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The Banking Sector's Role in Overcoming Clean Energy Adoption Challenges: Evidence from Tanzania

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ABSTRACT: The study examined the role of banking sector in overcoming clean energy adoption challenges in Tanzania. The specific banking roles employed in this study were; bank financing availability (BFA), policy and regulatory authority support (PRA), and bank expertise and capacity (BEC). In line with the three measures of CEA, the study investigates three hypotheses. The explanatory research design and quantitative research approach were applied to achieve the objective of the study. A sample of 100 respondents were invited to complete a standard questionnaire based on extensive evaluations of prior empirical investigations chosen using a simple random approach from a population of banking institutions. The results were estimated using the partial Least Square Structural Equation Modelling (PLS-SEM) method. Findings from the study revealed that bank expertise, policy and regulatory authority and bank financing availability had significant positive relationship with clean energy adoption. Therefore, banks can play a key role in advancing clean energy by investing in training for their loan officers and investment analysts, helping them better understand clean energy technologies, how to evaluate such projects, and the risks involved. They should also back stable and transparent regulatory frameworks, with clear and long-term renewable energy policies that build confidence and attract private investors. In addition, promoting blended finance models that bring together public and private funding can make clean energy projects more attractive and financially viable.

KEYWORDS: bank financing availability; bank personnel expertise; clean energy adoption; partial least squares; policy and regulatory authority.

1.0 INTRODUCTION

The global shift toward clean and renewable energy lies at the heart of efforts to tackle climate change and achieve sustainable development. For low- and middle-income countries, this transition is not only an environmental priority but also a pathway to greater energy security and inclusive growth. In Sub-Saharan Africa, renewable energy offers the potential to expand electricity access, improve livelihoods, reduce the health risks of indoor air pollution, and create green jobs. Yet turning abundant renewable resources into reliable, affordable, and widespread energy access requires much more than technical potential. It depends on mobilizing significant investment, implementing coherent policy frameworks, and strengthening domestic financial systems areas where many countries, including Tanzania, continue to face persistent challenges (Climate Policy Initiative, 2024; Omri et al., 2022).

Tanzania illustrates both the promise and the complexity of the clean energy transition in Africa. The country is richly endowed with solar radiation, biomass residues, small hydropower sites, and emerging geothermal resources (Government of Tanzania, 2024). Its official plans including the Tanzania Energy Policy and the National Five-Year Development Plan set clear goals for increasing the share of renewables and expanding electricity access to underserved communities (National Energy Policy, 2015; The Third Five Year Development Plan, 2021). Despite this strong policy intent and the support of various development partners, progress on renewable energy deployment has been slower than expected (Policy Forum, 2023; African Development Bank, 2023). The uptake of distributed solar systems remains modest, while investment in medium- and large-scale renewable projects continues to lag behind national targets (PowerShift Africa, 2023; African Development Bank, 2023).

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Several studies identify recurring barriers to renewable energies investment in Tanzania. Weak project preparation capacity, a limited pipeline of bankable projects, and the scarcity of long-term domestic finance are frequently cited as key impediments (IMF, 2024; SE4ALL, 2015). Many promising initiatives struggle to reach financial closure partly because commercial banks tend to view renewable energy lending as risky, unfamiliar, and outside their traditional business models. As a result, Tanzania finds itself in a paradoxical position rich in renewable energy potential, but constrained in translating that potential into actual investment and reliable energy access.

Scholarly and policy research increasingly highlights the link between financial sector development and renewable energy growth. Cross-country evidence shows that countries with deeper, more inclusive financial systems characterized by greater private sector credit, broader banking penetration, and longer-term lending tend to experience faster renewable energy deployment (Omri et al., 2022). Theoretically, well-functioning financial systems ease capital constraints, spread risk, and accelerate the diffusion of new technologies. Conversely, underdeveloped banking systems can inhibit clean energy transitions by maintaining high risk premiums and restricting credit for innovative projects. Within this broader relationship, financial innovation has emerged as a critical driver where mechanisms such as green bonds, blended finance structures, and targeted credit lines can help mobilize domestic capital and crowd in private investment, provided the underlying project pipelines are credible and policy signals are clear (Climate Policy Initiative, 2024; World Bank Group, 2024). At the same time, technological and business model innovations such as digital pay-as-you-go (PAYG) solar systems have expanded access for households and small businesses. These models convert small, irregular payments into predictable cash flows that can, in theory, be aggregated and financed by banks. However, scaling PAYG models beyond household systems to mini-grids and productive-use appliances requires stronger links with formal banking systems and secondary markets capable of extending longer-term credit (Emerald Insight, 2024; UNCDF & WRI, 2024).

Despite these advances, research on Tanzania and similar economies often focuses on the energy sector itself grid infrastructure, tariffs, or policy design rather than on the internal workings of the financial institutions that could enable energy investments. This gap limits understanding of how commercial banks interpret, assess, and manage clean energy opportunities and risks.

Therefore, banking sector could play an important role in bridging this financing gap by improving operational and investment strategies to support renewable energy projects and contribute to broader objectives of sustainable development and climate change mitigation. This study is designed to examine the role of the banking sector in overcoming clean energy adoption challenges.

Despite Tanzania's ambitious goals for renewable energy expansion and financial inclusion, the domestic banking sector remains only marginally engaged in financing clean energy (IMF, 2024; World Bank, 2023). While donor initiatives and isolated efforts such as concessional credit lines and the Kijani green bond have demonstrated the feasibility of green finance, these remain exceptions rather than indicators of systemic transformation (The Citizen, 2024; BOT, 2022). The broader financial system has yet to experience a structural shift that would integrate renewable energy finance into mainstream banking operations (AfDB, 2021; IRENA, 2017). Persistent challenges include a limited pipeline of bankable projects, inadequate expertise and data within banks to accurately assess renewable energy risks, and the predominance of short-term funding that is poorly aligned with the long-term nature of clean energy investments (SE4ALL, 2015; IRENA, 2022). Furthermore, little is known about how internal bank factors such as management priorities, staff skills, and institutional capacities shape lending decisions in this sector (OECD, 2021; UNDP, 2023; IPP Media, 2025).

Tanzania still faces a number of hurdles in growing its renewable energy finance sector. There are too few well-prepared, bankable projects for investors to support, leaving many opportunities untapped (AfDB, 2021; IMF, 2024). Many local banks also lack the technical expertise, reliable data, and practical experience needed to properly assess the risks and returns of renewable energy projects (IRENA, 2017; SE4ALL, 2015). On top of that, most of the financing available in the market is short-term, which doesn't match the long-term investment needs typical of clean energy ventures (World Bank, 2023; OECD, 2021).

Tanzania's financial sector faces structural barriers that make scaling up green finance difficult. Banks continue to struggle with liquidity pressures, foreign exchange risks, and a lack of long-term funding options, while the regulatory environment for green finance is still taking shape. At the same time, local capital markets remain too limited to effectively package or recycle renewable energy investments (AfDB, 2021; World Bank, 2023; BOT, 2022). Overcoming these challenges will require not only external financial support but also internal reforms within banks to embed green finance into their strategies, governance, and risk management practices (IMF, 2024; UNDP, 2023).

Furthermore, financial institutions can improve operational and investment strategies to support renewable energy projects and contribute to broader objectives of sustainable development and climate change mitigation. This study is designed to examine the role of the banking sector in overcoming clean energy adoption challenges. The research questions raised are: How does bank's funding availability (BFA), policy and regulatory authority (PRA) and bank's personnel expertise impact the adoption of clean energy? From the results, the study will give answers to these questions.

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The paper is divided into six different sections. First, is the introduction section that highlights the critical aspects and main considerations surrounding the fundamental theme. The literature review section provides an overview of the related previous studies, summary of their conclusions as well as their relevance to this study. Later, the methodology section that explains the analytical techniques and data processing methods employed in the study. The following section presents the empirical results derived from the application of various statistical models to the data collected. The last section focuses on the interpretations of the study results and hence providing detailed analysis and contextual understanding. The last section summarizes the essential views collected from the study, offering accurate assessment of its effects, and finally suggest steps for future studies on the role of banking sector in overcoming clean energy adoption challenges.

2.0 LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

2.1 Theoretical review

The study was guided by three prominent theories in understanding how the banking sector can address clean energy adoption challenges in Tanzania: the "Theory of Access to Finance", "Sustainable Finance Theory" and the "Institutional Theory".

2.1.1Theory of Access to Finance

The theory of access to finance underscores how financial inclusion can influence development outcomes. According to this theory, limited access to finance is a significant constraint to innovation and growth, especially in low-income countries. In the context of Tanzania, clean energy technologies often remain expensive to households and small enterprises due to upfront capital requirements. This theory supports the argument that increased participation of banks in designing inclusive financial products—such as green loans, energy-specific microfinance, and leasing schemes—can lower barriers to clean energy adoption. The theory also suggests that beyond availability, the terms of credit (interest rates, collateral requirements) significantly affect adoption rates. (Beck et al, 2007).

2.1.2 Sustainable Finance Theory

Sustainable finance theory emphasizes the integration of environmental, social, and governance (ESG) criteria into financial decision-making (Schoenmaker & Schramade, 2019). From this perspective, banks are not merely profit-seeking institutions but key actors in driving sustainable development. This theory frames the banking sector's role as proactive rather than reactive—supporting investments in renewable energy not only for financial return but also to fulfill environmental and social mandates. In Tanzania, where climate vulnerability is high, the theory supports the argument that banks have a responsibility to direct capital flows toward clean energy as a climate mitigation strategy

2.1.3 Institutional Theory

Institutional theory highlights the influence of formal and informal institutions—laws, regulations, norms—on organizational behavior. In Tanzania, banking institutions operate within a regulatory environment shaped by both energy and climate national policies and international frameworks such as SDGs and Paris Agreement. This theory implies that government incentives, regulatory pressures, and normative expectations can shape banks' engagement in clean energy financing. Therefore, central bank policies or green finance guidelines can altogether push commercial banks to allocate a portion of their portfolio to clean energy investments coupled with Institutional support that reduces perceived risks and enhances policy coherence for long-term investment in the sector.

2.2 Empirical review

2.2.1 Bank Financing Availability on Clean Energy Adoption

Tanzania's financial institutions have begun modest steps toward supporting renewable energy. According to a policy analysis by TaTEDO, commercial bank lending to renewable energy accounts for less than 1% of the entire loan portfolio (TaTEDO, 2022). Meanwhile, MFA-led efforts have made headway: the Tanzania Association of Microfinance Institutions reports that several microfinance institutions (MFIs) are now offering financing for renewable energy end users in response to C.S. Mott Foundation–supported initiatives (TAMFI, 2023). These channeling interventions expand the grassroots reach of clean energy finance but still leave overall bank engagement minimal.

Broader empirical studies emphasize the link between financial system depth and renewable energy adoption. Chireshe's regional analysis (2020) demonstrates that countries with more developed financial systems tend to deploy more renewables. In a similar vein, Nabaweesi et al. (2024) find that East African Community countries—including Tanzania—experience a significant positive relationship between financial sector development and modern renewable energy consumption.

- **H1**: There is a significant positive relationship between bank financing availability and the adoption of clean energy technologies in Tanzania.

2.2.2 Policy and Regulatory Authorities on Clean Energy Adoption

Barriers limiting bank involvement in Tanzania are multifaceted. The European Commission's Joint Research Centre highlights grid integration hurdles, land use complexities, long-term financing shortages, and permitting delays as critical constraints (European Commission Joint Research Centre, 2020). TaTEDO likewise identifies the absence of private bank investment and a lack of project pipelines as key policy constraints (TaTEDO, 2022).

At the institutional level, local banks face data gaps. According to TAREA and renewable energy stakeholders, banks and entrepreneurs suffer from mutual unfamiliarity and limited awareness of financing products, leading to a disconnect in clean energy lending opportunities (TAREA, 2022). This is reinforced by the World Resources Institute, which identifies challenges specific to financing productive-use renewable energy (PURE): local banks lack distinct loan categories, face borrower credit risks, suffer from currency mismatch in hard currency financing, and lack aggregation mechanisms (WRI, 2024).

- **H2**: A supportive regulatory and policy environment has a positive effect on bank financing availability and clean energy adoption.

2.2.3 Bank Personnel Expertise on Clean Energy Adoption

While green finance is nascent in Tanzania, broader African experiences demonstrate the potential of these instruments. FSD Africa's 2025 report reveals that the continent has issued approximately USD 9.6 billion in green bonds across 76 issuances, contributing to environmental outcomes and social inclusion (FSD Africa, 2025). Although still early-stage, the adoption of green bonds and their environmental dividends indicate potential pathways for scalable financing.

In East Africa, structuring success stories offers further lessons: Acorn Holdings in Kenya achieved dual listings of green bonds, while the Trade and Development Bank (TDB) advanced solar project financing via green bond revenues (JEPA Africa, 2024). In Tanzania, CRDB Bank's green bond issuance—around USD 68.3 million, oversubscribed and accredited by GCF—stands as a landmark instrument (Orucho, 2025). Though limited, such transactions signal that structured green instruments can attract capital and set precedents for broader replication.

- **H3**: Higher institutional capacity of banks (e.g., trained staff, clean energy loan products) is positively influencing clean energy adoption.

Opportunities to strengthen the banking sector's contribution to clean energy adoption in Tanzania largely revolve around policy alignment, innovative financial instruments, and multi-stakeholder partnerships. The evolving global emphasis on green finance has created a conducive environment for banks to diversify their portfolios towards sustainable investments (Taghizadeh-Hesary et al., 2023). In emerging economies, banks can leverage blended finance—combining public, private, and donor funding—to reduce investment risks and attract capital into clean energy projects (Euchner et al., 2024). Strategic collaborations between banks, renewable energy companies, and government agencies can enhance project bankability, particularly in rural and off-grid contexts where traditional lending models face limitations (Guta et al., 2023). Policy reforms that provide tax incentives, interest rate subsidies, or risk-sharing facilities have also been shown to encourage financial institutions to prioritize clean energy financing (Akinwale et al., 2022). Furthermore, integrating Environmental, Social, and Governance (ESG) metrics into lending criteria can help align banking operations with national and international sustainability goals (Zhang & Alhassan, 2023). Digital innovations such as mobile-based loan platforms and blockchain-enabled energy trading offer additional pathways for banks to expand outreach and improve transaction transparency (Narayan et al., 2023). These opportunities, if strategically pursued, can position Tanzanian banks as central actors in overcoming persistent barriers to clean energy adoption, while simultaneously contributing to the country's commitments under the Sustainable Development Goals (SDGs) and the Paris Climate Agreement.

3.0 RESEARCH METHODOLOGY

3.1 Research Design

This study adopts a **descriptive cross-sectional survey design** to examine the role of the banking sector in overcoming clean energy adoption challenges in Tanzania. A cross-sectional approach is suitable because it allows data to be collected at a single point in time from a large sample, providing a snapshot of prevailing perceptions, practices, and challenges (Creswell & Creswell, 2018). The design facilitates the collection of both quantitative and qualitative data, enabling the triangulation of findings for greater validity (Saunders et al., 2019).

3.2 Target Population

The target population will comprise:

1. **Banking sector personnel** — including credit officers, loan managers, and sustainability managers in Tanzanian banks.
2. **Clean energy project developers** — representing solar, wind, biomass, and mini-hydro projects.
3. **Regulatory and policy stakeholders** — from government energy agencies and financial sector regulatory bodies.

3.3 Sampling Technique and Sample Size

A **stratified random sampling technique** was applied to ensure proportional representation of respondents from different banking institutions and clean energy project categories. The sample was divided into strata representing commercial banks, development banks, and microfinance institutions.

The sample size was determined using **Cochran's (1977) formula** for large populations, adjusted for non-response. Anticipating a confidence level of 95% and a margin of error of 5%, the study will target approximately 100 survey respondents.

3.4 Data Collection Method

A **structured questionnaire** was used to collect quantitative data from bank personnel and clean energy project developers. The questionnaire employs a **five-point Likert scale** (ranging from 1 = "Strongly Disagree" to 5 = "Strongly Agree") to measure attitudes, perceptions, and experiences regarding:

- Bank financing availability (Objective 1)
- Policy and Regulatory Authority support (Objective 2)
- Bank expertise and capacity in clean energy (Objective 3)
- Clean energy adoption (Objective 4)

3.5 Data Analysis Technique

The Statistical Package for Social Sciences (SPSS) software, version 18, was used to record the responses received from managers of manufacturing companies. Each item on the questionnaire was assigned a code, which was then compared to the entries made in the SPSS to ensure that errors were kept to a minimum. In order to improve further statistical analysis, the data was subsequently cleansed by removing any conflicting data. The Partial Least Squares-Structural Equation Modeling (PLS-SEM) was used to conduct an inferential evaluation of the data in accordance with the study's goals. To accomplish all the goals of the research, the PLS-SEM was used. Due to the PLS-SEM's robustness in managing correlations between latent variables irrespective of normality issues unlike the covariance-based SEM (CB-SEM), it was chosen (Hair et al., 2019).

4.0 RESULTS AND DISCUSSION

4.1 Results

The study examines the role of banking sector in overcoming clean energy adoption challenges in Tanzania. Particularly, the study seeks to assess the effect of bank financing availability (BFA), policy and regulatory authority support (PRA) and bank expertise and capacity in clean energy (BEC) on clean energy adoption (CEA). The final sample for this study contained 100 respondents obtained through the sample random approach. The quantitative strategy and exploratory design are consistent with the current study.

4.1.1 Measurement model assessment

The measurement model was assessed to confirm construct reliability, indicator reliability, convergent validity, and discriminant validity.

4.1.2 Construct reliability, indicator reliability and convergent validity

The PLS – SEM results begin with a model evaluation to assess the fitness of the model by analyzing the indicator's reliability (loadings), construct's reliability (as assessed by Cronbach's Alpha and rho A), convergent validity, and discriminant validity (Hair et al., 2020). Additionally, composite reliability (CR) was used to evaluate construction dependability.

As shown in Table 1, all constructs demonstrate strong internal consistency reliability, with Cronbach's alpha values ranging from 0.837 to 0.912, and composite reliability values between 0.878 and 0.920, exceeding the recommended threshold of 0.70.

The Average Variance Extracted (AVE) for all constructs surpasses the acceptable value of 0.50, ranging from 0.730 to 0.776, confirming adequate convergent validity.

All individual item loadings exceed the recommended threshold of 0.70, indicating good indicator reliability. Loadings range from 0.731 (PRA4) to 0.940 (PRA2). Additionally, Variance Inflation Factor (VIF) values are all below the critical value of 5, suggesting no multicollinearity issues among the indicators.

4.1.3 Discriminant Validity

Discriminant validity assesses a construct's distinctiveness (Hair et al., 2020). Tables 2 and 3 assess the constructs' discriminant validity to show how good the model is (Hair et al., 2020). According to Hair et al. (2019), the discriminant validity evaluates the structural model for collinearity problems. The Heterotrait-Monotrait Ratio (HTMT) is used to evaluate the discriminant validity. The range of the HTMT cutoff scores is 0.85 to 1.0 (Hair et al., 2020). The HTMT performs better since it can identify a lack of discriminant validity under typical study circumstances. HTMT scores (correlation values among the latent variables) should normally be less than 1.0 in order to obtain discriminant validity. The construct values in Table 5 were all under 1.0. This illustrates how completely different one construct is from the others.

The findings indicate that all HTMT values are below the conservative threshold of 0.85, with the highest being 0.752 (between BEC and CEA). This confirms the constructs are empirically distinct. However, according to Fornell-Larcker Criterion, the diagonal values (square roots of AVEs) are greater than the corresponding inter-construct correlations, further supporting discriminant validity. For instance, the square root of AVE for BEC is 0.860, which is higher than its highest correlation with another construct (CEA = 0.690).

Table 1. Construct reliability, indicator reliability, and convergent validity

Variables	Loadings	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	VIF
Bank financing availability		**0.856**	**0.875**	**0.776**	
BF1	0.853				2.170
BF2	0.861				1.962
BF3	0.928				2.808
Policy and Regulatory Authority		**0.837**	**0.897**	**0.754**	
PRA1	0.919				2.908
PRA2	0.940				3.275
PRA4	0.731				1.515
Bank expertise and capacity in clean energy		**0.912**	**0.920**	**0.739**	
BEC1	0.837				2.401
BEC2	0.803				2.446
BEC3	0.882				3.350
BEC4	0.906				4.509
BEC5	0.866				3.695
Clean energy adoption		**0.876**	**0.878**	**0.730**	
CEA1	0.872				2.850
CEA2	0.901				4.304
CEA3	0.886				4.187
CEA4	0.749				1.364

Table 2 shows that the Q^2 predict values surpass the naivest benchmark, with indicator SCP2 having the lowest Q^2 predict value at 0.271. From Table 2, it can be seen that the model has a moderate capacity for prediction because none of the dependent construct indicators have larger RMSE or MAE prediction errors compared to the naive LM benchmark except CEA 4. These values are PLS-SEM RMSE and MAE, which are shown in bold. In this situation, it can be assumed that the PLS-SEM model has better predictive capabilities.

Table 2. PLS predict MV summary

	Q^2 predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE	IA_RMSE	IA_MAE
CEA1	0.310	1.013	0.531	1.077	0.780	1.356	1.091
CEA2	0.330	1.014	0.421	1.111	0.795	1.390	1.087
CEA3	0.271	1.015	0.723	1.102	0.800	1.347	1.024
CEA4	0.484	1.126	1.020	1.340	1.054	1.985	1.809

Standardized Root Mean Square Residual (SRMR) for the model is shown in Table 3, and according to Hu and Bentler (1999) and Henseler et al. (2016), it should be less than 0.08; this implies that the closer the Normed fit index (NFI) value is to 1.00, the better the fit. The model's estimated Chi-Square, which is calculated by dividing the degrees of freedom (number of observations minus number of independent variables) by the estimated value of the Chi-Square, should be less than 3 (Mantel, 1963).

Table 3 shows that the model's SRMR values of 0.059 and 0.059 are less than 0.08, which indicates a reasonable model fit with few deviations from the expected and observed correlations. Furthermore, the NFI value is greater than the threshold of 0.8; as a result, the model is considered to have marginal fit. In contrast, the model's Chi-Square evaluation is roughly 3.475 (i.e., 1150.260/331), which is above the benchmark of 3 indicating that the model has a marginal fit.

Table 3. Model Fit summary

	Saturated model	Estimated model
SRMR	0.059	0.059
d_ULS	0.941	0.941
d_G	0.334	0.334
Chi-square	1150.260	1150.260
NFI	0.821	0.821

4.1.4 Structural Model Assessment

The study further explores the research hypotheses after establishing construct and indicator reliability, as well as convergent and discriminant validity. By analyzing the direction and strength using the coefficients, p-values reflecting the level of significance using 5000 bootstraps, coefficient of determination (R^2 and R^2 Adjusted), effect size (f^2), Confidence Interval (CI), Q^2 predict, Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and variance inflation factor (VIF) in Table 4 this work was completed.

From Table 4, the endogenous variable is clean energy adoption (CEA) considered in this study. Hence, only direct relationships are performed in this study. It shows the effect of banking sector's role (BF, BEC and PRA) on CEA. The exogenous variables account for about 53.4 percent of the variations in CEA, according to the model produced by Table 4.

The structural model assessment provides insights into the relationships among the study's latent variables: Bank Financing Availability (BF), Policy and Regulatory Authority (PRA), and Bank Expertise and Capacity (BEC) in influencing Clean Energy Adoption (CEA) in Tanzania. The model assessment involved evaluating path coefficients, hypothesis testing, effect sizes, multicollinearity, and model fit indices. The model fit indices indicate a good fit. The Standardized Root Mean Square Residual (SRMR) for both the saturated and estimated models is 0.059, which is below the recommended threshold of 0.08. The Normed Fit Index (NFI) value is 0.821, suggesting acceptable model fit. Other fit indices such as d_ULS and d_G are consistent across the saturated and estimated models.

The study next reports the PLS-SEM path coefficients and significance in Figure 1 after finishing the diagnostic tests. Figure 1 can be used to address all of the study hypotheses in a single model. The factor loadings were omitted to improve clarity for easy comprehension.

It can be seen from Figure 1 that the third research hypothesis on the influence of BEC on CEA is found to be positive and most significant (β=0.535, p-value < 0.001). It suggests that the null hypothesis of no significant influence of BEC on CEA is rejected. It can be said that a unit increase in BEC corresponds to a 0.535 unit increase in CEA. This confirms that institutional capacity, such as staff training, product innovation, and experience with clean energy projects, play a critical role in scaling renewable energy in Tanzania. The results therefore, support both theoretical expectations from Sustainable Finance Theory and Access to Finance Theory, emphasizing that the trained banks' staff are more responsive to sector-specific financing needs.

Moreover, the second research hypothesis on the effect of PRA on CEA is investigated. It can be seen that PRA (β = 0.216, p-value < 0.001) has a significant positive effect on CEA. Hence, the null hypothesis of no significant influence of PRA on CEA is rejected. In this manner, a unit increase in PRA corresponds to a 0.216 unit increase in CEA. It can then be concluded that PRA is relevant in enhancing CEA in Tanzania through supportive policy environment including tax incentives, permitting reforms, or central bank guidance by primarily shaping the banks' operating environment and risk perceptions.

Lastly, the third research hypothesis on the effect of BF on CEA is investigated. It is observable that BF (β = 0.076, p-value = 0.016) exhibits the weakest influence among the three. This implies that while financing availability matters, the quality and structure of financing such as loan tenor, interest, security mechanisms along with institutional capacity are more decisive for adoption outcomes than mere access to capital.

4.1.5 Robustness

In this study, the importance-performance map (IPM) is used to evaluate the most important bank roles that could improve CEA. The IPM for bank financing availability (BF), policy and regulatory authority (PRA) and bank personnel expertise and capacity (BEC) is given in Figure 2. It demonstrates explicitly how crucial each of the banking roles included in this study ensures clean energy adoption in Tanzania.

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Table 4. Hypotheses Testing

Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	2.5%	97.5%	Decision Rule
H1: BF -> CEA	0.076	0.078	0.032	2.407	0.016	0.015	0.139	Supported
H2: PRA -> CEA	0.216	0.216	0.040	5.377	0.000	0.136	0.294	Supported
H3: BEC -> CEA	0.535	0.534	0.042	12.835	0.000	0.451	0.616	Supported

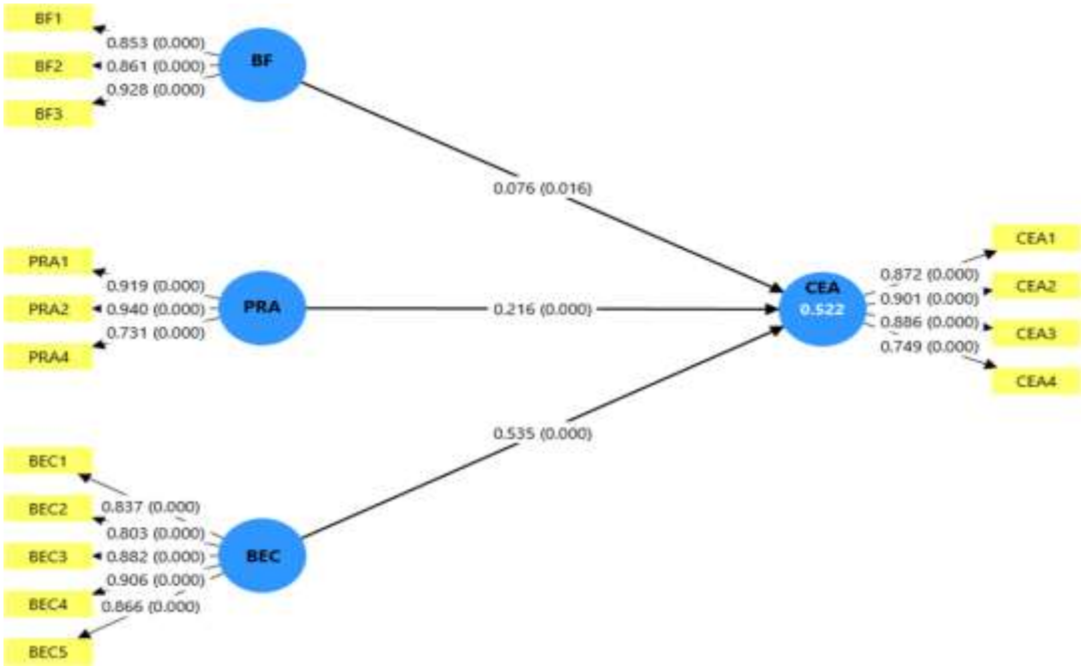

Figure 1. Structural path coefficients and bootstrapping.

Note*: BF, PRA, BEC and CEA represent Bank financing availability, Policy and regulatory authority support, Bank expertise and capacity in clean energy and Clean energy adoption.*

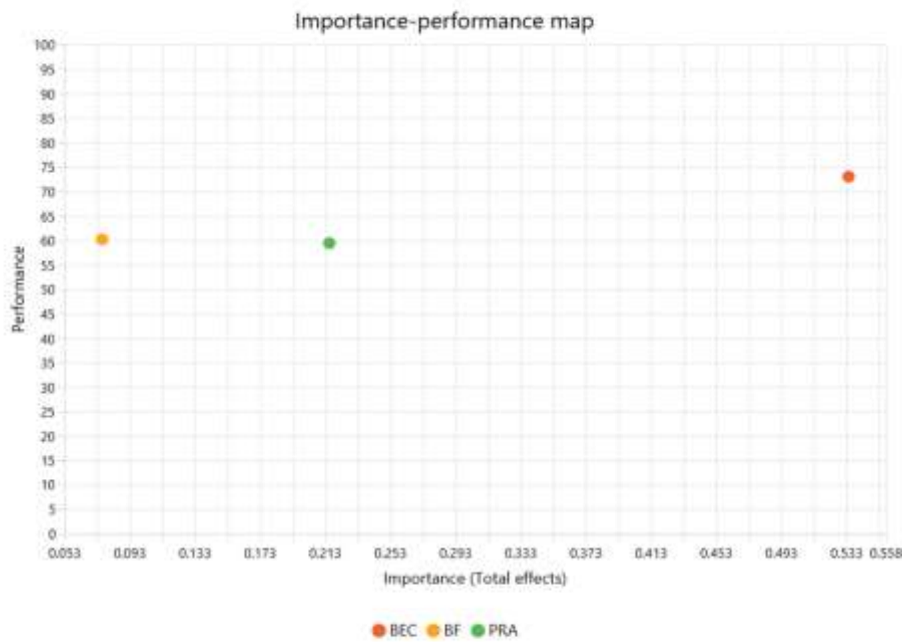

Figure 2. Importance- performance map.

Note: BF, PRA, BEC and CEA represent Bank financing availability, Policy and regulatory authority support, Bank expertise and capacity in clean energy and clean energy adoption

The importance performance map (IPM) of the exogenous factors employed in this investigation is shown in Figure 2. Comparatively, the IPM aids in determining the most significant banking functions that contribute to clean energy adoption. Figure 2 reveals that Bank Expertise and Capacity (BEC) is both highly important and well-performing, suggesting that it is the most impactful area to sustain and further improve. The impact of BEC on CEA is next followed by PRA and finally BF. Policy and Regulatory Authority (PRA) show a moderate performance but relatively higher importance than bank financing. This implies that policy interventions, especially around risk mitigation and regulatory clarity could yield significant gains. Moreover, the results reveal that bank financing availability (BF) had the lowest effect size despite moderate performance suggesting that access to finance alone is insufficient without capacity and enabling environments. Therefore, as BEC signals the greatest influence on CEA, policy actions on capacity building within banks need to be prioritised through staff training, green finance toolkits, and technical assistance from development partners. Similarly, financial innovation such as green bonds, blended finance to mention few, mush be scaled beyond pilot projects and integrated into core banking products and portfolios.

Table 5. Importance-performance values

Variables	Total effect (TE)	Performance (P)	Overall score (P/TE)	Rankings
BEC	0.535	73.009	136.545	1
BF	0.076	60.184	788.297	3
PRA	0.216	59.401	275.146	2

Note: *BF, PRA, BEC and CEA represent Bank financing availability, Policy and regulatory authority support, Bank expertise and capacity in clean energy and Clean energy adoption.*

Table 5 demonstrates the total effects (direct) on CEA. It can be seen from Table 5 that the determinants of CEA have a direct impact to a degree above 50%. Improvement in these factors would have serious repercussions on the CEA in Tanzania. However, the most impact on CEA is bank expertise and capacity. This is followed by BF and PRA. It is important that clean energy adoption in Tanzania is improved whereas policy and regulatory authorities are reviewed from time to time.

4.2 Discussion

4.2.1 There is a significant influence of bank expertise and capacity on clean energy adoption

It was discovered in the third hypothesis that BEC has a strongest and significant positive influence on CEA. This suggests that the null hypothesis of no significant influence of BEC on CEA is rejected. Consequently, the results reveal that bank expertise and capacity in clean energy (BEC) is the most critical determinant of clean energy adoption. This suggests that when banks possess the necessary technical knowledge and experience, they are more capable of supporting clean energy projects effectively, leading to higher adoption rates.

Furthermore, expert advice emphasizes the significance of ensuring clean energy adoption particularly through the role of the BEC. This agrees with the outcome by Sullivan and Goldson (2017) who highlighted that many banks lack internal expertise to access non-traditional clean energy risks and returns. Institutions that invest in internal capacity-building show higher levels of engagement and success in clean energy lending. Moreover, the findings by Hall and et al. (2017) examined low-carbon transitions in the UK and found that financial institutions with dedicated clean energy departments significantly contributed to higher rates of renewable energy project success.

4.2.2 There is a significant effect of policy and regulatory authority on clean energy adoption

Similarly, the second research hypothesis revealed that PRA has a significant positive effect on CEA. Thus, the null hypothesis of no significant influence of PRA on CEA is rejected. This indicates that there is a significant positive effect of PRA on CEA. It can then be concluded that PRA is relevant in enhancing CEA in Tanzania. Hence, factors such as clear policies, fiscal incentives, and enforcement mechanisms are essential to create an enabling environment for financiers and project developers. This is supported by the view that policy and regulatory authority (PRA) play a critical, positive role in clean energy adoption (CEA). For example, in Tanzania the SEFA Renewable Energy Investment Facility underscores that setting ambitious government targets like increasing the share of renewables, and expanding off-grid access depends fundamentally on enabling policies, regulatory streamlining, and investment facilitation (African Development Bank, 2020).

Likewise, studies on renewable energy capital flows across Africa find that institutional quality including regulatory effectiveness, low levels of corruption, and stable legal frameworks significantly attracts investment in renewable energy projects (Asongu & Odhiambo, 2023). The case of Tanzania's emerging electric vehicle (EV) policy likewise demonstrates that obstacles such as high taxes, unclear regulatory standards, and infrastructure deficits like charging networks and technical expertise reduce the pace of clean energy transition. However, the proposed measures such as tax incentives and regulatory clarity are expected to

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enhance adoption (The Citizen, 2025). This agrees with study by Czaplika-Kolarz et al. (2024) who argued that even where natural resources potential is high, stakeholders report that regulatory and legal weaknesses, financial constraints, and lack of human capacity are major impediments to clean energy investments.

4.2.3 There is a significant effect of bank financing availability on clean energy adoption

To end with, the study revealed an insignificant effect of BF on CEA. It can be said that, the null hypothesis of no significant influence of BF on CEA is not rejected. This means that bank financing availability is a weak enhancer of CEA. Hence, it can be concluded that despite the fact that access to funds is necessary, yet it is not sufficient on its own without corresponding expertise, risk assessment capacity and enabling policy frameworks. This is in favour of the study by Polzin et al. (2015) who argued that the availability funds alone cannot be considered a necessary condition for clean energy investments rather must be coupled with capable financial intermediaries who understand the specific risks and requirements of renewable energy projects. In the Tanzanian context, banks often lack specialized financial products and the technical know-how to structure financing for clean energy projects, which limits the practical impact of available funds (Blimpo & Cosgrove-Davies, 2019).

Moreover, institutional and policy support also play an indispensable role in translating financing availability into actual clean energy adoption. According to Huenteler et al. (2016) emphasized that a successful energy transition depends on the interplay between finance, policy, and technical expertise. Therefore, without supportive government policies such as incentives, risk-sharing mechanisms, or clear regulatory frameworks, banks may remain cautious or uninterested in lending to the clean energy sector. For example, in Tanzania, the absence of robust policy support and risk mitigation tools contributes to the weak relationship between financing availability and clean energy adoption (Urpelainen & Yao, 2017). Similar observation was reported by UNDP (2018) whereby minimal uptake of green credit facilities in countries like Ghana and Kenya was attributed by factors such as low awareness, insufficient technical capacity, and high perceived risks by lenders.

5. CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES

5.1 Conclusion

The study was set out to examine the influence of bank expertise and capacity (BEC), policy and regulatory authority (PRA), and bank financing (BF) on clean energy adoption (CEA) in Tanzania. Based on the analysis of the three research hypotheses, the findings reveal distinct roles played by these factors in promoting clean energy initiatives.

First, the results indicate that BEC has a positive and significant effect on CEA, highlighting it as the most critical determinant in the adoption of clean energy solutions. This underscores the importance of banks possessing technical knowledge, strategic capacity, and operational expertise in the clean energy sector to effectively support and drive adoption efforts.

Second, the study confirms that PRA also has a significant positive effect on CEA. This suggests that the ability of financial institutions to assess and manage risks associated with clean energy projects is a key enabler of successful implementation. Sound risk evaluation mechanisms build investor confidence and reduce uncertainties that typically hinder the financing of clean energy projects.

However, the findings from the first hypothesis reveal that BF has an insignificant positive effect on CEA, implying that the availability of bank financing alone does not strongly influence clean energy adoption. While access to capital remains necessary, it is insufficient in isolation. Without the accompanying expertise and robust risk assessment frameworks, financing alone cannot effectively drive the transition to clean energy.

In conclusion, the study demonstrates that technical capacity and risk management play more substantial roles in enhancing clean energy adoption than mere access to financing. For Tanzania to accelerate its clean energy transition, policy and institutional efforts should focus not only on increasing financial flows but also on strengthening the expertise and risk assessment capabilities within the banking sector. These findings offer valuable insights for policymakers, financial institutions, and stakeholders aiming to develop more effective strategies for sustainable energy development.

5.2 Recommendations

The study recommends from the third research hypothesis that for accelerating clean energy adoption in Tanzania, there is a clear need to strengthen the expertise and technical capacity of financial institutions in the area of clean energy financing. Also from the second research hypothesis, it is recommended that the government and relevant regulatory bodies should create a more enabling environment for clean energy adoption through clear, consistent, and supportive policies.

Additionally, the banking sector needs to improve its risk assessment mechanisms in order to capture the unique risks, technical, environmental and financial related constraints that ensure likelihood of clean energy investments' success. Similarly, investors in clean energy should focus on training programs mainly on project designing, financial modeling, and compliance with regulatory requirements so as to enhance the quality and bankability of clean energy related projects.

5.3 Suggestions for Further Studies

Future research could broaden this study by examining the role of diverse financial actors such as microfinance institutions, credit unions, venture capital firms, and development finance institutions in supporting clean energy projects, especially in underserved rural areas. Longitudinal studies would also be valuable for tracking how bank personnel expertise and capacity (BEC), policy and regulatory authority (PRA), and bank financing (BF) influence clean energy adoption (CEA) over time as markets and regulations evolve.

Further work should incorporate end-user perspectives to understand how access to financing affects adoption decisions among households and small businesses, helping to connect institutional financing mechanisms with real-world behaviour. Comparative studies across East African or Sub-Saharan African countries could reveal best practices and shared challenges relevant to strengthening Tanzania's clean energy ecosystem.

Research could also investigate how financial factors interact with non-financial barriers such as social acceptance, technical capacity, infrastructure, and cultural attitudes using mixed methods to capture these complex dynamics. Finally, examining the role of international climate finance and donor-supported programmes would shed light on how external grants and concessional funding shape local banking practices and investment patterns, and how such support can better align with sustainable energy transitions.

REFERENCES

1. International Renewable Energy Agency (IRENA). (2022). *Renewable Energy Market Analysis: Africa and its Regions – Sourcing the Sun*. Abu Dhabi.
2. Mgaya, G., & Mwakapugi, A. (2021). Barriers to renewable energy financing in Tanzania: A stakeholder perspective. *Tanzania Journal of Development Studies*, 19(2), 88–104.
3. Organisation for Economic Co-operation and Development (OECD). (2020). *Developing sustainable finance definitions and taxonomies*. OECD Publishing.
4. United Nations Development Programme (UNDP). (2021). *Tanzania Sustainable Energy for All (SEforALL) Action Agenda*. UNDP Tanzania.
5. United Republic of Tanzania (URT). (2021). *National Energy Policy 2020*. Ministry of Energy.
6. World Bank. (2020). *Unlocking private investment in clean energy in Africa: The role of the financial sector*. World Bank Group.
7. Sustainable Energy for All (SE4ALL). (2015). Tanzania's SEforALL Action Agenda and Investment Prospectus. Ministry of Energy and Minerals, United Republic of Tanzania.
8. World Bank. (2024). [Country report — mobilizing climate finance and green markets in Tanzania]. World Bank Group. (See the World Bank country diagnostic on green finance and barriers).
9. Zawya / The East African. (2025, July 14). Tanzania's CRDB goes global with landmark green bond listing. Zawya / The East African.
10. United Nations Capital Development Fund (UNCDF). (2024). Unlocking domestic finance through East Africa's first sub-national green bond: The Tanga case study. UNCDF.
11. Anku, J. E. (2025). Barriers to renewable energy adoption in Sub-Saharan Africa: A stakeholder perspective. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1234567
12. Climate Policy Initiative. (2024). Landscape of climate finance in Africa 2024. Climate Policy Initiative. https://www.climatepolicyinitiative.org
13. Emerald Insight. (2024). Renewable energy consumption, financial inclusion, and renewable deployment studies. International Journal of Energy Sector Management, 18(4), 512–529. https://doi.org/10.1108/IJESM-05-2024-0105
14. European Commission Joint Research Centre. (2020). Barriers to large-scale solar Power in Tanzania. JRC Publications Repository. https://publications.jrc.ec.europa.eu
15. International Monetary Fund. (2024). United Republic of Tanzania: Selected issues and statistical appendix. IMF eLibrary. https://www.imf.org
16. Luxembourg Stock Exchange. (2025, July 1). CRDB Bank lists the historic Kijani Bond on LuxSE. https://www.luxse.com
17. Omri, A., Daly, S., Rault, C., & Chaibi, A. (2022). Unbundling the dynamic impact of renewable energy and financial development in Africa. Scientific Reports, 12(1), 115–134. https://doi.org/10.1038/s41598-022-05230-3
18. Sustainable Energy for All. (2015). Tanzania SEforALL Action Agenda. Ministry of Energy and Minerals. https://www.seforall.org
19. The East African. (2025, July 14). Tanzania's CRDB goes global with landmark green bond listing. https://www.theeastafrican.co.ke

Corresponding Author: Jastine Katabaro

20. United Nations Capital Development Fund & World Resources Institute. (2024). Unlocking domestic finance through East Africa's first sub-national green bond: The Tanga case study. UNCDF/WRI. https://www.uncdf.org
21. World Bank Group. (2024). Country diagnostic: Mobilizing climate finance and green markets in Tanzania. World Bank. https://www.worldbank.org

Corresponding Author: Jastine Katabaro