauses, and any other national utility obligations stated in the power purchase agreement.
- Develop a local funding architecture to address funding challenges specific to Zimbabwe and establish a fund solely dedicated to renewable energy. The Green Energy Fund, proposed in the National Renewable Energy Policy of 2019, will use a variety of instruments to channel finance towards renewable energy investment. These instruments include grants, concessional loans, and grace periods within loan agreements. This fund will improve the country's readiness to access and disburse national and global climate finance. It will also support investments that are prioritised on a national level to deploy renewable energy. The Green Energy Fund will facilitate financial flows into domestic renewable energy projects that align with national priorities and blend private and public financing to achieve the country's targets for renewable energy.

By putting these recommendations into action, Zimbabwe will be able to holistically address the challenges of developing renewable energy, thereby creating an energy sector that is both sustainable and inclusive, which will benefit all of the country's citizens. Zimbabwe can effectively harness its abundant renewable energy potential to meet its energy needs and contribute to a greener, more resilient future if it fosters an enabling policy environment, provides targeted financial support, and addresses investment risks. These are the three pillars of the enabling policy environment.

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