Potential Impact of Renewable Energy Technologies as an Enabler of Economic Growth in Tanzania

An Evidence-Based Assessment of Policy, Institutional, Technological, and Economic Dimensions of Renewable Energy for a Sustainable Energy Transition

*Energy*CARDS & REPOA

Research Report 2025/04

Published by:

REPOA
157 Migombani/REPOA Streets, Regent Estate,
P.O. Box 33223
Dar es Salaam.

Authors: Energy CARDS & REPOA
Copy-editing & initial layout: Vincent Nalwendela | REPOA

Suggested citation:
*Energy*CARD & REPOA. (2025). Potential Impact of Renewable Energy Technologies as an Enabler of Economic Growth in Tanzania - An Evidence-Based Assessment of Policy, Institutional, Technological, and Economic Dimensions of Renewable Energy for a Sustainable Energy Transition. REPOA, Dar es Salaam.

Research Report 2025/04

Suggested Keywords:
Renewable Energy; Technology; Economic Growth; Energy Transition; Tanzania
ISBN 978-9987-753-32-1

Table of Contents

List of Figures

List of Tables

ACKNOWLEDGEMENTS

*Energy*CARDS wishes to extend its sincere gratitude to all who contributed to the successful completion of the research study titled "*Renewable Energy Technologies as Enablers of Economic Development in Tanzania*." This collaborative research with REPOA was guided by six specific objectives aimed at examining the policy and institutional framework, technological advancement, adoption barriers, emerging opportunities, cost-benefit dynamics, and strategic recommendations for enhancing the role of renewable energy in Tanzania's economic development.

We are deeply grateful to REPOA for its trust, guidance, and unwavering support throughout the study. Their commitment to evidence-based policy formulation to inform sustainable economic development provided a strong foundation for this work.

Special appreciation goes to the retired energy sector pioneers whose insights, experience, and historical perspectives enriched the study with depth and context. Their lifelong contributions to Tanzania's energy landscape continue to inspire future generations.

We also acknowledge the invaluable input from the 50 stakeholders engaged during the primary data collection phase, including the 28 respondents who provided written contributions. Their diverse perspectives, spanning from national views at Central Government and sectoral levels through the respective institutions including the Ministry of Energy, Vice President's Office (VPO's Office), Ministry of Minerals, Geological Survey of Tanzania (GST), Ministry of Livestock, Ministry of Water, Controller and Auditor General (CAG), Tanzania Electric Supply Company (TANESCO), Rural Energy Agency (REA), Energy and Water Utilities Regulatory Authority (EWURA), National Environment Management Council (NEMC), Dar es Salaam Institute of Technology (DIT), Commission for Science and technology (COSTECH), Local Government Leaders, community representatives and other key stakeholders with specific theme views: Development Partners, Cooperative and Rural Development Bank (CRDB), African Development Banks (AfDB), World Bank, Tanzania Renewable Energy Association (TAREA), Tanzania Traditional Energy Development and Environment Organization (TaTEDO), United Nations Industrial Development Organization (UNIDO), European Union (EU), Geo-Wind, Jumeme, Uwemba Mission, Mbeya University of Science and Technology (MUST), Sokoine University of Agriculture (SUA), and developers for their contributions and collaboration.

Our heartfelt thanks go to all interviewees and field visit participants across Dar es Salaam, Morogoro, Dodoma, Njombe, Mbeya, Singida, Shinyanga, and Mwanza. Your openness, time, and thoughtful reflections illuminated the realities of renewable energy implementation on the ground.

To the dedicated *Energy*CARDS Research Team, whose expertise, rigor, and collaborative spirit drove every phase of the study, from literature review and global benchmarking to fieldwork, data analysis, and dissemination, we express gratitude for your professionalism and commitment to excellence.

This study stands as a collective achievement, and we are confident that its findings will contribute meaningfully to Tanzania's energy transition and economic growth. We remain hopeful that the recommendations presented herein will inform future policies, investments, and innovations in the renewable energy sector.

FOREWORD

This research study on Renewable Energy Technologies (RETs) in Tanzania is the result of a collaborative effort between REPOA and *Energy*CARDS, driven by a shared commitment to advancing sustainable development through evidence-based policy and strategic innovation. As Tanzania continues to explore pathways for inclusive economic growth, the role of renewable energy has become increasingly central to national development priorities.

The study provides a comprehensive analysis of Tanzania's renewable energy landscape, drawing on global benchmarking, stakeholder engagement, field assessments, and rigorous data analysis. It captures both institutional and grassroots realities of RET implementation, offering insights into the opportunities, challenges, and transformative potential of renewable energy across sectors and regions. This work reflects the contributions of a diverse range of stakeholders whose perspectives and experiences enriched the study's findings. The dedication of the *Energy*CARDS Research Team, together with REPOA's strategic oversight, ensured the study's depth, relevance, and integrity.

We hope this report will serve as a valuable resource for policymakers, investors, researchers, and practitioners shaping Tanzania's energy future. We believe that the insights and recommendations presented here will inform bold, inclusive, and forward-looking decisions, accelerate the adoption of renewable energy technologies and contribute meaningfully to national development.

DISCLAIMER

This report is the result of a collaborative research effort between REPOA and EnergyCARDS, conducted to examine the potential impact of Renewable Energy Technologies (RETs) on economic growth in Tanzania. While every effort has been made to ensure the accuracy, reliability, and relevance of the information presented, the findings, interpretations, and conclusions expressed herein are those of the authors and do not necessarily reflect the views of REPOA, *Energy*CARDS, or any of the institutions and individuals consulted during the study.

The data and insights contained in this report are based on literature reviews, stakeholder interviews, questionnaires, and field visits conducted during the study period. Given the dynamic nature of the renewable energy sector, some information may evolve over time. Users of this report are therefore encouraged to consult additional sources and exercise discretion when applying its content to policy, investment, or operational decisions.

Neither REPOA, *Energy*CARDS, nor any contributors to this study shall be held liable for any consequences arising from the use of this report, whether direct or indirect. The inclusion of specific organizations, individuals, or technologies does not imply endorsement or recommendation.

ABBREVIATIONS

ADB	Asian Development Bank
AFD	Agence Française de Développement
AfDB	African Development Bank
CAG	Controller and Auditor General
CAPEX	Capital Expenditure
CBOs	Community Based Organizations
CDM	Clean Development Mechanism
CIF	Climate Investment Funds
COSTECH	Tanzania Commission for Science and Technology
CO_2	Carbon dioxide
CRDB	Cooperative and Rural Development Bank
CSP	Concentrated Solar Power
DIT	Dar es Salaam Institute of Technology
DNI	Direct Normal Irradiance
DPs	Development Partners
EACREEE	East African Centre of Excellence for Renewable Energy and Energy Efficiency
*Energy*CARDS	Energy Competency Advisory Research and Development Solutions
EU	European Union
EV	Electrical Vehicle
EWURA	Energy and Water Utilities Regulatory Authority
FDI	Foreign Direct Investment
FiT	Feed-in Tariff
FPV	Floating Photovoltaic
FYDP III	Third Five-Year Development Plan
GH_2	Green Hydrogen
GST	Geological Survey of Tanzania
GW	Gigawatt
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
IRR	Internal Rates of Return
ISA	International Solar Alliance
JET	Just Energy Transition
LCOE	Levelized Cost of Energy
LPG	Liquefied Petroleum Gas
MoE	Ministry of Energy
MoF	Ministry of Finance
MRV	Monitoring, Reporting, and Verification
MUST	Mbeya University of Science and Technology
NBS	National Bureau of Statistics
NDCs	Nationally Determined Contributions
NEMC	National Environment Management Council
NEP	National Energy Policy
NGOs	Non-Governmental Organizations
NPV	Net Present Value

O&M	Operations and Maintenance
PPP	Public-Private Partnership
PSMP	Power System Master Plan
PtG	Power-to-Gas
PtL	Power-to-Liquid
PtX	Power-to-X where X is hydrogen, synthetic natural gas, or chemicals
PUE	Productive Use of Energy
PV	Photovoltaic
RE	Renewable Energy
REA	Rural Energy Agency
REEEP	Renewable Energy and Energy Efficiency Partnership
REF	Rural Energy Fund
REN21	Renewable Energy Policy Network for the 21st Century
RETs	Renewable Energy Technologies
RPS	Renewable Portfolio Standards
RUCU	Ruaha Catholic University
RUWASA	Rural Water Supply and Sanitation Agency
R&D	Research and Development
SA	South Africa
SACREEE	Southern African Centre for Renewable Energy and Energy Efficiency
SDGs	Sustainable Development Goals
SEFA	Sustainable Energy Fund for Africa
SE4All	Sustainable Energy for All
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SME	Small and Medium-sized Enterprise
SPPs	Small Power Producers
SREP	Scaling Up Renewable Energy Program
SUA	Sokoine University of Agriculture
TANESCO	Tanzania Electric Supply Company
TAREA	Tanzania Renewable Energy Association
TaTEDO	Tanzania Traditional Energy Development and Environment Organization
TBS	Tanzania Bureau of Standards
TEEMO	Tanzania's Environment and Empowerment Movement
TGDC	Tanzania Geothermal Development Company
ToC	Theory of Change
TPA	Tanzania Ports Authority
TRA	Tanzania Revenue Authority
TREEEP	Tanzania's Rural Electrification Expansion Program
UDSM	University of Dar es Salaam
UN	United Nations
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
VCM	Voluntary Carbon Market
VPOs	Vice President's Office
VRE	Variable Renewable Energy
WB	World Bank
WTE	Waste-to-Energy
ZESTAs	Zero Emissions Ship Technology Association

Units of Measurement

GW (Gigawatt): A unit of power equal to one billion watts (109 watts). 1 GW = 1,000 MW
MW (Megawatt): A unit of power equal to one million watts (106 watts). 1 MW = 1,000 kW
TW (Terawatt): A unit of power equal to one trillion watts (1012 watts).1 TW = 1,000 GW

EXECUTIVE SUMMARY

This study critically examines the role of Renewable Energy Technologies (RETs) in advancing Tanzania's economic development. Anchored in a central research objective—to evaluate the contribution of RETs to inclusive and sustainable growth—the study is structured around six specific aims: assessing the adequacy of existing policy frameworks, identifying technological and financial constraints, and exploring strategic opportunities for sectoral expansion.

Employing a mixed-methods approach, the research integrates qualitative insights from expert interviews with quantitative data collected from 50 respondents across key government ministries and institutions. The overarching goal is to generate empirically grounded recommendations to inform policy and strengthen the institutional and investment landscape of Tanzania's renewable energy sector.

The findings reveal that, despite Tanzania's substantial renewable energy potential, the sector's current contribution to GDP remains below 2%, indicative of its nascent stage. Nonetheless, projections suggest that RETs could contribute between 1.5% and 10% of GDP by 2043, contingent upon targeted interventions. By 2030, the sector could yield cumulative economic benefits exceeding USD 18 billion, including USD 3.5 billion in savings from reduced fossil fuel imports and USD 8.4 billion in avoided health costs linked to biomass-based cooking. The Government of Tanzania has set an ambitious target to mobilize USD 4.039 billion in private sector investment, with projected annual revenues of up to USD 500 million in tax receipts and USD 300 million from carbon credits by 2035.

However, the study identifies several persistent barriers to RET adoption. These include a disconnect between policy formulation and implementation, limited operational guidelines, bureaucratic inefficiencies, high capital costs, and constrained access to affordable long-term financing. Technological challenges—such as underdeveloped grid infrastructure, reliance on imported components, and shortages of skilled personnel—further inhibit sectoral growth.

To address these constraints, the study proposes a suite of strategic interventions. These include the establishment of a centralized "One-Stop Regulatory Centre" to streamline approval processes, the creation of a Renewable Energy Investment Fund to catalyse private capital, and the introduction of fiscal incentives for both imported inputs and domestic manufacturing. Capacity-building efforts should prioritize vocational training and applied research to localize technology solutions, while the development of national quality standards would enhance consumer protection and market confidence.

In conclusion, Tanzania is at a critical juncture in its energy transition. While the policy environment is broadly supportive, realizing the full potential of RETs will require coordinated action to bridge the gap between policy and practice. Addressing financial, technical, and institutional challenges—while fostering a conducive environment for private sector engagement—will be essential to achieving universal energy access, accelerating economic growth, and ensuring environmental sustainability.

The study further recommends targeted research to assess the socio-economic impacts of decentralized RETs in rural communities, evaluate the feasibility of innovative financing instruments such as green bonds and micro-lending, and conduct technical assessments of smart grid technologies and the domestic RET value chain to inform industrial policy and local capacity development.

CHAPTER ONE: BACKGROUNG AND INTRODUCTION

1.1. Background and Context of the Study -The Global and Tanzania Energy Landscape

This chapter provides the foundational context for understanding the evolution of energy systems globally and within Tanzania, with particular attention to the growing importance of Renewable Energy Technologies (RETs). It establishes the background against which the research is set, highlighting the global energy transition, the drivers of change, and how these dynamics are shaping Tanzania's pathway toward sustainable economic and environmental development.

The global energy sector is undergoing a transformative shift, propelled by the urgent need to mitigate climate change, reduce greenhouse gas emissions, and enhance energy security as part of a broader agenda for sustainable development. Renewable Energy Technologies (RETs), including solar, wind, hydro, biomass, geothermal, green hydrogen and ocean energy (such as tides & wave power) have emerged as essential pillars of this transition. Over the past two decades, rapid technological advancements, rising productivity and profitability, declining costs, and supportive international policy frameworks have significantly accelerated the global adoption of renewables.

The cost of renewable power generation, particularly from solar and wind, has dropped dramatically, making these sources competitive with, or even cheaper than, fossil fuels in many regions (**Table 1**). This cost decline has been driven by steep learning curves, reflecting increasing technological proficiency, economies of scale from large-scale production, and continuous innovation. In contrast, certain heat and transport technologies, such as geothermal heating systems and hydrogen fuel cells, remain relatively expensive and less commercially mature.

One striking example of this transformation is the dramatic fall in solar photovoltaic (PV) module prices, which have declined by approximately 99% since the 1970s. The cost of solar modules has dropped from about $106 per watt in 1976 to around $0.38 per watt in 2019, with prices decreasing by roughly 20% for every doubling of global installed capacity. This unprecedented cost reduction underscores how technological progress, coupled with supportive policy interventions, has redefined the economics of global energy production and consumption.

Similarly, the Levelized Cost of Energy (LCOE) for wind power, particularly in areas with high wind potential and for onshore projects, has become increasingly competitive in recent years. As of 2023, the global LCOE for onshore wind energy was as low as $0.03–$0.04 per kilowatt-hour (kWh), depending on turbine technology, geographic location, and financing conditions. Offshore wind remains more expensive, averaging between $.080–$0.12/kWh (IEA, 2023). These reductions are largely attributed to technological improvements, economies of scale, and heightened market competition (Molly Lempriere, 2024) (Joel Jaeger, 2021).

This overall downward trend in renewable energy costs represents a paradigm shift in the global energy market, strengthening the case for a rapid transition from fossil-fuel -based to

clean energy systems. It also provides valuable lessons for developing economies such as Tanzania, which aim to leverage renewable technologies for sustainable growth and energy independence.

Table 1: Change in total installed costs/kWh and LCOE/kWh between 2010

	Total installed costs (2023 USD/kW)			Capacity factor (%)			Levelised cost of electricity (2023 USD/kWh)		
	2010	2023	Percent change	2010	2023	Percent change	2010	2023	Percent change
Bioenergy	3 010	2 730	-9%	72	72	0%	0.084	0.072	-14%
Geothermal	3 011	4 589	52%	87	82	-6%	0.054	0.071	31%
Hydropower	1 459	2 806	92%	44	53	20%	0.043	0.057	33%
Solar PV	5 310	758	-86%	14	16	14%	0.460	0.044	-90%
CSP	10 453	6 589	-37%	30	55	83%	0.393	0.117	-70%
Onshore wind	2 272	1 160	-49%	27	36	33%	0.111	0.033	-70%
Offshore wind	5 409	2 800	-48%	38	41	8%	0.203	0.075	-63%

Notes: CSP = concentrated solar power; kW = kilowatt.

According to the International Energy Agency (IEA, 2023), countries such as China, India, Germany, Brazil, and the United States have demonstrated that Renewable Energy Technologies (RETs) are not only environmentally sustainable but also economically viable. Their experiences affirm that renewable energy contribute significantly to job creation, enhanced energy security, lower energy costs, improved public health, foreign exchange savings, and long-term economic growth. In addition, international frameworks such as the Paris Agreement and the Sustainable Energy for All (SE4All) initiative are accelerating the adoption of renewable energy technologies in developing nations. These global commitments (see **Table 2**) are propelling countries toward net-zero emissions targets, reinforcing the critical role of renewable energy in achieving inclusive and sustainable economic transformation worldwide.

Table 2: Global renewable energy plans, targets and strategies

Global Plan/framework	Target	Strategy
Paris Agreement 2015[1]	- Limit global warming to below 2°C, preferably 1.5°C. - Achieve net-zero emissions by mid-century	- Nationally Determined Contributions (NDCs). Regular Global stock -taking to review progress. Climate financing of $100 billion/year. - Promote adaptation strategies, technology innovation, capacity building, enhance transparency and accountability, undertake collaborative regional initiatives and - Foster regional policy harmonization and integration
UN-Energy Plan of Action (2021-2025)[2]	- Provide electricity access to 500 million more people - Enable 1 billion people to access clean cooking solutions by 2025	- Develop analytical inputs to guide intergovernmental energy and climate agendas. - Convene annual Global SDG 7 Action Forums to assess progress

[1] Official Website: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[2] https://un-energy.org/wp-content/uploads/2022/04/UN-Energy-Plan-of-Action-At-a-Glance-final.pdf

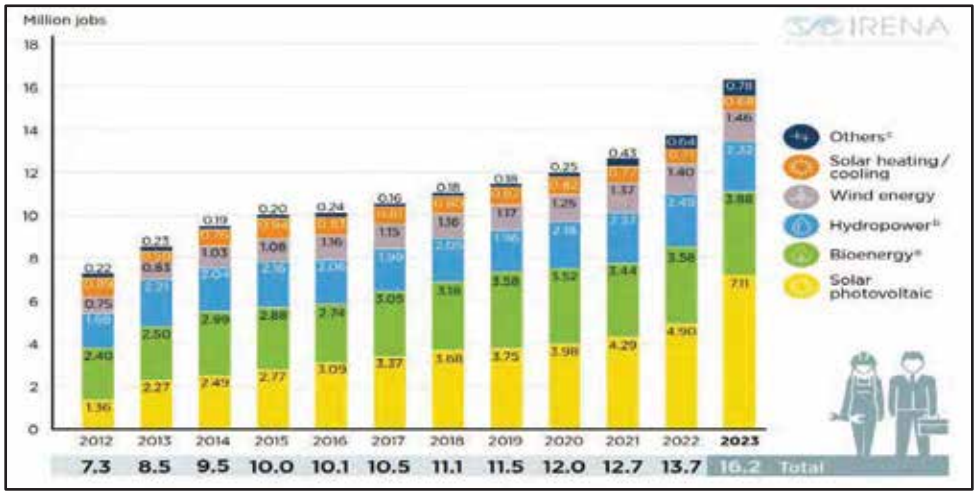
Global Plan/framework	Target	Strategy
	- Create 30 million jobs in RETs and energy efficiency by 2025	
IRENA Global Renewable Outlook (roadmap)[3]	- Achieve 90% renewable energy share in power generation by 2050. - Create 42 million renewable energy jobs.	- Country-specific roadmaps. - Support policy frameworks for renewable investments. Encourage regional cooperation. - Electrify key sector using renewable energy - Promote RETs e.g. Hydrogen, bioenergy
Sustainable Development Goal 7 (SDG7)[4]	- Universal access to affordable, reliable, modern energy by 2030. - Increase renewable energy share in the global mix. - Double energy efficiency improvement rate.	- Promote off-grid and mini-grid solutions. Support developing nations with renewable energy financing and capacity-building.
Net Zero by 2050	- Achieve carbon neutrality by 2050. - Transition to renewable energy in main fossil fuel consuming sectors- sectors, i.e. power, transport, and industry.	- Deployment of advanced technologies like green hydrogen. - Phasing out coal and investing in renewables like wind and solar.
Global Renewable Energy Alliance (GRA)[5]	- - global target of tripling renewable capacity by 2030 to at least 11,000 GW; annual addition of 150,000MW by 2030 - Mobilize $1 trillion annually for renewable energy projects globally, with a focus on developing countries.	- Policy advocacy for enabling policies such as feed-in tariffs, renewable portfolio standards, and subsidies for green technologies. - -Technical and policy advice - Capacity building and knowledge sharing - encourage collaboration between government, private sector and multilateral organization to fund and implement renewable energy projects - promote innovations and technology deployment in RETs - Support cross-border cooperation
Sustainable Energy for All (SE4ALL)[6]	- Electrify 600 million people in Sub-Saharan Africa by 2030. - Double renewable energy and energy efficiency	- Promote clean cooking solutions. - Partner with governments and private sector to mobilize investments
Clean Energy Ministerial (CEM)[7]	- Accelerate global deployment of clean energy technologies. - Increase energy efficiency in key industries.	- Initiatives like 21st Century Power Partnership and International Smart Grid Action Network. - Foster public-private partnerships
Powering Past Coal Alliance (PPCA)[8]	- Phase out unabated coal power globally by 2030 (developed countries) and 2050 (developing countries).	- Provide financial and technical support for transitioning to renewables. - Promote clean energy alternatives like solar and wind.
Global Environment Facility (GEF)[9]	- Support renewable energy adoption in developing countries. - Mitigate 1 billion tons of CO_2 by 2030.	- Collaborate with governments to integrate renewables in energy policy -Grant funding for renewable energy projects.
European Green Deal[10]	- Make Europe the first climate-neutral continent by 2050. - 55% reduction in emissions by 2030 (compared to 1990 levels).	- Implement Fit for 55 Package. - Introduce carbon pricing and renewable energy incentives. - Enhance cross-border energy trade.

[3] Full Report: https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020
[4] Full Report: https://www.iea.org/reports/net-zero-by-2050
Official SDG 7 Overview: https://sdgs.un.org/goals/goal7
[5] https://globalrenewablesalliance.org
[6] Official Website: https://www.seforall.org
[7] Website: https://www.cleanenergyministerial.org
[8] Website: https://www.poweringpastcoal.org
[9] Official Website: https://www.thegef.org
[10] Official Document: https://ec.europa.eu/clima/eu-action/european-green-deal_en

Global Plan/framework	Target	Strategy
Mission Innovation[11]	- Accelerate public and private investment in clean energy innovation. - Double clean energy R&D investment.	- Focus on breakthrough technologies like energy storage, green hydrogen, and smart grids. - Encourage international collaboration.
International Solar Alliance (ISA)[12]	- Deploy 1,000 GW of solar capacity by 2030. - Mobilize $1 trillion for solar investments.	- Promote solar energy policies in member countries. - Provide technical and financial assistance for solar projects.

The renewable energy industry experienced its largest ever increase in employment in 2023, reflecting the sector's accelerating momentum and global economic impact. Total renewable energy jobs grew from 13.7 million in 2022 to 16.2 million in 2023, marking a record expansion across all major renewable sectors **(Figure 1** and Figure 2). China led the global renewables workforce, accounting for an estimated 7.4 million jobs, or 46 per cent of the global total. Within this, approximately 4.6 million jobs were created in solar photovoltaic (PV) sector, while around 800,000 jobs were in the wind industry, particularly in turbine manufacturing and installation. According to the International Labour Organization (ILO, 2024), the rapid expansion of clean energy manufacturing contributedsignificantly to China's economic performance, accounted for around 5% of its GDP growth in 2023 (ILO, 2024). This surge in renewable energy employment underscores the sector'sgrowing role as a driver of inclusive, sustainable economic growth, demonstrating that climate action and job creation can advance in tandem.

Figure 1: Evolution of global renewable energy employment, 2012-2023

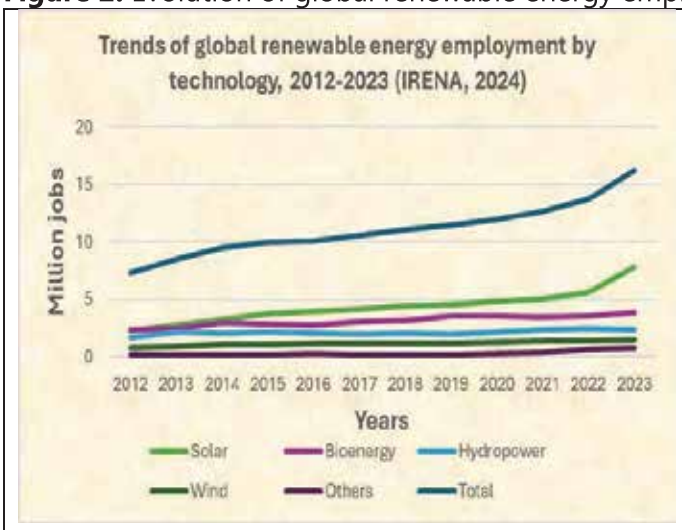


Source: (ILO, 2024)

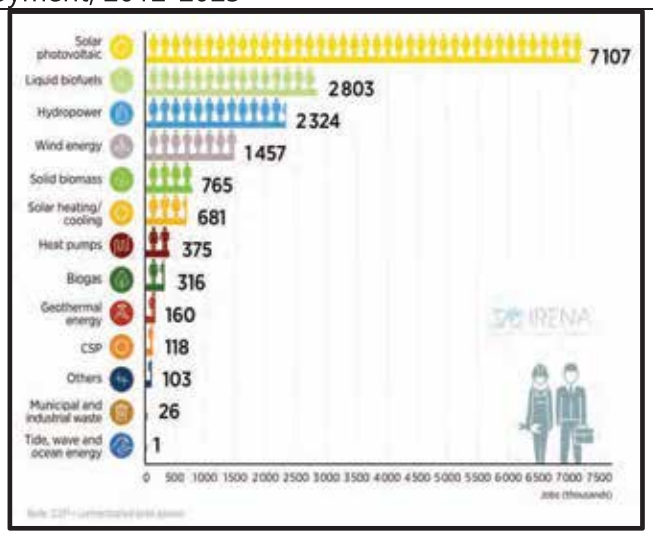
[11] Official Website: https://www.mission-innovation.net

[12] Official Website: https://www.isolaralliance.org

Figure 2: Evolution of global renewable energy employment, 2012-2023



Trend of employment by different technologies



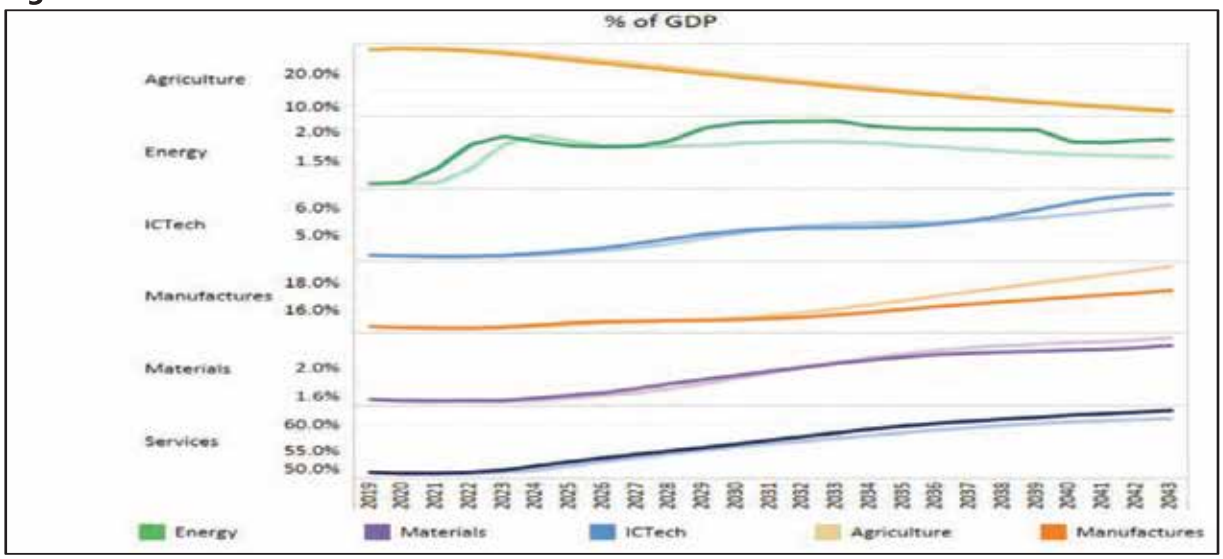
Global employment by technology in year 2024

Source: (IRENA, 2024)

Despite the remarkable global momentum in renewable energy adoption, many developing nations including Tanzania, continue to face challenges in fully harnessing the potential of their renewable energy resources.

Tanzania is richly endowed with diverse renewable sources such as solar, wind, hydro, geothermal, biomass, hydrogen and ocean energy (tides & waves). However, these resources remain largely untapped due to limited resource assessments, inadequate infrastructure, and insufficient investment in technology, innovation and capacity development. According to the Central Bank of Tanzania's 2024 First Quarter Report (2024), the electricity and gas sector grew by 7% highlighting steady progress in the country's energy development efforts. lectricity plays an indirect yet vital role in GDP growth by powering the industrial, transport, and storage sectors, thereby driving productivity across the economy.. Nonetheless, the overall energy sector's share of GDP remains below 2%, underscoring its underexploited potential in driving national economic transformation (**Figure 3**).

Figure 3: Sectoral contributions to the Tanzania GDP



Source: (Cilliers, 2024)

1.2. Tanzania's Energy Policy, Access, and Socio-Economic Context

Energy remains a key priority for the Government of Tanzania, which acknowledges that expanding access to modern and reliable energy services is critical for achieving its national development objectives. Tanzania's current national energy balance currently consists of 85% biomass, 9.3% petroleum, 4.5% electricity, and 1.2% coal and other sources. Despite this resource base, energy supply is not yet optimally developed, and the country experiences an annual power demand growth of 10 - 15%. As of 2025, the national grid and total country's installed capacities has reached 4,031.71 and 4,087.85 MW respectively while the maximum demand hit 1,888.72 MW respectively while the maximum demand hit 1,888.72 MW (MoE, 2025 - Unpublished). While all villages in Tanzania are technically electrified, the national access rate stands at 78.4% with urban access at 99.6% and rural access at 69.8%. The connectivity is lower, at 46% nationwide (urban 79% & rural 36%). Out of 64,359 hamlets, only 32,827 (≈52%) have electricity access (NBS & the National Energy Compact, 2025). According to the World Bank's 2023 Report, the number of Tanzanians using clean cooking solutions has been gradually increasing but at a slow rate from 1.5% in 2010 to 6.9% in 2021. However, current statistics show that the use of clean energy for cooking has increased to 27% as of March 2025 (MoE, 2025 – Unpublished)

Recent initiatives, including the National Clean Cooking Strategy (2024-2034), the National Renewable Energy Strategy (2024-2034), the National Energy Efficiency Strategy (2024-2034), and various donor-supported projects, have established a foundation for progress. However, pace of adoption remains slow due to due to policy, legal, regulatory, and institutional governance challenges, as well as low public awareness. Rural communities, which experience higher poverty levels and energy deprivation, continue to lack access to reliable and affordable energy, exacerbating socio-economic disparities.

Energy consumption in Tanzania is heavily skewed toward the residential sector (72.5%), followed by industries (14.4%), transport (5.8%), agriculture (4.2%), and other uses (3.1%) (EWURA, 2024). The relatively low consumption by economic sectors reflects the limited contribution of energy to overall GDP growth. Given these challenges, expanding investments in Renewable Energy Technologies (RETs) is essential for Tanzania to achieve energy security, address climate change, ensure universal access to modern energy services by 2030, and enhance livelihoods.

This study is both timely and essential, aiming to explore how Renewable Energy Technologies can drive sustainable economic growth in Tanzania.

1.3. Objectives and scope of the study

1.3.1. Objectives of the Study

The primary objective of this study was to examine the potential impact of Renewable Energy Technologies (RETs) as a catalyst for economic growth in Tanzania with a focus on the relationship between energy innovation and sustainable development. To achieve this overarching goal, the study was guided by the following specific objectives:

1. To examine the **policy and institutional framework** governing renewable energy development in Tanzania.
2. To assess the **current state and advancement of Renewable Energy Technologies** and benchmark them against global trends in order to identify gaps and opportunities.
3. To **identify the causes, barriers, and challenges** hindering the exploitation and adoption of renewable energy technologies.
4. To explore and evaluate **emerging opportunities for renewable energy deployment** across key sectors such as manufacturing, agriculture, and rural electrification.
5. To conduct a **cost benefit analysis of exploiting and adopting renewable energy technologies**, considering economic, social, and environmental dimensions.

To propose strategic interventions and policy recommendations aimed at enhancing the contribution of renewable energy to national economic growth and sustainable development.

1.3.2. Scope of the Study

This study examined Tanzania's renewable energy sector with particular attention to solar, wind, hydro, biomass, and geothermal technologies. It explored both urban and rural contexts, to assess how RETs can expand energy access, stimulate local economies, and contribute to the country's overall economic development. The study reviewed key elements shaping renewable energy landscape including, an existing policies, institutional arrangements, renewable energy potential, value chain, job creation, industrialization, technological capabilities, market dynamics, energy transformation and transition to net zero by 2050. Global and regional best practices were also analysed to contextualize Tanzania's progress and identify potential areas of opportunity.

In addition to extensive literature review, the study collected primary data through interviews, questionnaires and field visits to selected stakeholders and projects. The study further examined, analysed, and interpreted the findings to assess the feasibility and impact of renewable energy investments and utilisation as a catalyst for economic development in Tanzania. Finally, the study provides practical and actionable recommendations for renewable energy stakeholders mainly policymakers, investors, and development partners to strengthen Tanzania's renewable energy transition.

1.4. Significance of Renewable Energy in Tanzania's Socio-Economic Growth

Renewable Energy Technologies (RETs) offer practical, scalable solutions by harnessing the country's abundant solar, wind, hydro, and biomass resources to generate clean, decentralized energy (National Renewable Energy Strategy 2024–2034).

Renewable energy represents a transformative force in Tanzania's socio-economic landscape, offering a pathway toward inclusive growth, energy security, and environmental sustainability. With a population exceeding 60 million and rising electricity demand, Tanzania faces persistent challenges in ensuring universal access to reliable and affordable energy, particularly in rural and underserved areas. RETs offer practical, scalable solutions by harnessing Tanzania's abundant solar, wind, hydro, and biomass to generate clean, decentralized energy natural RE resources.

One of the most immediate benefits of renewable energy deployment is its role in advancing rural electrification. Solar mini-grids and off-grid systems have brought electricity to thousands of households, schools, and health centres improving education, healthcare, and overall quality of life. These systems also reduce dependence on polluting fuels such as firewood and charcoal, fostering environmental protection while catalyzing rural entrepreneurship, agro-processing, and digital connectivity.

At the macroeconomic level, renewable energy strengthens energy diversification, reduces reliance on imported fossil fuels, and enhances economic resilience. According to Tanzania's National Renewable Energy Strategy (2024–2034), installed renewable capacity is projected to expand significantly through initiatives such as feed-in tariffs and rural electrification programmes; creating thousands of jobs across manufacturing, installation, maintenance, and innovation sectors.

Moreover, renewable energy supports Tanzania's environmental commitments by lowering greenhouse gas emissions and mitigating climate risks. The strong correlation between renewable energy consumption and economic growth, underscores its strategic importance in Tanzania's sustainable development path. In essence, renewable energy is not merely a technical advancement, it is a socio-economic enabler capable of unlocking investment, innovation, and poverty reduction positioning Tanzania as a regional leader in the transition to a sustainable low-carbon future.

1.5. Conceptual Definitions & Framework

1.5.1. Conceptual Definition

To ensure conceptual clarity and consistency, the following key terms are defined as they are used in this study:

- ***Renewable Energy Technologies (RETs)*:** Technologies that generate energy from naturally replenishing sources such as solar, wind, hydro, biomass, geothermal, green hydrogen, and ocean energy (waves and tides). In this study, RETs include both large-scale centralized systems (e.g., hydropower plants) and decentralized systems (e.g., mini- and off-grid systems).
- ***Energy Access*:** The availability, affordability, reliability, and sustainability of modern energy services for households, businesses, and other users. This study adopts the World Bank's Multi-Tier Framework, which assesses energy access based on capacity (amount of power available for different uses), duration (hours of service per day and evening), quality (absence of voltage fluctuations or surges), reliability (low frequency of unplanned outages), and affordability (cost of energy relative to household income).

- ***Mini-grids:*** Small-scale electricity generation and distribution networks, typically ranging between 10 kW and 10 MW, that serve communities or clusters of users not connected to the national grid. Mini-grids can operate autonomously or interconnect with the main grid when it becomes available. They generally serve villages or small towns, while off-grid systems provide power to individual households, businesses, or institutions.
- ***Socio-economic Growth*:** The process of improving both the economic and social well-being of individuals and communities. It is reflected in rising incomes, employment creation, better access to healthcare and education, poverty reduction, and enhanced resilience to economic or environmental shocks, environmental stewardship, and social inclusiveness.
- ***Sustainability*:** The capacity to meet present energy and development needs without compromising the ability of future generations to meet theirs.
- ***Energy Transition*:** The structural transformation of energy systems from dependence on fossil-fuels- toward low-carbon, renewable, and energy efficient alternatives. It aims to foster sustainable development, energy security, and climate resilience.

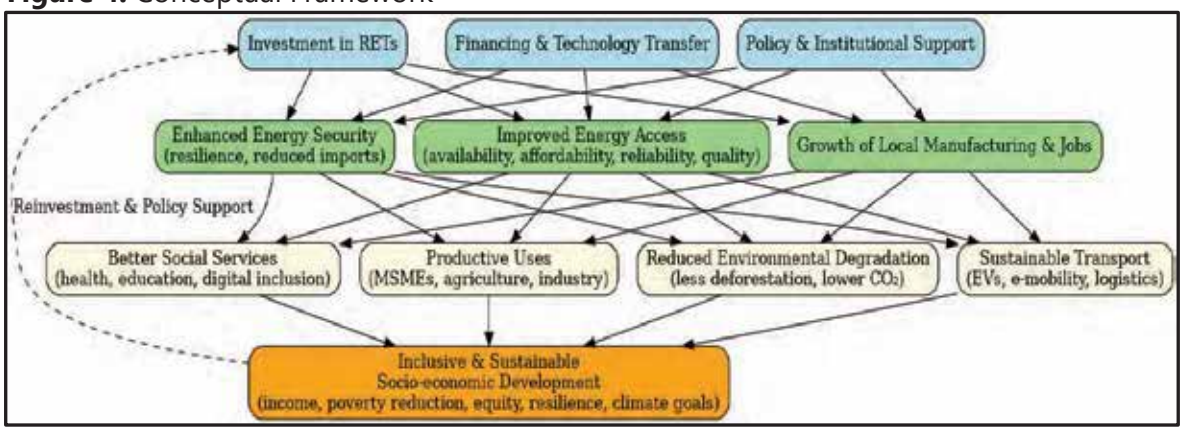
1.5.2. Conceptual Framework

The conceptual framework for this study illustrates the interlinkages between Renewable Energy Technologies (RETs) and sustainable economic development in Tanzania. It captures how the deployment of RETs contributes to multiple national development objectives, including energy access, economic diversification, environmental protection, and regional integration. The framework is anchored on six key relational pathways, as outlined below:

1. **Improved Energy Access:** Expanding renewable energy solutions —such as solar mini-grids, small hydropower, and wind systems—facilitates the provision of reliable and affordable electricity to underserved communities, particularly in rural areas and peri-urban areas. Improved energy access stimulates productive use of energy (such as agro-processing and small-scale manufacturing), enhances the delivery of social services (education and healthcare, and water supply) and mitigates environmental degradation resulting from reliance on biomass and kerosene.
2. **Enhanced Energy Security:** Diversifying energy sources through renewable technologies strengthens national energy security by reducing dependence on a single or limited number of energy supply chains. RETs reduce vulnerability to global energy price shocks, geopolitical disruptions, and fossil fuel scarcity, thereby ensuring a more stable and resilient energy system capable of supporting long-term national development.
3. **Reduced Energy Dependence:** By investing in domestic renewable energy resources, countries can substantially lower their reliance on imported fossil fuels. This not only improves balance-of-payment positions and foreign exchange stability but also fosters national energy sovereignty. The shift toward self-sustaining energy systems enhances economic independence and shields economies from the volatility of international energy markets.

4. **Growth of Local Manufacturing and Employment:** Developing renewable energy infrastructure stimulates the growth of local industries and supply chains. RET deployment creates direct and indirect employment opportunities across installation, operation, maintenance, and component manufacturing sectors. Moreover, it facilitates promotes technology transfer and innovation, building domestic technical capacity and fostering inclusive industrial growth.
5. **Support for Regional Cooperation:** Renewable energy projects that span national borders—such as regional power pools, shared hydropower facilities, and interconnection frameworks—strengthen regional integration and cooperation. Collaborative frameworks enable efficient resource utilization, knowledge exchange, and harmonization of energy policies. This collective approach supports the realization of regional development goals under initiatives like the East African Power Pool (EAPP) and the African Continental Free Trade Area (AfCFTA).
6. **Facilitation of Electric Vehicle (EV) Adoption & Green Transport:** A clean and diversified energy mix provides the foundation for transition to electric mobility and sustainable transport systems. By greening the electricity grid, renewable energy facilitates large-scale EV adoption, reduces urban air pollution and contributes to achieving national climate targets The integration of renewable-powered charging infrastructure further promotes circular and low-carbon economic growth.

Figure 4: Conceptual Framework



Source: Authors

These improvements collectively foster socio-economic growth and sustainability. The conceptual framework (

Figure *4*) illustrates how investments in Renewable Energy Technologies (RETs) translate into broader developmental outcomes through a sequence of interrelated drivers, intermediate results, and pathways.

1. **Driver:** Investment in RETs, Financing & Technology Transfer, Policy and Institutional Support. The process begins with strategic investments in renewable energy infrastructure, supported by enabling policies, effective institutional frameworks, and access to appropriate financing mechanisms. Technology transfer and capacity development ensure that RET solutions are adapted to local conditions and can be maintained sustainably.

2. **Intermediate (Energy System Outcomes):** Improved Energy Access (availability, affordability, reliability, and quality), Enhanced Energy Security (resilience, reduced imports), and Growth of Local Manufacturing & Jobs. Improved Energy Access, Enhanced Energy Security, and Growth of Local Manufacturing and Jobs. At the system level, RET investments lead to improved availability, affordability, reliability, and quality of energy supply. Diversification of energy sources enhances energy security and resilience, reducing import dependence and exposure to external shocks. Simultaneously, the expansion of renewable energy infrastructure stimulates local manufacturing, job creation, and technology innovation, reinforcing industrial development.
3. **Development Pathways**: The improved energy system catalyses a range of socio-economic and environmental benefits through four key pathways:
    a. **Productive Uses:** Increased access to reliable power supports micro, small, and medium enterprises (MSMEs), agro-processing, and industrial production, driving local economic growth.
    b. **Better Social Services:** Enhanced energy availability improves the delivery of health, education, and digital services, narrowing rural–urban disparities.
    c. **Reduced Environmental Degradation:** Transitioning from biomass and fossil fuels reduces deforestation and greenhouse gas emissions, supporting climate mitigation goals.
    d. **Sustainable Transport:** A cleaner grid facilitates electric mobility (EVs, e-mobility) and green logistics, cutting urban air pollution and promoting sustainable cities.
4. **Final Outcome:** Inclusive & Sustainable Socio-Economic Development. Over time, these combined effects contribute to broad-based economic growth, poverty reduction, improved resilience, social equity, and progress toward climate goals. The framework envisions a feedback loop in which economic gains and policy stability reinforce further investments in RETs, creating a self-sustaining cycle of innovation, productivity, and environmental stewardship.

1.6. Summary Interpretation

The model illustrates that investing in Renewable Energy Technologies (RETs), supported by sound policies, financing, and institutional support, generates multiple reinforcing outcomes: strengthened energy systems, boosts social and economic performance, and enhanced environmental sustainability. These interconnected feedback loops accelerate Tanzania's transition toward an inclusive, low-carbon, and resilient development pathway.

CHAPTER TWO: APPROACH AND METHODOLOGY

This chapter presents the approach and methodology employed in conducting the study. Guided by six specific objectives, the study adopted a mixed-methods research design, combining both qualitative and quantitative techniques to generate comprehensive insights and supported evidence-based policy recommendations. The integration of multiple data sources and analytical methods ensured robustness, validity, and a holistic understanding of the role of Renewable Energy Technologies (RETs) in driving Tanzania's socio-economic transformation.

2.1. Detailed Description of the Research Method Used

The study employed a mixed-methods approach that integrated qualitative and quantitative strategies. This design provided both depth and breadth of analysis, enabling a thorough examination of the potential impact of RETs as enablers of economic growth in Tanzania.

2.1.1. Qualitative Component

The qualitative aspect involved in-depth, semi-structured interviews with key stakeholders drawn from government agencies, development partners, private sector actors, financial institutions, and local communities. These interviews explored stakeholder perceptions, policy and institutional challenges, technological barriers, and emerging opportunities related to RETs development and deployment. Additionally, field visits were undertaken to selected project sites to observe operational realities, community engagement, and implementation outcomes.

2.1.2. Quantitative Component

The quantitative component comprised structured surveys and questionnaires designed to collect measurable data on tariffs, energy costs, installed capacities, resource availability, and socio-economic indicators. This component provided empirical evidence to quantify the economic and developmental impacts of RETs adoption at both local and national levels.

2.1.3. Research Phases and Processes

This research was carried out in five interconnected phases, ensuring systematic progression from conceptualization to policy formulation:

- **Phase I – Literature Review and Benchmarking**: A comprehensive desk review, was undertaken to analyse existing literature, national policies, and international best practices on renewable energy and economic growth. Comparative benchmarking was conducted with global case studies to identify lessons relevant to Tanzania's context.
- **Phase II** – Case Study Analysis: Selected international and regional case studies were examined to understand successful models of RET deployment, financing, and governance, highlighting transferable strategies and success factors.
- **Phase III – Primary Data Collection:** Surveys, interviews, and field visits were conducted to collect first-hand information from stakeholders and communities directly involved in or affected by renewable energy projects.
- **Phase IV – Data Analysis and Synthesis:** Data were analysed using triangulation techniques to cross-verify findings from different sources. Thematic and narrative synthesis was applied to organize insights around the study's six specific objectives, ensuring analytical coherence and relevance.
- **Phase V – Validation and Policy Formulation**: Key findings were discussed and validated through consultative meetings with sector experts and policymakers. The

validated results were then distilled into policy briefs and actionable recommendations to inform future planning and investment in the renewable energy sector.

2.2. Data Sources

- **Primary Data:** Obtained through stakeholder interviews, field observations, and survey questionnaires administered to energy users, service providers, and regulatory institutions.
- **Secondary Data:** Drawn from academic literature, government reports, international databases, and published case studies to provide the conceptual and contextual foundation for analysis.

2.3. Data Integration and Validation

The study employed **data triangulation** to enhance validity and reliability by cross-checking findings from different sources and methods. Both qualitative narratives and quantitative metrics were synthesized to present a unified interpretation of how RETs contribute to energy access, economic diversification, and sustainable development.

2.4. Study Approach and Design

The study employed an exploratory and evaluative research design, aligned with the six specific objectives. This dual design enabled the investigation of both the determinants and the impacts of Renewable Energy Technologies (RETs) on Tanzania's socio-economic development. The study focused on policy frameworks, technological advancement, adoption barriers, emerging opportunities, cost-benefit analysis, and strategic recommendations for sustainable energy transition.

The exploratory aspect of the design sought to uncover the underlying factors influencing the adoption and diffusion of RET. This included examining stakeholder perceptions, institutional arrangements, and socio-economic conditions shaping the renewable energy landscape. It emphasized understanding contextual dynamics, market readiness, and community engagement in renewable energy deployment.

The evaluative component, on the other hand, assessed the feasibility, performance, and impact of RET initiatives through comparative benchmarking, cost-benefit analysis, and strategic forecasting. It examined how renewable energy investments translate into measurable developmental outcomes, such as increased energy access, job creation, and environmental sustainability. The study combined macro-level institutional analysis focusing on national policies, regulatory frameworks, and investment trends with micro-level insights derived from project implementation experiences and local community interactions. This multi-scalar approach ensured a balanced assessment that captures both policy intent and ground-level realities.

Structured in multiple phases, the study systematically advanced from data collection to interpretation, integrating both qualitative and quantitative evidence. The analytical process was guided by two key conceptual and theoretical frameworks: like the Diffusion of Innovation Theory and the Sustainable Development Goals, ensuring relevance within both national and global development contexts.

- **The Diffusion of Innovation Theory**, which explains the adoption dynamics of new technologies and the role of communication channels, social systems, and innovation characteristics in influencing uptake.

- **The Sustainable Development Goals (SDGs) Framework**, which situates renewable energy development within global sustainability priorities, particularly SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action).

By grounding the research within these frameworks, the study ensured both contextual relevance to Tanzania's national development agenda and alignment with global sustainability objectives. This integrative approach strengthened the analytical rigor and policy applicability of the findings.

2.5. Data Collection Process

Data collection for this study was conducted through four main streams: (i) literature review, (ii) comparative case studies, (iii) primary data collection, and (iv) field visits. This multi-pronged approach ensured comprehensive coverage of both secondary and primary information sources, integrating global, national, and local perspectives on Renewable Energy Technologies (RETs).

2.5.1. Literature Review

The literature review involved a desk-based examination of existing studies, reports, and policy documents focusing on renewable energy resources and technologies, their state of development, emerging trends, and regulatory environments. It encompassed analyses of policy, legal, and institutional frameworks governing renewable resources in Tanzania, across Africa, and globally.

Data sources included:

- Official government policy instruments and sectoral strategies related to renewable energy;
- Academic journals and peer-reviewed research articles;
- Publications from international development agencies and financial institutions;
- Industry reports, market assessments, and grey literature;
- Global databases and repositories accessed via reputable search engines.

This comprehensive review provided a foundational understanding of RET development, policy frameworks, and global best practices. **Table 10** below provides a summary of the categories of literature reviewed.

Table 3: Sources of secondary data

Category	Description
Government Documents	National Energy Policy (NEP) 2015, National Development Plans, Renewable Energy Strategy (2024-2034), PSMP, National Clean Cooking Strategy (2024-2034), National Energy Compact (2025), Energy Efficiency Strategy & Action Plan, Electricity Act 2020, EWURA Act, REA Act, regulations and rules that govern the development and integration of renewable energy into the national grid and off-grid solutions, and other sectors' governing instruments related to the energy sector.
Academic Journals & Research Articles	Peer-reviewed studies on renewable energy technologies, energy economics, and socio-economic impacts of renewable energy projects.

Category	Description
International & Regional Organizations	Publications from World Bank, African Development Bank (AfDB), UN agencies, IRENA, EACREEE, SACREEE, and other bodies focused on energy and climate change.
Industry Reports & Market Analysis	Reports from renewable energy developers, market analysts, and industry associations (e.g., TAREA) covering investment trends, case studies, and market potential.
Grey Literature	Conference papers, working papers, NGO reports (e.g., TaTEDO), and consultancy studies offering practical insights into renewable energy challenges and opportunities in Tanzania.
Global Databases & Search Engines	Systematic searches via Google Scholar and websites of key institutions like the Ministry of Energy, IRENA, IEA, and development banks.

2.5.2. Comparative Case Studies

To contextualize Tanzania's renewable energy landscape within a broader international perspective, the study conducted comparative case studies across 21 countries spanning six continents. Initial selected criteria included renewable energy potential, current exploitation levels, energy demand, and energy mix diversity.

From of these, 12 countries were shortlisted for more detailed benchmarking based on additional parameters:

- Level of technological advancement and innovation in RETs.
- Socio-economic impacts of renewable energy adoption.
- Strength and consistency of policy and regulatory frameworks.
- Availability of financing models and incentives.
- Geological and climatic comparability to Tanzania; and
- Country size and stage of economic development.

The case studies were then categorized into three groups, -emerging, moderate, and advanced contexts of renewable energy development. This typology enabled comparative evaluation of policy frameworks, financing mechanisms, and institutional arrangements. Lessons derived from these case studies informed Tanzania's strategic options for scaling up renewable energy technologies (RETs) deployment facilitating benchmarking against global peers and identifying policy, investment, and capacity-building gaps.

2.5.3. Primary data collection

To obtain an in-depth and context-specific understanding of Tanzania's renewable energy ecosystem, the study employed both quantitative and qualitative methods. These included structured questionnaires and semi-structured interviews with a wide range of stakeholders.

Sampling Procedures and Sample Size: A purposive and stratified sampling strategy was used to ensure representation across key stakeholder categories and geographic regions.

To obtain an in-depth and context-specific understanding of Tanzania's renewable energy ecosystem, the study employed

- **Purposive sampling** targeted individuals and institutions with direct involvement or expertise in renewable energy development.

- **Snowball sampling** was employed to identify additional respondents recommended by initial participants.

Stakeholders were broadly classified into two main groups:

1. **Governmental institutions** – including ministries, regulatory authorities, and public utilities; and
2. **Non-governmental actors** – including development partners, academic institutions, private companies, financial entities, and community representatives.

This design enabled the study to integrate insights from both policy-level decision-makers and on-the-ground implementers.

2.5.4. Questionnaire Method

Self-administered, structured questionnaires were distributed to capture quantitative data from conveniently selected respondents. Of the 50 individuals approached, 28 completed the survey successfully, representing diverse demographic and professional backgrounds in the energy sector.

The questionnaires gathered data on:

- Tariff structures and investment costs.
- Tax incentives and fiscal policies.
- Employment creation and industrial linkages.
- Trade and market opportunities; and
- Broader socio-economic indicators, such as income and living standards.

This structured approach facilitated comparative analysis and provided a quantitative foundation for subsequent cost–benefit assessments and policy evaluation.

2.5.5. Interview Method

Complementing the survey, semi-structured interviews were conducted to capture qualitative insights into stakeholder perceptions, challenges, and opportunities within the RETs sector. The interviews explored dimensions such as institutional readiness, policy effectiveness, financing barriers, community participation, and socio-economic impact.

Interviews were conducted across eight regions in March and April 2025: Dar es Salaam, Morogoro, Dodoma, Njombe, Mbeya, Singida, Shinyanga, and Mwanza. Four research teams, each composing of two experts, carried out the consultations and site assessments.

In Dar es Salaam, key participants included representatives from:

- The Norwegian Embassy, NEMC, UDSM, DIT, COSTECH, World Bank, AfDB, TPA, TGDC, TRA, CRDB, TAREA, TaTEDO, UNDP, EU, UNIDO, Geo-Wind; and
- Senior energy pioneers: Eng. Bashir J. Mrindoko, Eng. Maneno Katyega, and Eng. Anastas Mbawala.

In other regions, interviews were conducted with officials from the Ministry of Energy, VPO's Office, Ministry of Minerals, GST, Ministry of Livestock, Ministry of Water, CAG, TANESCO, REA,

EWURA, as well as academic institutions and project sites (e.g., Uwemba Mission, MUST, SUA, and RUCU). Participants also developers, equipment importers/suppliers, end users, and regional administrators.

The interviews yielded rich, context-specific narratives that complemented the quantitative data and informed the study's strategic policy recommendations.

2.5.6. Field visits

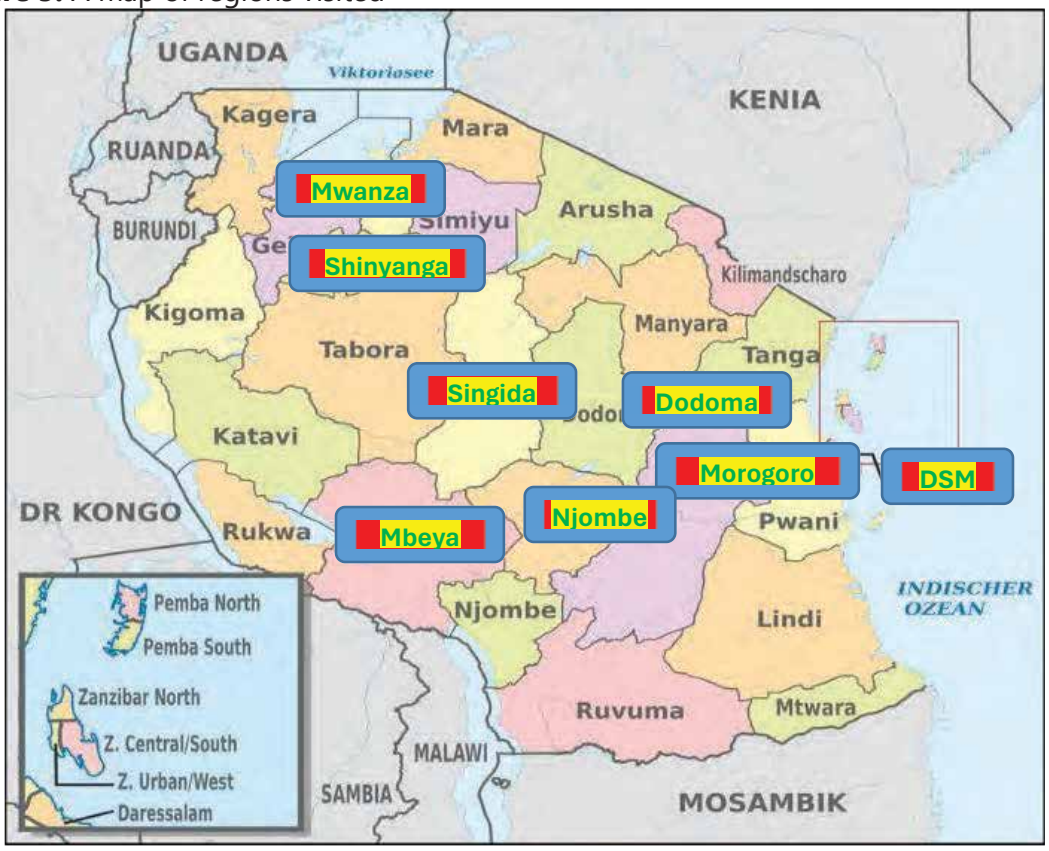
Field visits were undertaken to key renewable energy project sites to validate data and observe implementation practices first-hand. The visited sites (

), included:

- Solar installations in Singida and Shinyanga.
- Small hydropower projects in Njombe; and
- A geothermal development site in Mbeya.

These visits provided valuable insights into technical performance, community participation, and operational challenges, helping bridge the gap between policy design and on-the-ground realities. Observations gathered from these sites enhanced the study's evidence base and enriched its qualitative analysis.

Figure 5: A map of regions visited



2.5.7. Discussion of Findings – Applied Approach

The discussion of findings employed a combination of analytical techniques to ensure clarity, rigor, and alignment with the study's objectives. Stakeholder perspectives were systematically correlated to each objective to maintain relevance and analytical precision.

Thematic analysis was applied to organize the findings around the specific research objectives, identifying recurring patterns, relationships, and emerging issues. Triangulation was then used to validate insights by cross-verifying evidence from literature, interviews, questionnaires, and field observations. The integration of qualitative and quantitative further strengthened the analysis by combining perceptions and lived experiences with empirical data and cost–benefit indicators.

Comparative benchmarking provided an additional interpretive lens, situating Tanzania's renewable energy trajectory within broader international experiences and best practices. Narrative synthesis was used to integrate the diverse strands of evidence e into coherent, logical explanations, while critical reflection enabled the identification of contradictions, limitations, and underlying drivers shaping the observed patterns.

Together, these techniques ensured that the findings were comprehensive, contextually grounded, and strongly evidence based. Although not explicitly stated, the interpretation of results was conceptually guided by frameworks such as the Diffusion of Innovation Theory and the Sustainable Development Goals, which helped to frame the broader developmental implications of the study's outcomes.

2.6. Data Analysis and Interpretation Techniques Applied

To effectively analyse and interpret the data collected in the study on Renewable Energy Technologies (RETs), a combination of quantitative and qualitative techniques was employed. Quantitative methods such as descriptive statistics, inferential analysis, and cost-benefit evaluation, were used to summarize numerical data, identify relationships among variables, and assess economic implications. Visual tools including charts, graphs, and tables were applied to illustrate trends and patterns clearly.

On the qualitative side, techniques such as thematic and content analysis, narrative interpretation, and framework mapping were utilised to derive nuanced insights from interviews stakeholder perspectives, and field observations. Integrative approaches, including triangulation and comparative benchmarking ensured consistency across data sources and positioned Tanzania's renewable energy progress within a global context.

Finally, strategic forecasting was applied to translate analytical insights into targeted, actionable policy recommendations, ensuring that the study remained both evidence-based and solution-oriented.

2.7. Limitation, Risks, and Mitigation Strategies

Despite the comprehensive design and execution of the study, several limitations and risks were encountered that could influence the depth, representativeness, and reliability of the findings. These challenges were systematically identified and addressed through appropriate mitigation measures to preserve the study's integrity and analytical robustness.

A key limitation was the modest questionnaire response rate, with only 28 out of 50 targeted stakeholders completing the survey. This was mitigated by conducting in-person interviews and expanding stakeholder categories to achieve broader representation. Sampling bias posed another potential risk due to the geographic concentration of data collection in selected regions and institutions; however, the inclusion of diverse stakeholder groups helped balance this limitation.

The reliability of self-reported data was addressed through triangulation, comparing survey responses with literature reviews and field observations. Some literature sources were

outdated or incomplete, but this was mitigated by using multiple databases and prioritizing recent peer-reviewed publications. To reduce subjectivity in qualitative interpretation, structured coding frameworks and peer reviews were employed to ensure analytical consistency.

During interviews, language and comprehension barriers occasionally arose, these were managed through guided explanations, albeit extending session durations. Time constraints during field visits limited the depth of on-site assessments, which was mitigated by focusing on key project sites and conducting follow-up consultations. To reduce subjectivity in qualitative interpretation, structured coding frameworks and peer review were employed to ensure analytical consistency.

Comparability challenges in global case studies were managed by applying standardized benchmarking criteria and clearly articulating contextual differences between countries. Political and institutional sensitivities were navigated through maintaining neutrality, securing ethical clearance, and anonymizing sensitive responses.

Given the rapidly evolving nature of renewable energy technologies (RETs) there is a risk that some findings may become outdated over time. This was mitigated by incorporating forward-looking scenarios and recommending periodic policy reviews. Additionally, limited technical data on RET performance and costs were addressed through collaboration with technical institutions and the use of proxy indicators.

Finally, the study recognized the risk of overgeneralizing findings across Tanzania's diverse regions. To address this, region-specific follow-up studies were recommended to enhance contextual accuracy and policy relevance.

Overall, these mitigation strategies collectively helped maintain the study's reliability, validity, and relevance, while highlighting key areas for future research and refinement. **Table 4** summarizes the main risks encountered and the proactive measures taken to manage their impact.

Table 4: Research limitations and mitigation strategies

Limitation / Risk	Mitigation Strategy
Limited stakeholder participation (only 28 out of 50 completed questionnaires)	Increase follow-up efforts, offer digital survey options, and incentivize participation.
Sampling bias due to concentration in specific regions and institutions	Diversify geographic and institutional coverage in future studies.
Data reliability issues from self-reported responses	Cross-validate with secondary data and field observations.
Incomplete or outdated literature sources	Use multiple databases and prioritize peer-reviewed and recent publications.
Language and comprehension barriers during interviews	Use trained local facilitators and translated materials where needed.
Limited time for field visits and data collection	Extend fieldwork duration or conduct phased follow-ups.
Subjectivity in qualitative data interpretation	Apply structured coding frameworks and peer review of analysis.
Comparability challenges in global case studies	Use standardized criteria for benchmarking and clearly define context differences.

Limitation / Risk	Mitigation Strategy
Potential political or institutional sensitivities	Ensure ethical clearance, maintain neutrality, and anonymize sensitive responses.
Rapidly evolving RET landscape may outdate findings	Include forward-looking scenarios and recommend periodic policy reviews.
Limited technical data on RET performance and costs	Collaborate with technical institutions and use proxy indicators where direct data lacks.
Risk of generalizing findings across diverse regions	Clearly state scope limitations and recommend region-specific follow-up studies.

CHAPTER THREE: RENEWABLE ENERGY LANDSCAPE IN TANZANIA

3.1. Powering Progress: Tanzania's Renewable Energy Imperative

Energy is the backbone of modern civilization, powering homes, industries, businesses, and technological innovation that collectively drive human progress and national socio-economic transformation (World Bank, 2025). Despite notable progress, Tanzania continues to face significant energy access challenges. As of 2021/22, only 78.4% % of mainland households had access to electricity (urban 99.6%; rural 69.8%), while just 45.8% (urban 79% and rural 36%) were actively connected to the grid (NBS, 2024).

Rural and peri-urban communities remain disproportionately underserved, constraining productivity, industrialization, and social development. Moreover, two in three households still rely primarily on firewood for cooking, reflecting a continued dependence on traditional biomass energy sources (NBS, 2024).

Concurrently, the growing global climate crisis underscores the urgent need for transition from fossil fuels to sustainable, renewable energy solutions. According to the IPCC's Sixth Assessment Report (2022), East Africa, including Tanzania is projected to experience unprecedented rates of climate change characterized by rising temperatures, more frequent and intense heatwaves, prolonged drought, and erratic rainfall patterns. These changes heighten the risks of flooding, agricultural disruptions, and water scarcity, all of which threaten the national food security and economic stability (IPCC, 2022).

In this context, transitioning to renewable energy is not merely an environmental imperative but also a strategic economic necessity for Tanzania's sustainable growth and resilience.

Limiting global warming to 1.5°C, as emphasized by the IPCC, could substantially mitigate these adverse effects, protecting both ecosystems and livelihoods. In this context, transitioning to renewable energy is not merely an environmental imperative but also a strategic economic necessity for Tanzania's sustainable growth and resilience.

Tanzania's abundant renewable energy potential spanning solar, wind, hydro, geothermal, and biomass presents transformative opportunities to align with international climate commitments while advancing domestic development goals. Harnessing these resources can yield multiple socio-economic benefits, including:

i. Earning carbon credits through low-emission energy generation.
ii. Exporting surplus energy to regional markets.
iii. Creating green jobs across the value chain.
iv. Leveraging critical minerals for renewable technology manufacturing.
v. Enhancing industrial efficiency and competitiveness; and
vi. Building a resilient, inclusive, and sustainable energy system with strong multiplier effects across the economy.

In sum, this chapter examines Tanzania's renewable energy landscape—its current status, policy environment, institutional framework, and potential to drive sustainable socio-economic development in line with national and global energy transition goals.

3.2. Historical Evolution of Renewable Energy Development in Tanzania

3.2.1. Early Phase (1960s–early 2000s): Hydropower Dominance

Following independence in 1961, Tanzania prioritized electrification and industrial growth as cornerstones of national development. The government — supported by international partners such as the World Bank, the Nordic Development Fund, and bilateral donors — invested heavily in large-scale hydropower infrastructure. Hydropower was viewed as both a renewable and cost-effective option capable of supporting long-term economic expansion and rural transformation.

Notable investments during this period included the Kidatu Hydropower Plant (200 MW) and Mtera (80MW) commissioned in the 1970s, followed by the Pangani Falls (68MW) and Kihansi Hydropower Plant (180 MW) completed in the late 1990s and early 2000s. These projects became the backbone of the national grid, enabling urban electrification, industrial operations, and affordable households power access.

To guide the expanding energy sector, Tanzania formulated its first National Energy Policy in 1992, marking a key milestone in institutionalizing the management of energy resources. The policy was subsequently reviewed in 2003 and 2015 to reflect changing national priorities, global energy trends, and emerging sustainability imperatives.

3.2.2. Hydropower Dependence, Climate Vulnerability, and Transition Pathways

While hydropower historically provided clean and affordable energy, the sector's heavy dependence on river-based systems exposed Tanzania to significant climate and hydrological risks. Prolonged droughts and increased climate variability led to recurrent power shortages and nationwide load-shedding, forcing the country to rely on costly thermal generation and imported fossil fuels to fill supply gaps.

Droughts and irregular rainfall patterns repeatedly reduced river flows and reservoir levels. For instance, in 2022, output from the Kihansi Hydropower Plant plummeted from 180 MW to only 17 MW, triggering widespread to widespread power rationing and economic disruptions. Such events underscored the urgent need to diversify the national energy mix toward more climate-resilient renewable sources such as solar, wind, geothermal, and modern biomass.

This realization marked a turning point in Tanzania's energy planning—prompting policy reforms, new investment frameworks, and the gradual emergence of a multi-source renewable energy strategy aimed at achieving energy security, environmental sustainability, and socio-economic resilience.

3.2.3. Emergency Generation and the Rise of Independent Power Producers (IPPs)

In response to recurring power shortages caused by declining hydropower generation, Tanzania turned to Emergency Power Plants (EPPs) and Independent Power Producers (IPPs) as short-term solutions to stabilize electricity supply. Beginning in the early 2000s, these measures marked a turning point in the country's energy landscape by introducing private participation into power generation, previously dominated by the state utility, TANESCO.

Key players during this period included Independent Power Tanzania Limited (IPTL, 2002), Aggreko (2004), Richmond Power, Songas (2004), and Symbion Power (2011). Among these, Songas became a major contributor to the national supply, generating approximately 180 MW

using natural gas from the Songo Songo fields, thus marking a significant milestone in Tanzania's transition toward domestic gas utilization. Meanwhile, Aggreko, *Richmond* and *Symbion Power* provided short-term emergency generation that helped mitigate acute shortages during hydropower crises.

Although these initiatives enhanced generation capacity and improved grid reliability, they introduced serious financial and governance challenges. The high operational and fuel costs of thermal plants placed a heavy financial burden on TANESCO (the national utility) and ultimately on electricity consumers. In addition, several emergency power contracts were criticized for lack of transparency, cost inefficiency, and limited long-term sustainability.

While EPPs and IPPs interventions were instrumental in bridging short-term gaps, their limitations underscored the need for strategic energy diversification and investment in sustainable renewable energy technologies to achieve long-term energy security and fiscal stability.

3.2.4. Evidence of Climate Impacts

Empirical evidence from recent studies and institutional reports underscores the growing influence of climate variability on Tanzania's power sector performance and policy direction:

- Africanews (2022) reported that Tanzania experienced a 300–350 MW generation shortfall during drought-induced power rationing, severely affecting industrial and household supply.
- The African Development Bank **(**AfDB, 2016) highlighted Tanzania's heavy dependence on hydropower and emphasized the country's significant but underutilized potential in solar, biomass, geothermal, and wind energy.
- According to Trade.gov (2021), during periods of reduced hydropower output, the government routinely resorts to Emergency Power Producers (EPPs) to bridge the supply gap, often at high fiscal and environmental cost (see **Table 5**).
- The International Monetary Fund **(**IMF, 2024) recommended that Tanzania align energy planning with climate resilience goals and scale up renewable investments to mitigate economic shocks arising from droughts and fossil-fuel volatility.

Collectively, these findings reinforce the necessity of transitioning toward a diversified and climate-resilient energy mix, positioning renewable energy technologies as both an economic and environmental imperative for Tanzania's sustainable development.

It was increasingly recognized that scaling up the use of alternative renewable energy sources could stabilize Tanzania's power system, reduce exposure to hydrological shocks, and lower long-term generation costs, thereby enhancing both energy security and economic resilience.

Table 5: Impact of EPPs & IPPs contracts on Tanzania's economy

Economic Impact	Contextual Notes	Remarks
Business losses from power outages	15% of annual sales (World Bank Enterprise Survey)	This figure represents the cost to businesses in Tanzania due to power outages.
TANESCO's net loss (2013)	USD 295 million (up from USD 112 million in 2012)	A significant portion of this loss was due to the high cost of

Economic Impact	Contextual Notes	Remarks
		contracting emergency power plants.
IPTL's monthly capacity charges	Originally claimed $4.5 million per month, reduced to $2.6 million per month by arbitration.	This was a fixed cost to TANESCO, regardless of whether the plant was generating power.
Richmond Power (later Symbion)	$4 million per month in capacity charges for two years while the plant was idle.	This resulted in a total loss of $96 million over that period.
Total direct costs of EPPs	$1.5 billion related to the IPTL saga.	This figure represents the direct costs to Tanzania from the IPTL contracts, including inflated costs and legal fees.
Cost of electricity from IPPs vs. TANESCO	TANESCO paid IPTL over 12 cents per unit, while its own generation cost 7-9 cents.	This shows the high tariff burden on national utility.
Cost difference between IPPs	In 2015, IPTL's unit cost was 31 cents per kWh, while Songas' was 0.05 cents per kWh.	This highlights the significant cost variations and inefficiencies in the contracts, with IPTL's high cost attributed to its use of expensive imported diesel.
TANESCO's revenue used for IPPs	~90% of total revenue in some years.	This indicates the extreme financial burden of IPP contracts, which represented less than 30% of national generation capacity.
TANESCO's loans and subsidies	USD 250 million in commercial loans and a USD 220 million budget transfer (2013/14)	These were required to cover losses from high-cost IPP contracts.

3.2.5. Liberalization and Reform Era (1990s–2000s): Private Participation and Diversification

The economic liberalization reforms of the 1990s marked a turning point in Tanzania's energy sector, paving the way for institutional restructuring, private participation, and market diversification. In line with broader structural adjustment programs, the government introduced policies to enhance efficiency, attract investment, and expand access to electricity beyond urban centres.

Key institutional milestones during this period included the establishment of the Energy and Water Utilities Regulatory Authority (EWURA) in 2001, mandated to regulate and oversee the electricity, petroleum, and water sectors, and the Rural Energy Agency (REA) in 2005, tasked with promoting and financing rural electrification initiatives (World Bank, 2003; REA, 2007).

Donor-supported pilot projects during era began exploring decentralized renewable energy solutions, including small-scale solar, biomass, and mini-hydropower systems, particularly in rural and off-grid communities. However, recurrent and severe droughts in the late 1990s and

early 2000s underscored the vulnerability of the national grid's dependence on hydropower, leading to frequent power outages, reduced industrial output, and economic slowdowns. To mitigate these impacts, the government resorted to emergency thermal generation, primarily diesel- and gas-fired power plants, to stabilize electricity supply and sustain economic activity during hydropower shortfalls.

3.2.6. Acceleration Era (2010s–Present): Renewable Integration

By the 2010s, the combination of frequent hydropower disruptions, growing electricity demand, and climate-related risks intensified Tanzania's drive to diversify its energy mix. The National Energy Policy of 2015 formally recognized renewable energy as a strategic pillar for achieving sustainability, energy security, and universal access (MEM, 2015).

This policy shift coincided with the emergence of influential global frameworks such as the Paris Agreement (2015), Sustainable Development Goal 7 (SDG7), on affordable and clean energy, the Sustainable Energy for All (SE4All) initiative, and the Scaling-Up Renewable Energy Program (SREP). Together with expanding access to concessional climate finance, these frameworks accelerated renewable energy investments across Tanzania.

A wave of off-grid solar enterprises emerged during this period, pioneering pay-as-you-go models, solar home systems, and community mini-grids that reached previously underserved and remote populations (ESMAP, 2020). These innovations not only improved energy access but also demonstrated the economic viability of decentralized renewable solutions.

In recent years, Tanzania's policy direction has become even more deliberate. The Power System Master Plan (PSMP) 2024 Update, the National Renewable Energy Strategy 2024–2034, and the Ruling Party's Election Manifesto collectively signal a decisive transition from pilot projects to large-scale deployment, consistent with the national development visions TDV 2025 and TDV 2050 (MEM, 2024).

3.3. Key Drivers of Renewable Energy Adoption in Tanzania

Findings reveal that key drivers of renewable energy adoption in Tanzania include:

- Abundant natural resources (solar, wind, geothermal, and biomass).
- Socio-economic transformation and rising electricity demand.
- Persistent rural energy access gaps.
- Climate vulnerability of hydropower generation.
- Commitment to environmental sustainability and global climate goals.
- Influence of donors and access to international climate finance.
- Growth of local entrepreneurship in off-grid and mini-grid solutions.
- Strong political will and policy alignment under TDV 2025 and TDV 2050.

Table 6 below presents the anticipated socio-economic benefits of Tanzania's Renewable Energy Strategy, illustrating its potential to reduce generation costs, attract domestic and foreign investment, and enhance livelihoods across the country.

Table 6: Expected social economic benefits

Benefit Area	Expected Economic Impact	Remarks
Avoided High-Cost Generation	IPTL's generation costs were as high as 31 cents per kWh, while modern renewable sources offer	This highlights the high financial burden of older, fossil-fuel-based IPPs that the renewable energy

Benefit Area	Expected Economic Impact	Remarks
	significantly lower long-term costs.	strategy aims to avoid (IMF, 2024; World Bank, 2015).
Reduced Financial Strain on TANESCO	Aims to alleviate losses, such as the $295 million net loss in 2013, a significant portion of which was due to expensive EPP contracts.	The push for renewables is a direct response to the financial crisis faced by the national utility (World Bank, 2015).
Mobilized Private Investment	The government targets $4.039 billion in private sector investment to support the energy transition.	This figure demonstrates the substantial capital expected to flow into the sector under the new energy strategies (MEM, 2024).
Increased Energy Access Funding	The Tanzania Rural Electrification Expansion Project (TREEP) received $209 million initially, with an additional $341 million.	This shows the scale of international financial support for renewable-focused electrification projects (World Bank, 2023).
Reduced Business Operating Costs	A small-scale mining business reduced daily costs by nearly 90%, from TZS 1.2 million to TZS 100,000, after switching from diesel to grid electricity.	This example illustrates the direct economic benefit to local businesses from reliable, affordable electricity (REA, 2022).
Increased National Electrification Rate	The strategy targets an increase from 46% (2022) to 75% by 2030.	This is a key national development goal tied directly to the expansion of energy access through renewables and other sources (MEM, 2024).
Number of People Connected to Grid	The TREEP program has connected nearly 8 million people.	This figure quantifies the large-scale social impact of a single renewable-focused electrification project (World Bank, 2023).
Number of Social Institutions Connected	TREEP has also connected over 1,600 healthcare facilities and 6,500 educational institutions.	Providing electricity to these institutions improves healthcare and education quality across the country (World Bank, 2023).
Impact on Rural Income	In communities with solar mini-grids, the median income of residents has quadrupled.	This highlights the transformative economic effect of energy access on rural livelihoods and small businesses (ESMAP, 2020).

3.3.1. Policy and Institutional Context

Renewable energy now occupies a central position in Tanzania's long-term development agenda, notably within the Tanzania Development Vision (TDV) 2050, the Power System Master Plan (PSMP) 2024, and Renewable Energy Strategy (2024–2034). However, the National Energy Policy (NEP, 2015) has become outdated, as it does not reflect recent advancements in energy storage, electric mobility, and green hydrogen technologies. Recognizing this policy gap, the Ministry of Energy has announced plans to initiate a comprehensive policy review before the end of 2025.

In parallel, there is growing consensus among policymakers, development partners, and the private sector on the need for a standalone renewable energy policy to accelerate sectoral transformation and attract targeted investments. Over the past three years, the Ministry of

Energy has launched three complementary national strategies, each covering a ten-year period (2024–2034):

- The National Renewable Energy Strategy (2024–2034);
- The National Clean Cooking Strategy (2024–2034); and
- The National Energy Efficiency Strategy (2024–2034).

Furthermore, in January 2025, Tanzania launched its National Energy Compact, a key instrument that sets measurable renewable energy targets and provides an actionable roadmap for scaling up deployment and achieving universal access. Tanzania's energy sector is anchored in a robust policy and institutional framework that governs planning, investments, and private sector participation. The key components include:

i. National Energy Policy (NEP, 2015): Provides the overarching framework for ensuring reliable, affordable, and sustainable energy access, with emphasis on diversification beyond hydropower.
ii. Public–Private Partnership (PPP) Policy (2009) and PPP Act (2010, amended 2014, 2018 and 2023): Facilitate private sector participation in generation, transmission, and distribution through Independent Power Producers (IPPs) and joint ventures.
iii. Rural Energy Agency (REA) Act (2005): Establishes the REA and Rural Energy Fund, promoting rural electrification through grid extension, mini-grids, and off-grid renewable solutions.
iv. Energy and Water Utilities Regulatory Authority (EWURA) Act (2001), with subsequent amendments 2006, 2008, 2019, 2020 and 2021, establishes an independent regulator responsible for licensing, tariff setting, and service quality oversight in the energy and water sectors.
v. Electricity Act (2008): Provides the legal basis for generation, transmission, distribution, and trade of electricity, including detailed provisions for licensing, private participation, and market liberalization.

Together, these policies and legal instruments form a comprehensive governance framework that facilitates investment mobilization, strengthens transparency and regulatory oversight, and drives Tanzania's transition toward a diversified, climate-resilient, and sustainable energy future.

3.3.2. Tanzania Development Vision 2050: Energy as a Driver of Transformation

The Tanzania Development Vision 2050 (TDV 2050) articulates an ambition for high levels of industrialization, inclusive prosperity, and sustainable economic growth (Planning Commission, 2024). Within this framework, energy is positioned at the heart of national transformation, serving as both an enabler of industrial competitiveness and a foundation for social progress.

Achieving universal electricity access by 2050 is framed not merely as a social objective but as an economic imperative. Without affordable, reliable, and sustainable energy, industrial growth, agricultural value addition, and digital innovation, all central pillars of the national transformation agenda cannot be fully realized (AfDB, 2022).

TDV 2050 explicitly links energy expansion with productivity, job creation, and environmental sustainability. Renewable energy plays a strategic role in this vision, positioning Tanzania to leapfrog carbon-intensive development pathways and pursue low-carbon, climate-resilient growth model.

According to projections by the Ministry of Energy (MEM, 2024), renewables are expected to supply most of Tanzania's electricity by mid-century, marking a decisive shift toward a clean, secure, and inclusive energy future.

3.3.3. Renewable Energy Potentials and Technological Advancement

Tanzania is richly endowed with abundant renewable energy resources, many of which remain partially or fully untapped, offering significant opportunities for economic growth, energy security, and climate resilience.

- **Solar:** Tanzania receives 4.5–7 kWh/m^2/day of solar radiation and enjoys over 280 days of sunshine annually, making it one of the most favourable solar regimes in Sub-Saharan Africa (World Bank & ESMAP, 2021). Current contributions include 5 MW to the national grid and 3 MW via mini-grids and solar home systems. Small-scale projects totalling 113 MW are underway, with 22 MW undersigned contracts. A large-scale 150 MW project is in progress, with 50 MW nearing completion, 100 MW under negotiation, and an additional 100 MW tender expected soon.
- **Wind Energy:** Viable wind corridors exist in Singida, Kititimo, and Makambako, with average speeds of 6–9 m/s, suitable for utility-scale development (ME, 2024). These sites have a combined potential of 7,500 MW capable of generating approximately 26,413 GWh annually. Currently, Tanzania operates a single 2.4 MW wind farm, which supports rural grid reinforcement. Plans are underway for a 100 MW wind project, with three additional 100 MW tenders anticipated in the near future.
- **Hydropower:** Large hydropower remains the dominant electricity source, supplying 66.8% of the national grid and 66.5% of the total power generation exemplified by the recently completed 2,115 MW Julius Nyerere Plant. Tanzania's total hydro potential is estimated at 4,700 MW (AfDB, 2022). Small scale hydropower contributes 0.53% to the grid and 0.54% to national generation although additional projects, both large and small are in the pipeline.
- **Geothermal Energy:** Situated along the East African Rift, Tanzania has an estimated potential exceeding 5,000 MW, with promising sites at Ngozi (Mbeya) and Lake Natron (IRENA, 2021). According to the Power System Master Plan (PSMP 2024), approximately 22.2% of this potential (~1,110 MW) is scheduled for development between 2028 and 2050 across eight sites.
- **Biomass Energy:** Biomass accounts for over 80% of household energy, primarily through firewood and charcoal. Modern: biogas applications, including biogas, briquettes, and cogeneration, offers cleaner and more efficient alternatives (UNDP, 2022). Currently, biomass contributes 10.5 MW (0.26%) to the national grid, with an additional 50 MW generated through captive power plants.
- **Emerging Frontiers (Green Hydrogen and Marine Energy)**: Tanzania possesses significant potential for green hydrogen production, leveraging abundant solar and wind resources. Its Indian Ocean coastline also offers opportunities for marine

energy from ocean currents, tides, and waves, particularly benefiting coastal and island communities.

In summary, renewable energy technologies (including large hydropower) account for 67.8% of the national grid and 68.2% of total power generation. Excluding large hydropower, their contribution drops sharply to 0.92% of grid supply and 2.3% of total generation. This underscores the critical need for diversification into solar, wind, and geothermal sources, particularly given hydropower's vulnerability to drought and climate variability (World Bank, 2023).

Harnessing this resource diversity will expand electricity supply, enhance resilience, and support Tanzania's long-term sustainable development goals.

3.3.4. National Renewable Energy Strategy 2024-2034 and Mission 300

Tanzania's Renewable Energy Strategy 2024–2034 serves as the operational roadmap for achieving Vision 2050, marking a transition from pilot initiatives to scale-scale, systematic deployment of renewable energy technologies. The strategy targets an additional of 1,600 MW of new renewable generation capacity, the rollout of off-grid solar systems in 2,000 rural communities, and the expansion of local assembly and manufacturing of renewable technologies.

Key enablers include the promotion of Public–Private Partnerships (PPPs), the introduction of fiscal incentives such as VAT exemptions and concessional financing, the establishment of innovation hubs like the Renewable Energy Research Centre, and capacity-building programs to develop domestic expertise across the renewable energy value chain.

At the heart of the strategy is Mission 300/National Energy Compact 2025, an implementation initiative designed to accelerate, diversify, and deliver Tanzania's energy transformation. Mission 300 is anchored on three core pillars:

- Scale: Rapid deployment of both utility scale and distributed renewables energy systems.
- Diversification: Reduction of overdependence on hydropower by expanding solar, wind, geothermal, and biomass energy generation, and
- Access: Achievement of affordable and universal electricity access for households, enterprises, and productive sectors.

Mission 300 aims to deliver an additional 1,973 MW of new renewable capacity, substantially increasing the share of non-hydro renewables in the national generation mix, while expanding energy access to underserved rural and peri-urban communities. Implementation will align with PSMP 2024 update, leveraging targeted subsidies, results-based financing mechanisms, and streamlined grid-extension procedures to enhance efficiency and investor confidence.

- The financial requirements for Mission 300 are estimated at USD 7–9 billion over the decade (MEM, AfDB, IRENA projections). Of this, public financing will cover enabling infrastructure and subsidies (approximately 25%), while private investments are expected to contribute 60–65%, supported through blended finance instruments, concessional loans, and multilateral guarantees. Annual fiscal incentives, including VAT exemptions, import duty waivers, and tax credits are projected to cost USD 40–60 million, though these are anticipated to be offset by macroeconomic benefits such as: GDP growth acceleration of 0.5–0.7% per year.

- Creation of over 150,000 new jobs across renewable energy value chains.
- Reduced fossil fuel import costs, saving an estimated USD 200–300 million annually; and
- Enhanced resilience to climate variability and external energy shocks.

By combining finance-ready targets, transparent investment frameworks, and biennial performance reviews, Mission 300 aims to transform policy ambition into bankable, implementation-driven projects. The initiative will play a central role in industrializing Tanzania's economy, strengthening national energy security, and anchoring the country's low-carbon growth trajectory in alignment with Vision 2050.

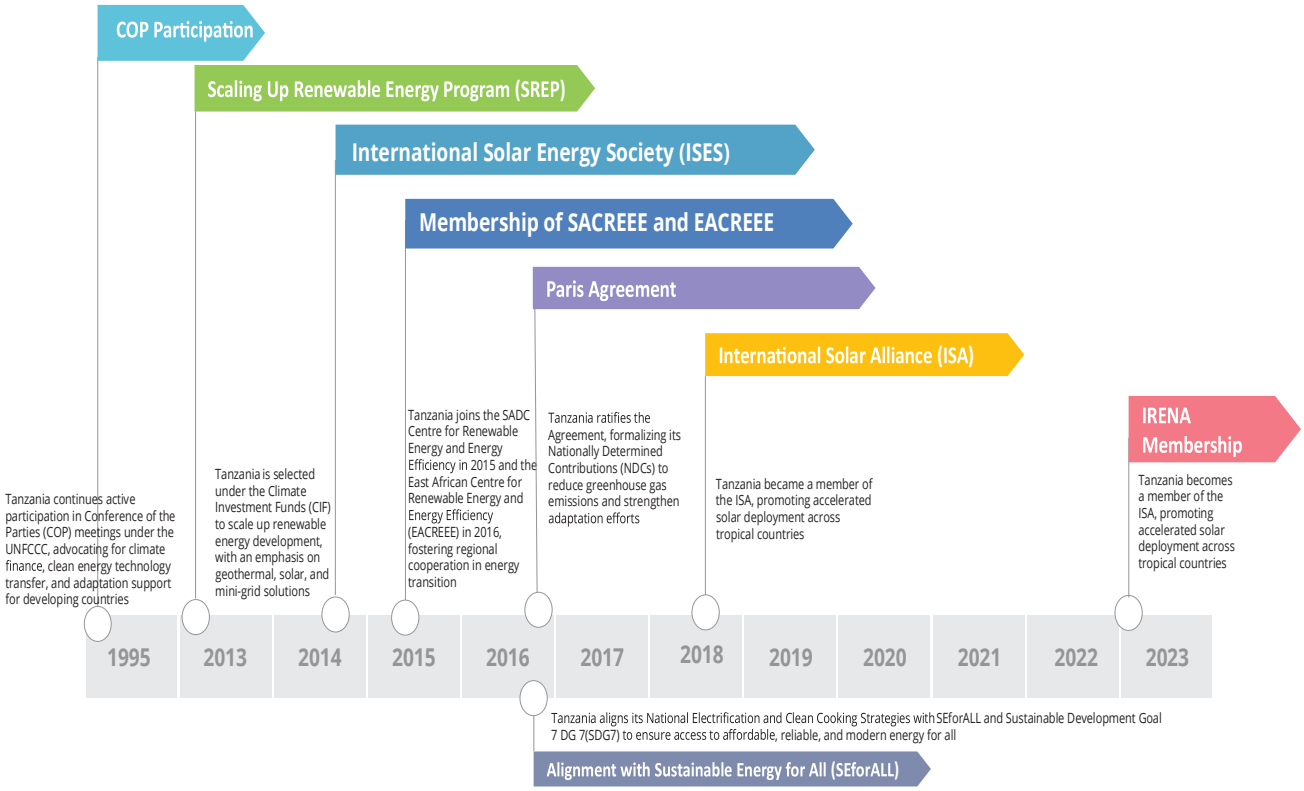
3.3.5. Fiscal Implications of Renewable Energy Expansion

The PSMP 2024 projects total investment requirements of approximately USD 20 billion by 2050 to finance generation, transmission, and off-grid renewable energy systems (MoE, 2024).

- On the expenditure side, costs will arise from infrastructure development, targeted subsidies, and fiscal incentives designed to attract private investment and promote technology localization.
- On the revenue side, renewable energy expansion is expected to generate substantial economic returns through increased foreign direct investment (FDI), job creation, industrial productivity, and tax expansion. Achieving national renewable energy targets could raise annual GDP growth by 1.5–2% and generate up to USD 500 million in additional tax revenues by 2035 (World Bank, 2023).
- Regarding fiscal trade-offs, VAT and import duty exemptions are estimated to cost approximately USD 100 million annually in foregone revenue. However, these incentives serve as catalytic investments unlocking greater private participation and yielding long-term fiscal and developmental dividends (UNDP, 2022).

3.3.6. International Engagement in Renewable Energy and Climate Action

Beyond domestic initiatives, Tanzania has actively engaged in international frameworks and partnerships aimed at promoting renewable energy deployment and enhancing climate resilience. These collaborations strengthen technical capacity, align national policy with global commitments, and expand access to concessional finance. The key milestones are chronologically summarized below:



3.4. Unlocking Renewable Energy Potential

3.4.1. Economic Regulation of Renewable Energy

Unlocking Tanzania's renewable energy potential demands a coordinated framework of legal, institutional, financial, technical, and social reforms. Sustainable progress depends on stable regulations, enforceable contracts, innovative financing mechanisms, grid and off-grid expansion, and inclusive capacity- development. Key action areas include:

i. **Bankable Policy and Contract Frameworks:** Strengthening project bankability through transparent, long-term tariffs, standardized Power Purchase Agreements (PPAs), and guaranteed grid access. Projects that lack cost-reflective tariffs or regulatory stability face increased risk and limited investor confidence (Clyde & Co., 2025).

ii. **Enforceable Institutions and Legal Certainty:** Enhancing the capacity of independent regulators, ensuring effective judicial and arbitration system, and improving compliance monitoring. Tanzania's ongoing institutional review under the Renewable Energy Strategy 2024–2034 underscores the importance of these reforms (Nishati, 2024).

iii. **Financing and De-risking Mechanisms:** Expanding the use of blended finance, concessional loans, public guarantees, and multilateral support. The National Energy Compact (2025) aims to catalyse both public and private investment, thereby strengthening the renewable energy financing ecosystem (World Bank, 2025).

iv. **Grid and Off-Grid Expansion:** Upgrading transmission and distribution networks; scaling mini-grids; and promoting solar home systems. Rural electrification remains a strategic priority, with national plans targeting significant connectivity increases by 2030 through both central grid and off-grid solutions (EAP, 2025).

v. **Local Capacity, Social Inclusion and Domestic Manufacturing:** Expanding technical training, particularly for youth and women while incentivizing local manufacturing and enforcing environment & social safeguards. The Renewable Energy Strategy (2024–2034) emphasizes socio-economic co-benefits and local content as core pillars (Nishati, 2024).

The anticipated benefits across governmental, economic, private sector, and human dimensions are summarized in **Table 7** below**.**

Table 7: Anticipated Benefits of Renewable Energy Deployment in Tanzania

Action Area	Key Interventions	Estimated Benefits / Figures	Government Benefits	Economic Benefits	Private Sector Benefits	Human / Social Benefits
Bankable Policy and Contract Frameworks	Long-term transparent tariffs Standardized & approved PPAs Guaranteed grid access	Could attract USD 2–3 bn in private investments by 2035; reduce fiscal burden by 20–30% of projected capex	Reduces capital needs, strengthens investor confidence, enhances international credibility	Expands electricity access to 70% by 2035; stimulates 50,000+ jobs; lowers business costs	Stable revenue, reduced project risk, tech transfer, market expansion	More reliable electricity for households & SMEs
Enforceable Institutions and Legal Certainty	Independent regulators -Effective contract enforcement Active monitoring	Could reduce project financing costs by 10–15%; lower investor risk premiums	Builds legitimacy, curbs corruption, ensures law enforcement	Accelerates energy sector growth; reduces project costs	Confidence contracts honored; timely payments; easier financing	Reliable service delivery; reduced risk of supply interruptions
Financing and De-risking Mechanisms	- Blended finance - Public guarantees - Concessional loans - Multilateral bank support	Could mobilize USD 1–2 bn in climate finance; reduce tariff volatility by 15%	Attracts FDI, unlocks climate finance, reduces public borrowing	Expands infrastructure investment; catalyses green growth; aligns with NDCs	Lower financing costs, improved access to long-term capital, stronger investor confidence	Affordable clean energy; local jobs; reduced diesel/kerosene use
Grid and Off-Grid Expansion	- Transmission & distribution upgrades - REA mini-grids - Solar home systems	Could electrify 2,000+ rural communities; increase rural electricity access from 25% to 60% by 2035	Expands tax base; reduces diesel subsidies; strengthens political legitimacy	Boosts productivity in agriculture, education, healthcare; reduces urban–rural gap	New markets for energy companies, tech providers; profitable mini-grid projects	Reliable electricity for homes, schools, clinics; empowers local entrepreneurs
Local Capacity and Social Inclusion	- Technical training (youth/women) - Local manufacturing incentives	Could create 30,000–50,000 skilled jobs by 2035; stimulate domestic RE	Builds national workforce; reduces dependence on foreign contractors;	Employment generation; gender equity; strengthens energy	Reduces operational costs; strengthens supplier	Job creation; community empowerment; social inclusion;

Action Area	Key Interventions	Estimated Benefits / Figures	Government Benefits	Economic Benefits	Private Sector Benefits	Human / Social Benefits
	- Environmental & social safeguards	industry growth	supports inclusive development	sector resilience	networks; boosts local investment	improved livelihoods
Domestic Energy Manufacturing	- Incentives for local assembly of solar panels, batteries, wind turbines - Public–private partnerships to establish renewable energy industrial parks - Import substitution policies - enhance R&D investment and technology transfer programs	Could reduce equipment import costs by 20–25% by 2035; create 15,000–25,000 skilled jobs in manufacturing and supply chains; increase local content to 40% of renewable energy projects	Strengthens industrial base; reduces forex outflow on imports; enhances energy security	Stimulates domestic industries; supports GDP growth by 1–2% annually; encourages innovation ecosystems	Expands supply chain opportunities; reduce logistics costs; increases competitiveness of local firms; opens new export markets within EAC and SADC	More affordable renewable energy technologies for households; local job creation; stronger community ownership and pride in "Made in Tanzania" clean energy solutions

Notes on Figures / Estimates:

- *Investment figures (USD bn) are based on projected capital needs for 1,600 MW of additional renewable capacity and rural electrification (Tanzania Renewable Energy Strategy 2024–2034).*
- *Job creation estimates assume ~25–30 jobs per MW of installed renewable capacity, plus additional jobs in mini-grid and off-grid deployment.*
- *Tariff reduction / risk mitigation percentages are derived from typical blended finance de-risking models in Sub-Saharan Africa (IRENA, 2023; World Bank, 2022).*

3.4.2. Renewable Energy and Economic Growth

Energy shortages are estimated to cost Tanzania approximately 2% of GDP annually (World Bank, 2023). Expanding renewable energy generation to 3,000 MW by 2034 could reverse these losses by ensuring reliable power for industrial and commercial use. Channelling electricity toward productive sectors, including agro-processing, ICT, and mining, is expected to stimulate structural transformation and strengthen national competitiveness.

Furthermore, establishing green financing facilities targeting small and medium enterprises (SMEs) would catalyse local innovation and entrepreneurship in clean energy technologies. With an estimated USD 15 billion in cumulative investment by 2034, Tanzania's GDP growth could accelerate by 1.5–2% per year, accompanied by substantial employment creation fiscal revenues gains (UNDP, 2022).**Table 8** below summarizes the Tanzania's renewable energy landscape,, highlighting key challenges, human and socio-economic aspects, fiscal and economic considerations, policy linkages, and strategic recommendations.

Table 8: Illustrating the Renewable Energy Landscape in Tanzania

Dimension	Key Questions / Sub Elements	Possible Data / Indicators	Challenges / Caveats	Human / Socio-economic Lens	Fiscal / Economic Lens	Policy / Strategic Linkages	Recommendations	References / Sources
Technology and Innovation	- Breakthroughs in solar PV, wind, hydro, biomass, geothermal• Storage, smart grid, hybrid systems - Emerging renewables (hydrogen, biofuels) -Commercial readiness	– Battery storage uptake for off-grid solar– Hybrid systems for hospitals and mini-grids– Large-scale solar: Kishapu 50 MW– Hydropower: JNHPP 2,115 MW, Ruhudji 358 MW, Rumakali 222 MW in pipeline	– Limited efficiency data– Emerging tech like hydrogen not commercially deployed– Storage & grid integration insufficient	• Improved access enhances education, healthcare, livelihoods• Supports rural entrepreneurship	• Attracts FDI • Lowers generation costs, boosts, industrial productivity	• MEM PSMP 2024: Integrated generation & hybrid systems• RE Strategy 2024–2034: Scale-up utility & distributed renewables• SE4All & SDG7	• Promote local R&D for solar, wind, and storage • Facilitate pilot hydrogen & biofuel projects • Incentivize hybrid systems in critical infrastructure	MEM 2024; RE Strategy 2024–2034; World Bank & ESMAP 2021; IRENA 2021
Policy, Regulation and Institutional Environment	• Policies supporting deployment (subsidies, feed-in tariffs, auctions) • Legal/governance frameworks • Institutional capacity	– Import duty reductions on solar– SPP Policy 2008 for mini-grids; feed-in tariffs under review– EWURA & REA regulate tariffs, interconnection– Target: 75% renewables by 2030	– Policy implementation gaps – Institutional capacity limited outside major cities – Land/zoning delays	• Supports equitable access & community energy projects	• Reduces government capital requirements via co-financing• Mobilizes private investment (~USD 7–9B for Mission 300)	• Paris Agreement & NDCs: Low-carbon incentives• SE4All & SDG7: Ensure regulatory support	• Fast-track net metering & feed-in tariff implementation • Strengthen institutional capacity at local/regional level • Streamline land permitting	UNDP 2025; Green Building Africa 2020; MEM 2024
Economic and Financial Factors	• Capital and O&M cost trends• Financing mechanisms (PPP, green bonds)	– Private investment target USD 12B (~61% mobilized) Donor support: EU, AFD, AfDB, World Bank– Incentives:	– Cost transparency limited– Currency, inflation, off-taker risk–	• Job creation in construction & maintenance• Reliable electricity supports SMEs	• Fiscal gains: tax revenue, reduced fuel imports (~USD 200–300M/yr)	• NDCs & Paris Agreement: Low-carbon investment incentives• Carbon markets: Revenue	• Establish green financing facilities for SMEs & off-grid projects • Develop risk mitigation	UNDP 2025; SolarQuarter 2025; World Bank 2023; MEM 2024

Dimension	Key Questions / Sub Elements	Possible Data / Indicators	Challenges / Caveats	Human / Socio-economic Lens	Fiscal / Economic Lens	Policy / Strategic Linkages	Recommendations	References / Sources
	• Risk profile & barriers • Economic viability	VAT/import exemptions, capital allowances– T&D losses ~14.5%	Hidden costs: storage, grid reinforcement		• VAT/duty exemptions (~USD 40–60M/yr) • GDP impact: +0.5–0.7%	from emission reductions • SE4All & RE Strategy: PPP frameworks	instruments (currency hedges, guarantees) • Increase transparency in cost and LCOE data	
4. Environmental and Sustainability Considerations	• Life cycle emissions • Land, water, biodiversity • Recycling & sustainability • Climate resilience	– Large hydropower (JNHPP) reduces GHG; environmental concerns for Selous – Kakono 87 MW hydro: ~214,000 tCO_2/yr reduction – Off-grid solar reduces diesel use	– Life cycle emissions data limited – Recycling /disposal of solar/batteries underdeveloped – Hydro vulnerable to drought	• Reduces indoor air pollution → health benefits • Climate-resilient livelihoods	• Avoided fuel imports • Eligible for carbon market credits	• Paris Agreement/NDCs: Guide emission reduction • Carbon markets: monetize avoided emissions • SDG13	• Conduct full life-cycle assessments for large projects • Promote recycling & local manufacturing • Integrate climate-resilience measures in project planning	Reuters 2024; SolarQuarter 2025; IRENA 2021
5. Social & Equity Impacts	• Access & equity (rural, marginalized) • Employment & skills • Land rights, participation	– Rural electrification: 78.4% → 100% by 2030; connectivity 36% → 75%– Off-grid solar/mini-grid; Kakono hydro serves ~4M– Job creation, skill development	– Rural/remote areas underserved–Large hydro → displacement–Skills gaps; benefit sharing unclear	• Gender equity: reduces time burden for women • Supports youth employment & education	• Expands taxable economy • Reduces household energy expenditure	• SE4All & SDG7: Equitable access• RE Strategy: Inclusive energy policies	• Ensure benefit-sharing & community consultation• Expand vocational training for renewable energy jobs• Subsidize low-income household access	REA 2025; Business Insider 2025; MEM 2024
6. Market Deployment and Scale	• Deployment scale & adoption trends• Key regions driving growth • Grid integration pace	–– Pipeline: Ruhudji, Rumakali, Kishapu, Nyumba ya Mungu, Singida	– Financing, regulatory delays– Grid capacity constraints–Hydro seasonal variability	• Expands access • Employment & local entrepreneurship	• Mobilizes domestic & foreign investment • Reliable electricity to industry	• MEM PSMP: Guides scale-up• Paris Agreement/NDCs: Clean energy market expansion	• Strengthen grid infrastructure• Facilitate fast-track approvals for high-potential regions • Support off-grid adoption in remote communities	REN21 2025; gepc.or.tz; Africa Energy Portal 2021

Dimension	Key Questions / Sub Elements	Possible Data / Indicators	Challenges / Caveats	Human / Socio-economic Lens	Fiscal / Economic Lens	Policy / Strategic Linkages	Recommendations	References / Sources
7. Energy Systems / Grid Integration andcFlexibility	• Grid adaptation to intermittent renewables • Micro-grids & decentralized generation • System design & stability	– Hybrid solar+battery – Mini hydro & SPPs in rural areas	– Forecasting & balancing challenging– Storage limited; high cost – Transmission weak in remote areas	• Ensures reliable energy for critical infrastructure • Rural livelihoods	• Reduces diesel imports • Improves industrial productivity	• SE4All & RE Strategy: Grid flexibility & storage • SDG9: Industry & innovation	• Expand utility-scale battery storage • Incentivize private micro-grid operators • Develop smart grid pilots	Africa Energy Portal 2021; BSLBATT; MEM 2024
8. Policy and Regulatory Barriers and Enabling Conditions	• Barriers: regulatory, technical, market, social • Policy reforms needed • Institutional capacity • Role of donors	– Delays, unclear tariffs, net metering incomplete– SPP revision planned– Donor support from EU, AFD, World Bank	– Slow implementation – Institutional capacity varies– Grid interconnection & pricing	• Clearer policies → equitable access & jobs • Donor partnerships enable skill transfer	• Attracts private investment • Reduces public capital burden	• Paris Agreement/NDCs: Low-carbon alignment • SE4All: Technical assistance • RE Strategy: Private sector enablers	• Fast-track regulatory approvals • Update SPP & net metering frameworks • Strengthen institutional oversight	allAfrica.com; SolarQuarter 2025; Africa Energy Portal
9. Economic, Social and Environmental Trade-offs / Co-benefits	• Co-benefits: health, jobs, air quality, import reduction • Trade-offs: land, environment, cost vs stability	– Improved rural electricity access– Reduced diesel & GHG emissions– Job creation & skill development– Environmental assessment included	– Sparse quantitative health/air quality data– Land displacement for large hydro– Intermittency costs	• Health, livelihood, skill-building • Community engagement	• Reduced fuel imports (~USD 200–300M/yr) • GDP growth +1.5–2% annually• Higher fiscal revenues	• Carbon markets: monetize emissions• Paris Agreement/NDCs: Track co-benefits• SDG7 & 13	• Integrate co-benefits in project evaluation• Promote small hydro & solar in low-impact areas• Implement carbon credit programs	World Bank & ESMAP 2021; UNDP 2022; SolarQuarter 2025
10. Future Prospects, Risks and Roadmaps	• Projections 2030/2050 • Emerging risks: resource limits, climate, supply chain • Innovation & scaling	– 75% electricity from renewables by 2030 – Pipeline: Rumakali, Ruhudji, Kishapu, Nyumba ya Mungu, Singida,	– Targets ambitious; financing, permitting, grid capacity may constrain – Climate impacts, supply	• Expands access, builds resilience • Employment & low-carbon pathways	• Fiscal savings from fuel imports • Attracts FDI & climate finance	• Paris Agreement, NDCs, SDG7/13: Decarbonization & resilience • SE4All, • Carbon markets: Revenue	• Regularly update renewable roadmap & risk assessments • Diversify energy mix (solar, wind, geothermal, biomass) • Strengthen disaster-resilient infrastructure	Green Building Africa 2020; MoE Energy Compact 2025; Africa Energy Portal

Dimension	Key Questions / Sub Elements	Possible Data / Indicators	Challenges / Caveats	Human / Socio-economic Lens	Fiscal / Economic Lens	Policy / Strategic Linkages	Recommendations	References / Sources
	• Adaptation & resilience	– Off-grid & mini-grid growth projected	chain, nascent tech risks		• GDP growth via productive energy			2021; MEM 2024

CHAPTER FOUR: DISCUSSION OF FINDINGS, DATA ANALYSIS AND INTERPRETATION

This chapter presents the key findings derived from secondary data, case studies and primary data (interviews, questionnaires and site visits), organized around the five specific objectives of the study. The findings are followed by a detailed analysis and interpretation, highlighting how RETs influence Tanzania's economic development.

4.1. Primary Data - Stakeholders' views

This section, synthesizes stakeholder perspectives obtained through interviews, questionnaires, and site visits on Tanzania's renewable energy sector, structured around the five specific objectives. It explores policy frameworks, current technologies, adoption barriers, emerging opportunities, and comparative cost-benefit dynamics. The findings provide a multidimensional perspective on the challenges and prospects facing Tanzania's energy transition. However, due to limited insights from interviews and questionnaire responses, much of the data and analysis for Objective 5 draws from publicly available literature.

4.1.1. Specific Objective 1: Policy and Institutional Frameworks

Stakeholders expressed concern that while Tanzania has set ambitious renewable energy targets, such as achieving 75% renewable energy by 2030 -these goals remain largely aspirational, lacking legislative backing and enforceable mandates. The 2015 National Energy Policy was widely regarded as outdated, offering no clear provisions for integrating emerging technologies.

Interviewees highlighted limited prioritization of renewable energy, compounded by bureaucratic inefficiencies and institutional fragmentation across key agencies, including the Ministry of Energy, Ministry of Finance, TANESCO, TBS, TRA, EWURA, and REA. This fragmentation has contributed to operational inefficiencies and prolonged regulatory delays. Many stakeholders advocated for the establishment of a dedicated Renewable Energy Policy and a specialized Department within the Ministry of Energy, alongside the creation of a standalone renewable energy agency. They also emphasized the importance of streamlining licensing procedures and modernizing grid codes to bring them in line with international best practices.

4.1.2. Specific Objective 2: State and Advancement of RETs

Stakeholders noted that Tanzania's electricity mix remains heavily reliant on large hydropower, which accounts for approximately 66% of the national grid. Despite this imbalance, they emphasized that, solar energy is steadily gaining momentum through utility-scale projects. Currently, a 5 MW solar plant is operational, and construction of a 50 MW segment within a planned 150 MW project is at an advanced stage. Respondents also highlighted notable progress in small-scale solar and biomass energy generation, particularly through mini-grids and industrial self-consumption. They further pointed out that Tanzania's only 2.4 MW wind farm, though modest in size, contributes to energy security by supporting a rural grid network. In addition, stakeholders reported that discussions are underway on a 100 MW solar project and two 100 MW wind projects, with four additional tenders expected to be announced, one for solar and three for wind.

Geothermal exploration is underway at promising sites such as Ngozi and Kiejo-Mbaka, while emerging technologies including green hydrogen and ocean current energy were also mentioned as areas of growing interest. Although Tanzania's national grid now extends to all villages and 52% of hamlets, overall electricity connectivity stands at 46% (79% urban and 36% rural), providing access to 78.4% of the population (99.6% urban and 69.8%v rural).

Despite these advances, interview responses point to unfavourable tariffs and the absence of a clear, consistent compensation model for mini-grids, particularly when the national grid expands into their service areas as significant deterrents to investment in mini-grid projects. Stakeholders also highlighted major gaps in renewable energy development, including a shortage of skilled labour, limited local manufacturing capacity and insufficient support for research and development (R&D). The launch of the National Clean Energy Strategy (2024–2034) and finalization of the Renewable Energy Strategy (2024-2034) were widely welcomed as step forward towards accelerating electrification and advancing clean cooking initiatives. Nevertheless, many respondents felt the pace of technological diversification remains slow compared to global leaders.

4.1.3. Specific Objective 3: Barriers to Renewable Energy Adoption

During the interviews, stakeholders identified ten systemic challenges that continue to hinder the adoption of renewable energy in Tanzania. These included persistent gaps in policy and regulation, financial constraints, and institutional fragmentation. Grid integration issues were also frequently cited as major obstacles to renewable energy development. Other critical deficiencies mentioned were limited market incentives and subsidies, coupled with low community awareness of renewable energy solutions. Stakeholders further highlighted bureaucratic procurement procedures, a lack of technical expertise, weak innovation systems, and insufficient support for research and development. In addition, the absence of net metering and non-cost-reflective tariffs were identified as key deterrents to private sector investment. Cross-cutting challenges were also emphasized, including regulatory delays, high capital costs, and the growing impacts of climate change on hydropower. Finally, Political interference and misaligned vocational training programs were noted as continuing barriers to sectoral progress.

Renewable Energy Progress and Challenges:

- **Current Energy Mix: ~**Hydropower contributes about 66% of Tanzania's electricity supply. Non-hydro renewables remain marginal, accounting for less than 0.5%..
- **Progress Areas:** Solar: 5 MW installed, 50 MW under construction as part of a 150 MW expansion plan.
  Wind: 2.4 MW operational; two 100 MW projects in the pipeline, with tenders expected.
  Geothermal: Active exploration underway at sites such as Ngozi, Kiejo-Mbaka. **Biomass & Mini-grids**: Increasingly adopted for SMEs and rural electrification.
- **Emerging** Interests: Development of Green hydrogen, Exploration of ocean currents.
- **Key Challenges**:
  - ✓ Unfavourable tariff structure and unclear compensation mechanisms when the national grid reaches areas with existing mini-grids.
  - ✓ Shortages of skilled labour, limited local manufacturing capacity, and weak support for R&D.
- **Positive Developments:**
  - ✓ Launch of the National Clean Energy Strategy (2024–2034). and the adoption of the Renewable Energy Strategy (2024–2034) both seen as important steps toward sectoral reform and investment confidence.

High interest rates on loans, ranging from 11% to 20%, were regarded as a major deterrent to investment, further compounded by the requirement for 30% equity contribution and the absence of risk mitigation instruments. Poor coordination between national and local institutions also emerged as a recurring theme, weakening policy implementation and oversight. Stakeholders emphasized the lack of centralized data systems and the underdevelopment of carbon markets, both of which constrain strategic planning and access to climate finance. Moreover, gender and social inclusion were found to be peripheral in current energy strategies, thereby restricting the sector's potential to deliver equitable and socially transformative growth.

Key Barriers to Renewable Energy Adoption

1. **Policy and Regulatory Gaps:** absence of net metering, non-cost-reflective tariffs, and limited engagement in carbon market.
2. **Financial barriers:** High loan interest rates of 11–20% compared to 3-7% in developed economies viewed as a major deterrent. These challenges are compounded by the absence of risk-mitigation instruments, limited financing options for SME, and the lack of a dedicated national RE investment fund.
3. **Institutional barriers:** Fragmented mandates, weak PPP frameworks, poor inter-agency coordination, and bureaucratic procurement procedures.
4. **Technical barriers**: Persistent grid integration challenges, outdated grid codes, and insufficient local technical expertise.
5. **Market barriers:** Heavy reliance on imported technologies, underdeveloped local manufacturing capacity, and limited investment in research, development, (R&D), and innovation capacity.
6. **Cross-cutting barriers:** The vulnerability of hydropower to climate change, (political interference in decision-making, low community awareness, and the limited integration of gender and social inclusion.

4.1.4. Specific Objective 4: Opportunities for Renewable Energy Technologies

Stakeholders emphasized that Tanzania is richly endowed with renewable energy resources as well as critical minerals needed for the manufacturing of batteries and other RE components. This presents a significant opportunity not only to accelerate the transition to green energy but also to drive inclusive economic development for both the nation and its people. Respondents identified solar, hydropower, and bioenergy as the top-priority technologies, while wind and geothermal were also recognized as having strong potential. Solar energy was particularly favoured for its nationwide availability and versatility, being suitable for large-scale grid-connected projects as well as off-grid and small-scale applications.

Hydropower was valued for its reliability, relatively low cost, and the advantage of existing infrastructure. Bioenergy was highlighted for its multiple social benefits, including reducing the petroleum import bill, saving foreign currency, generating employment in agriculture and processing, and stabilizing rural incomes.

Geothermal energy, meanwhile, was appreciated for its baseload capacity and long-term sustainability. Stakeholders further noted that Tanzania's abundant renewable energy resources, when coupled with the creation of a conducive investment environment, have strong potential to attract foreign direct investment (FDI). Key measures mentioned included establishing cost reflective pricing mechanism or introducing targeted subsidies for renewable

energy. Finally, the declining global costs of renewable energy technologies, particularly solar equipment, were viewed as creating a favourable opportunity for broader adoption across the country.

Additionally, stakeholders identified mini-grids, solar photovoltaic systems, productive use applications, e-mobility, and waste-to-energy solutions as high-potential renewable energy technologies that are receiving growing attention. These technologies were praised for their feasibility and their potential to generate employment, improve public health by reducing air pollution, and support critical sectors such as education, agriculture, and water supply through applications like solar-powered pumping. They were also recognized for strengthening energy security through diversification and supporting decentralized power generation.

Beyond these benefits, stakeholders emphasized their environmental advantages, particularly in enabling the earning of carbon credits and contributing to long-term economic resilience and stability. On a more optimistic note, the presence of critical minerals in Tanzania was viewed as a strategic opportunity to accelerate renewable energy sector development by leveraging these resources, the country could support local value chains for the manufacturing of technologies such as batteries, solar panels, and wind turbines thereby capturing greater value domestically while reinforcing its green industrialization agenda.

Opportunities for Renewable Energy Technologies in Tanzania

- **Abundant Renewable Resources:** Tanzania is endowed with significant solar, wind, hydro, biomass, and geothermal potential.
  - ✓ **Solar:** Highly scalable, and suitable for grid-connected systems, off-grid and mini-grid electrification, and mini-grid applications.
  - ✓ **Hydro:** A reliable and cost-effective option, though increasingly vulnerable to climate- variability and changing rainfall patterns.
  - ✓ **Biomass:** Strong potential for rural electrification and development of small and medium enterprises (SME) especially in agro-processing.
  - ✓ **Geothermal:** Offers long-term stability and baseload capacity, reducing reliance on seasonal resources.
- **Emerging RETs:** Mini-grids, distributed solar PV, e-mobility solutions, productive use applications, and waste-to-energy technologies are gaining momentum.
- **Falling technology costs:** Global price declines for solar PV, wind, and storage technologies create a favourable investment window, making RETs deployment more affordable and competitive compared to fossil fuels.
- **Investment Potential:** With an improved enabling environment, Tanzania could attract significant foreign direct investments in the enabling environment (policy clarity, incentives, and streamlined licensing), Tanzania could attract significant foreign direct investment (FDI) and private capital into the renewable energy sector.
- **Socio-Economic Co-Benefits:** Large-scale adoption of renewable energy has multiplier effects—job creation across value chains, improve public health from reduced air pollution, enhance agricultural productivity through solar irrigation, better education via electrified schools, and more reliable water service delivery through solar-powered pumping systems.
- **Strategic Resource Opportunities:** Tanzania holds reserves of critical minerals such as graphite, nickel, and rare earth elements - essential for manufacturing batteries, solar panels, and wind turbines. Harnessing these resources strategically could position the country as a regional hub for clean energy technologies while supporting global supply chains.

4.1.5. Specific Objective 5: Cost-Benefit Analysis of Exploiting & Adopting RETs.

Stakeholders underscored that renewable energy technologies (RETs) offer 40–60% lower lifecycle costs compared to fossil-based systems positioning them as a more sustainable long-term option. Among these, solar, wind, and hydropower were identified as the most cost-effective solutions. In addition to financial savings, renewables were found to consistently outperform fossil fuels across several dimensions, including Levelized Cost of Energy (LCOE), operation and maintenance expenses, environmental impact, and socio-economic co-benefits. The benefits extend well beyond cost reductions.

Transitioning to renewable energy could save Tanzania an estimated $1.2 billion annually in health-related costs, while avoiding 56 million tons of CO_2 emissions by 2050 and generate over 50,000 direct jobs by 2030. Financial performance metrics were also viewed as highly compelling, with internal rates of return projected at 13–15% and net present values exceeding $2.5 billion for solar and wind projects alone. With intensive investment, interviewees projected that Tanzania could realize an aggregate national impact exceeding $18 billion by 2030. This figure accounts for estimated fuel import savings of $6-8, potential carbon credit revenues of

$2-3 billion, and approximately $7 billion in wages from green jobs, while also mitigating the economic risks associated with volatile fossil fuel prices on international market.

Major issues Across All Objectives

1. **Policy, Governance and Coordination**

- ✓ Fragmented mandates across MoE, TANESCO, REA, EWURA, and other institutions undermine sector efficiency.
- ✓ Strong stakeholder demand for a **dedicated RE agency/department** to centralize leadership and accountability.
- ✓ Need for binding legislation and enforceable renewable energy targets to sustain long-term momentum.

2. **Financing and Investment**

- ✓ High loan interest rates on loan (11–20%) and absence of risk mitigation instruments deter private sector participation.
- ✓ Lack of a national RE investment fund restricts access to capital, particularly for SMEs.
- ✓ Untapped opportunities in carbon markets and blended finance could unlock significant new flows of climate finance.

3. **Infrastructure and Technology**

- ✓ Grid integration remains a major bottleneck due to outdated grid codes and limited absorption capacity for variable renewable energy (VRE).
- ✓ Universal village coverage masks disparities in household connectivity and supply quality.
- ✓ Minimal local manufacturing capacity for solar panels, batteries, and turbines reinforces heavy import dependency.
- ✓ Presence of critical minerals (e.g., for batteries, solar panels, and wind turbines) offer potential for building local value chains.

4. **Capacity and Knowledge**

- ✓ Persistent shortage of skilled labour and mismatch in vocational training programs.
- ✓ Weak R&D ecosystem and limited innovation support slow technology adaptation.
- ✓ Lack of centralized data systems and knowledge-sharing platforms hampers effective planning and erodes investor confidence.

5. **Social Inclusion and Awareness**

- ✓ Low community awareness of renewable energy options limits adoption at grassroots level.
- ✓ Gender and social inclusion remain peripheral in policy strategies, constraining equitable sector growth.
- ✓ Co-benefits of RETs —such as improved health, education, agricultural products, and rural development—remain under-prioritized.

6. **Climate and Resilience**

- ✓ Heavy reliance on hydropower exposes national energy security to risks from climate variability.
- ✓ Absence of a formal just energy transition strategy or resilience plan to safeguard future energy systems.
- ✓ Opportunities exist to align renewable energy expansion with national climate commitments and adaptation planning.

4.2. Synthesis of stakeholders' views

Tanzania's renewable energy sector stands at a critical turning point. While the government has set ambitious targets of achieving 75% renewable energy by 2030, progress remains constrained by outdated policies, fragmented institutions mandates, and weak enforcement mechanisms. Stakeholders emphasized the urgent need for a dedicated renewable energy

policy, stronger legislation, and streamlined coordination to attract investment and accelerate deployment.

The launch of the National Renewable Energy Strategy 2024–2034 marks a positive step forward, yet significant barriers remain. High capital costs, regulatory delays, grid integration challenges, and limited technical expertise continue to undermine momentum. Nonetheless, Tanzania's abundant renewable resources, combined with falling global technology costs, and the availability of critical minerals position the country to scale up solar, wind, biomass, geothermal, e-mobility, and waste-to-energy solutions.

The economic case for renewable energy adoption is particularly compelling. Technologies offer 40–60% lower lifecycle costs compared to fossil fuels, alongside substantial socio-economic and environmental gains. Projections indicate potential savings of approximately $1.2 billion annually in health-related costs, the creation of more than 50,000 direct jobs, and an aggregate economic impact exceeding $18 billion by 2030 (**Mission 300**). At the same time, renewables could help Tanzania avoid 56 million tons of CO_2 emissions by 2050 delivering long-term climate resilience and global environmental benefits.

A just energy transition is essential to ensure that the shift from fossil fuels drives inclusive growth, rural electrification, gender equity, and industrialization. Stakeholders stressed that embedding job creation, social benefits, and community participation into energy planning, will be critical for building resilience, and reducing poverty. Such an approach would not only strengthen public support for renewable energy adoption but also ensure that the benefits are widely shared across both urban and rural populations. By leveraging its abundant resources and aligning renewable energy expansion with social and industrial policy, Tanzania has the opportunity to position itself as a regional leader in sustainable, low-carbon development while simultaneously advancing its economic transformation agenda.

Implications:

i. **Opportunities are High**:

- Tanzania holds abundant renewable resources including solar, wind, geothermal, hydropower, and biomass.
- Global technology costs of renewable technologies continue to decline, making projects increasingly competitive.
- International climate finance and green investment flows are expanding, opening new avenues for funding.
- Renewable energy offers broad, socio-economic benefits, including, job creation, stronger energy security, improved health and education services, and enhanced social inclusion.

ii. **Challenges are Pressing:**

- Sector progress is hindered by policy gaps, fragmented institutional and governance frameworks, and underdeveloped market mechanisms.
- Energy access gaps remain substantial, with rural electrification and clean cooking solutions still lagging.
- Continued reliance on fossil fuels and traditional biomass generates high environmental and health costs.

- Climate change is already impacting hydropower undermining system reliability and energy security.

iii. Decisions Now are Pivotal:

- Strengthening Tanzania's policies, governance, and investment frameworks could accelerate renewable energy adoption, attract significant investments, and align the country with global sustainability commitments.
- Delayed action, however, risks missed opportunities, loss of green investments, unsustainable energy demand pressures, and falling behind in the rapidly emerging global energy system, which is defined by:
  - *Renewable Energy Dominance – Solar, wind, hydropower, geothermal, and biomass forming the backbone of power generation.*
  - *Green Hydrogen & New Fuels – Renewable-powered hydrogen produced supporting industrial processes, transport, and exports markets.*
  - *Energy Storage & Smart Grids – Advanced batteries, pumped storage, and AI- enabled grids ensuring system reliability and flexibility.*
  - *Electrification of Sectors – Transport, industry, and households increasingly powered by electricity instead of oil, coal or traditional biomass.*
  - *Decentralization & Access (Energy Democracy) – Mini-grids, off-grids, and community-based energy systems expanding reliable access in rural and underserved areas.*
  - *Economic Transformation – Growth of new jobs, industries, and trade opportunities along clean energy supply chains and critical minerals, with added benefits of local manufacturing, digital innovation, labour market shifts, and more inclusive development through universal energy access.*

4.3. Data Analysis, Presentation of the Results

This section provides a systematic analysis and structured presentation of the findings in line with the study's five specific objectives. Data were drawn from a triangulated methodology that combined stakeholder perspectives obtained through interviews, questionnaires, and site visits, with insights from an extensive literature review and selected case studies. This integrated approach ensures a robust and multidimensional understanding of the role RETs can play as a catalyst for sustainable economic development in Tanzania.

The analysis is organized around the study's specific objectives, beginning with an assessment of Tanzania's renewable energy potential, followed by a review of existing policies and regulatory frameworks, examination of investment trends and financing mechanisms, evaluation of socio-economic impacts, and identification of challenges and opportunities shaping the sector.

By weaving together qualitative insights from stakeholders and quantitative indicators from official reports and case evidence, the results highlight both the strengths and gaps within the current system. The findings also provide an evidence-based foundation for strategic recommendations aimed at strengthening policy coherence, enhancing investor confidence, and accelerating the deployment of RETs across the country.

4.3.1. Objective 1: Examination of Tanzania's Policy and Institutional Frameworks

Tanzania's renewable energy (RE) sector has made notable progress, guided by a combination of legislation, policies, regulations, and institutional frameworks designed to support sustainable energy development, socio-economic growth and environmental sustainability. The key instruments include:

i. Policies and Laws

- **National Energy Policy (2015):** - Promotes renewable energy but is considered outdated in addressing emerging technologies and global climate commitments.
- **Electricity Act (2008, amended 2020):** Governs generation, transmission, and distribution of electricity, and enables Independent Power Producers (IPPs).
- **EWURA Act (2001, amended 2007, 2019 and 2022):** Establishes the Energy and Water Utilities Regulatory Authority (EWURA) responsible for regulating electricity, petroleum, natural gas, and water, including tariffs, standards, and licensing.
- **Rural Energy Act (2005):** Establishes the Rural Energy Agency (REA) and the Rural Energy Fund to promote rural electrification and facilitate renewable energy deployment in underserved areas.
- **Public-Private Partnership (PPP) Policy 2009; and PPP Act (2010, amended 2014, 2018 and 2023):** Provides a framework for private sector participation in energy projects.
- **Environmental Management Act 2004 (amended 2016, 2021 and proposed 2025):** Requires Environmental Impact Assessments (EIAs), integrates climate change and energy transition into environmental planning, and supporting low-carbon development.
- **Land Act, 1999 (amended 2004, 2005, 2008 and proposed 2024) & Village Land Act, 1999 (amended 2004, and proposed 2024):** Regulates land acquisition, tenure and rights critical for renewable energy project siting.
- **Investment Act, 1997 (amended 2022, 2024 and 2025):** provides investor protection, including guarantees on repatriation of profits.
- **Water Resources Management Act (2009, amended in 2022):** Governs water resource allocation and use for hydro, biomass, and geothermal projects.

ii. Strategies

- **National Renewable Energy Strategy (2024–2034):** Provides a roadmap for scaling up renewable energy investment and integration into the national energy mix.
- **National Strategy for Clean Cooking Energy (2024–2034):** Promotes adoption of modern clean cooking technologies and fuels, aiming to reduce reliance on traditional biomass.
- **Tanzania Power System Master Plan (2024 update):** Guides expansion of power generation, transmission, and distribution expansion to ensure reliability and support growing demand.

- **Five-Year Development Plan III (2021/22–2025/26):** Prioritizes industrialization and inclusive energy access, emphasizing renewable energy infrastructure and rural electrification.
- **National Energy Efficiency Strategy (NEES) 2024–2034:** Sets targets for improving energy efficiency across electricity supply, cooking, manufacturing, mining, transportation, and buildings.
- **National Energy Compact (2030):** Represents Tanzania's international commitment to achieving universal energy access, scaling renewable energy, and advancing efficiency by 2030

iii. Regulations, Rules and Orders

- **The Electricity (Market Re-Organization and Promotion of Competition) Regulations, (2016):** Govern restructuring of the electricity market and promote competition across generation, transmission, distribution, consumer services, and private sector participation.
- Electricity (Development of Small Power Projects) Rules (2017): provide the framework for Standardized Power Purchase Agreements (SPPAs) for projects up to 10 MW.
- **The Electricity (Generation, Transmission and Distribution Activities) Rules, (2024):** Regulate matters related to electricity generation (including generation), transmission, distribution and cross-border trade.
- **The Electricity (Licensing and Registration Fees) Rules, (2022):** Apply to licensing and registration activities for generation, transmission, distribution, supply, import/export, and electrical installation.
- **The Electricity (Procurement of Power Projects and Approval of PPA) Rules, (2019):** Govern processes for initiating power projects and approving Power Purchase Agreements (PPAs).
- **The Electricity (Standardized Small Power Projects Tariff) Order, (2019):** Sets standardized tariffs for small power producers supplying electricity to the national grid or isolated mini grids
- **Electricity (Tariff Setting) Rules (2016):** Establish the methodology for tariff approval.
- **Renewable Energy Feed-in Tariff (REFiT), (2009):** Guarantees payments for electricity generated from renewable sources and supplied to the national grid.
- **Electricity (Market Operations Services) Rules (2016):** Regulate grid operations and dispatch.
- **The Electricity (Grid and Distribution Codes) Rules, (2017):** govern operations and management of the transmission and distribution systems.
- **Environmental (Impact Assessment and Audit) Regulations (2005, amended 2018):** Provide environmental safeguards for energy projects through EIAs and audits.
- **Grid Code (2016, 2017 updates):** Define interconnection requirements, technical standards, and operational guidelines
- **Renewable Energy Feed-in Tariff (REFiT) Guidelines (2013):** support implementation of REFiT by providing procedures for renewable power integration.

- **Mini-Grid Regulations (2012):** Provide a framework for licensing, operations, and tariffs of mini-grids
- **Model PPAs for Specific Technologies:** Standardized agreements tailored to renewable technologies to facilitate project development.
- **EWURA Licensing Procedures:** Define licensing requirements for generation, distribution, and supply.
- **Occupational Health and Safety (OSHA) Rules (2003):** Ensure workplace safety.

These frameworks collectively support the deployment of RETs, thereby expanding energy access, reducing indoor air pollution, and creating green jobs. In doing so, they contribute to Tanzania's economic growth, poverty reduction, and progress towards the Sustainable Development Goals, particularly SDG 1 (No Poverty), SDG 3 (Good Health and Well-Being), SDG 5 (Gender Equality), SDG 7 (Affordable And Clean Energy), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action), and SDG 15 (Life On Land).

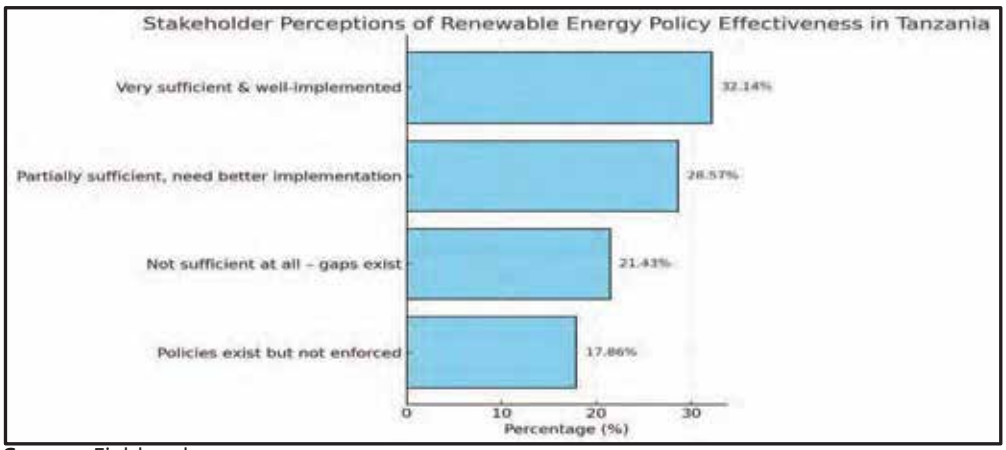
4.3.1.1. Stakeholders' Perceptions on Policy Framework Effectiveness

Survey findings revealed mixed perceptions regarding the effectiveness of Tanzania's renewable energy policies in advancing the objectives of the National Energy Policy (2015), namely universal energy access, climate action, economic growth, and private sector investment. Respondents raised concerns over the policy's outdated provisions, limited government incentives, and weak institutional coordination, and insufficient support for emerging technologies such as geothermal energy and e-mobility.

The survey results indicate the following distribution of views:

- 32% considered Tanzania's renewable energy policies to be very sufficient and well-implemented.
- 29% viewed them as partially sufficient but well implemented.
- 21% felt that the policies were not sufficient at all.
- 18% acknowledged that while policies exist, they are not effectively enforced.

Figure 6: for graphical representation of stakeholder perceptions



Source: Fieldwork

4.3.1.2. Stakeholders' Rating of the Effectiveness of RET Policy Framework

The survey assessed stakeholders' ratings of the effectiveness of Tanzania's renewable energy (RE) policy framework on a scale of 1 (Very Poor) to 5 (Excellent) (**Table 9**).

Findings show that nearly half of respondents (**46%)** rated the framework as **average**, *citing challenges such as the outdated National Energy Policy (2015), insufficient incentives, limited coverage of emerging technologies, bureaucratic hurdles, and the high costs of imported RE materials*.

Approximately **29%** of stakeholders rated the framework as good, recognizing progressive principles and support mechanisms, including the Small Power Projects (SPP) framework and certain tax exemptions. However, they emphasized the need for clearer incentives, streamlined procedures, and more effective regulatory processes.

A small proportion **(7%)** rated it **excellent**, highlighting its potential in driving sectoral reforms. By contrast, **4%** rated it **poor**, pointing to weak investor attractiveness, limited public awareness and inconsistent enforcement. No respondents rated the framework as **very poor**, suggesting that despite its shortcomings, it maintains a degree of functionality and provides a basis for improvement.

Further, survey results indicate a mixed perception of Tanzania's renewable energy framework, highlighting the following features of the policy framework:

- **Strengths:** Progressive intent, the presence of some incentives, and institutional support mechanisms.
- **Weaknesses:** Outdated policy, insufficient financial incentives, bureaucratic processes, and low public awareness.

Overall, findings suggest that comprehensive reforms and timely updates to the National Energy Policy (NEP), regulatory processes, and incentive mechanisms are critical for improving investor confidence and accelerating renewable energy deployment in Tanzania.

Table 9: Ratings of Tanzania's Renewable Energy Policy Framework

Rating	Percentage	Summary of Comments from Respondents
Average (3)	46%	Outdated NEP (2015); lacks incentives/subsidies; limited RE coverage; bureaucratic procurement; absence of net metering; tariffs not investment-friendly; high cost of imported materials
Good (4)	29%	Framework progressive in principle; support mechanisms exist (SPP framework, tax exemptions); need for clearer incentives and improved regulatory processes
Excellent (5)	7	Optimism about ongoing reforms and supportive institutional arrangements
Poor (2)	4%	Policy unattractive to investors; lacks enabling cross-sectoral policies; weak public awareness undermines sustainability
Very Poor (1)	0%	No respondents rated the framework as very poor

The ratings that are equal to or above average (3) at 46%, Good (4) at 29%, and Excellent (5) at 7%, together account for over *80% of respondents*. This indicates that the majority of stakeholders perceive Tanzania's renewable energy framework as at least moderately effective. While the average rating highlights persistent challenges, such as the outdated NEP (2015),

limited incentives, bureaucratic processes, absence of net metering, and high costs of imported materials, the good and excellent ratings reflect recognition of the framework's progressive intent, *the existence of support mechanisms like the Small Power Projects (SPP) framework and tax exemptions, and optimism about ongoing reforms and supportive institutional arrangements*.

This suggests that despite notable weaknesses, there is general confidence among stakeholders that the policy framework provides a viable foundation for renewable energy development, if reforms and improvements in incentives and regulatory processes, and coordination are implemented effectively.

4.3.1.3. Stakeholders' Perceptions on Renewable Energy Gaps

The **Figure 6** presents the results of a survey assessing the main gaps or challenges perceived by stakeholders in Tanzania's renewable energy (RE) sector. The horizontal bar chart illustrates the percentage of respondents highlighting each gap.

1. Incentives and Market Mechanisms **(26%)** – The top concern, cited by about a quarter of respondents, relates to insufficient financial and market incentives, including tariffs, subsidies, and mechanisms to attract private investment in RE.
2. Legal and Regulatory Gaps **(26%)**: Nearly a quarter of stakeholders identified weaknesses in laws, regulations, and enforcement mechanisms as major barriers. This includes outdated policies, unclear licensing procedures, and the absence of binding targets.
3. Institutional and Governance Issues **(17%)**: About 17% of respondents highlighted challenges with institutional capacity, coordination among agencies, and governance structures that hinder effective RE project implementation.
4. Grid and Infrastructure Challenges **(12%)**: Around 12% indicated that the current electricity grid and supporting infrastructure are inadequate for effectively integrating renewable energy.
5. Investment and Financial Barriers **(10%)**: Limited access to financing, high upfront costs, and lack of bankable projects were cited by roughly 10% of stakeholders.
6. Local Capacity and Sustainability **(7%)**: A smaller proportion of respondents identified gaps in local technical capacity, skills, and sustainability measures as key barriers.
7. Non-responsive **(2%)**: A minor portion of respondents did not indicate any specific gap.

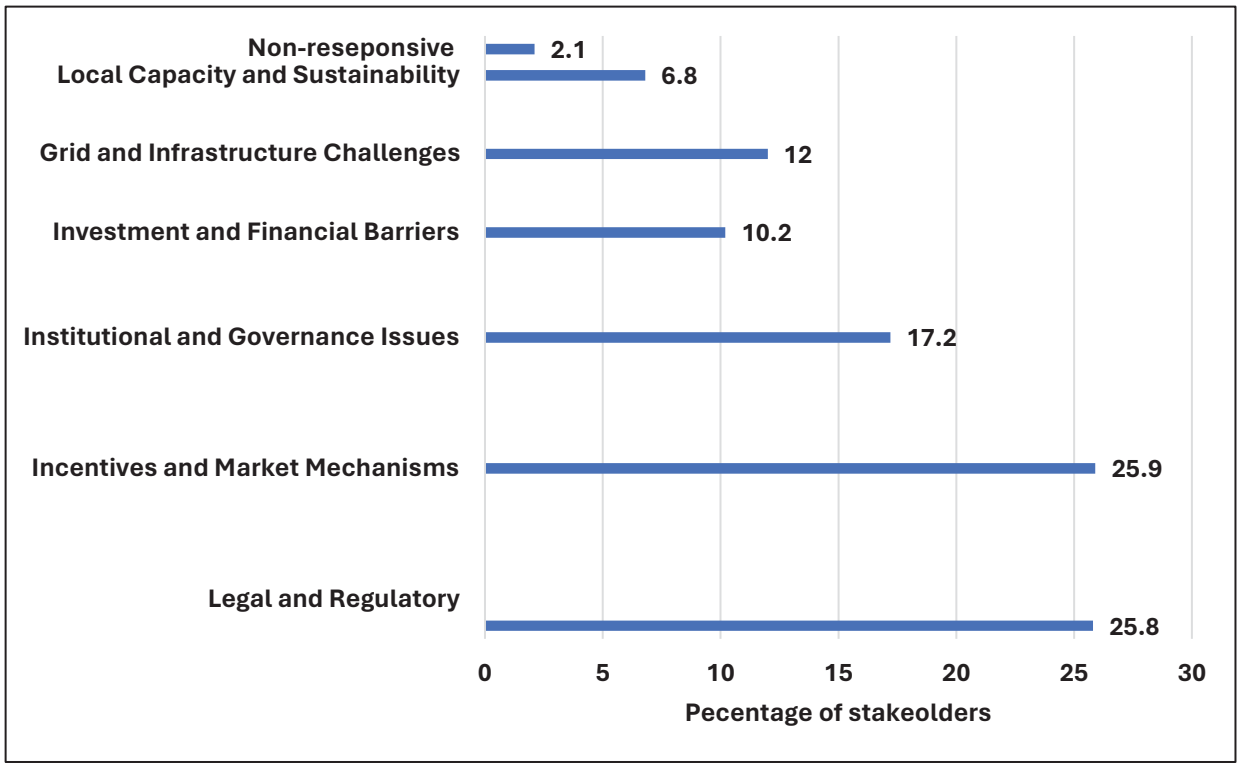
These results highlight that while financial and regulatory constraints are the most pressing challenges, addressing governance, infrastructure, and local capacity issues is also critical to accelerating renewable energy deployment in Tanzania.

Stakeholders perceive that the most critical gaps in Tanzania's renewable energy sector are primarily policy, legal, and market-related issues, followed by institutional challenges. Infrastructure limitations and financial barriers are also significant, though they are considered less pressing relative to regulatory and governance constraints.

These findings underscore *the need for regulatory reform, effective incentive mechanisms, and strengthened governance structures to accelerate RE development.* Addressing these priority

gaps will improve investor confidence, enhance project implementation, and foster more inclusive and sustainable growth in the sector.

Figure 7: Stakeholders' perceptions of gaps in RE policy in Tanzania



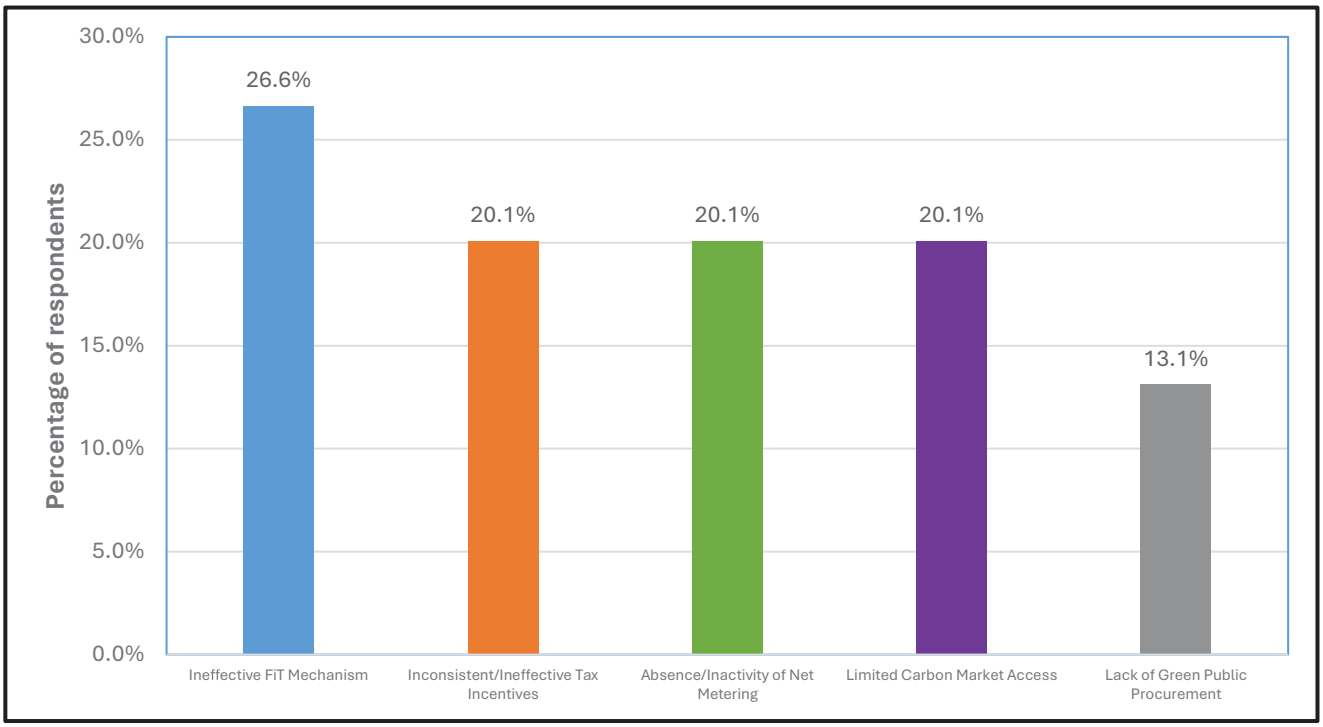
4.3.1.4. Stakeholders' Perceptions on Incentives and Market Mechanisms

Figure 8 illustrates stakeholders' perceptions of the most significant gaps in Tanzania's renewable energy incentives and market mechanisms. Approximately **27% of respondents** highlighted the ineffectiveness of the Feed-in Tariff (FiT) system as a key concern, pointing to shortcomings in economic regulation. Around **20%** emphasized issues with inconsistent tax incentives, the absence or limited activity of net metering schemes, and restricted access to carbon markets. A further **13%** noted the lack of green public procurement policies as a barrier to renewable energy uptake.

These findings suggest that, while some policy instruments exist, *their weak or inconsistent implementation constrains market participation, discourages private investment, and undermines the overall effectiveness of Tanzania's renewable energy framework.*

That inconsistency discourages private sector participation, undermines investor confidence, and diminishes the effectiveness of renewable energy framework all of which are hallmarks of a weak enabling environment.

Figure 8 Stakeholders Perception of Incentives and market mechanisms



Source: Field data

A range of factors shape the selection and deployment of renewable energy (RE) market mechanisms. These factors are closely tied to national policy objectives, *the maturity of energy markets, institutional capacity, and the availability of financial and technical resources*. As presented in **Table 10,** the key drivers for adopting specific mechanisms vary by context. However, it can be *inferred that the mechanisms highlighted are typical of developing countries,* where RE markets are still relatively immature and underdeveloped (Mingming Zhang, 2025). In such environments, stronger government intervention, targeted incentives, and risk-mitigation instruments are often required to encourage private sector participation and accelerate market growth.

Table 10: Factors influencing choice of RE market Mechanisms

Factor	Influence on Mechanism Choice	Example
Policy Objectives	Mechanisms are selected to align with national energy priorities, such as emissions reductions ***or expanding energy access***	A country targeting net-zero emissions may adopt carbon pricing or renewable portfolio standards (Guo, 2023).
Economic Conditions	Availability of financial resources and the need to attract private capital shape the choice of economic support mechanisms.	Developing countries may ***introduce feed-in tariffs or tax incentives to stimulate investment*** (Sustainability Directory, 2023).
Technical Capabilities	Existing infrastructure and technological expertise determine the feasibility of different mechanisms.	Countries with advanced grid systems may adopt net metering or

Factor	Influence on Mechanism Choice	Example
		standardized power purchase agreements.
Institutional Framework	The strength and capacity of regulatory bodies significantly influence the affective implementation and enforcement of mechanisms.	Strong institutions can manage complex tools such as renewable energy certificates (Crossley, 2019).
Resource Availability	Natural endowment of renewable resources drive the focus on particular technologies and mechanisms.	Regions with high solar potential may prioritize solar-specific incentives.
Market Structure (maturity)	The level of competition and maturity in energy markets affects whether mechanisms are regulated or market-driven.	Liberalized markets may Favor competitive auctions for renewable energy projects (Mingming Zhang, 2025).

Implications: Tanzania's RE incentive framework requires comprehensive reform to enhance its effectiveness and strengthen investor confidence. Key priorities include strengthening feed-in tariffs (FiTs), ensuring predictable and transparent tax incentives, operationalizing net metering, and expanding access to carbon markets and green public procurement opportunities. Implementation of these reforms would foster a more stable and enabling environment, stimulate private sector participation, and accelerate the deployment of renewable energy technologies.

4.3.1.5. Stakeholders' Perceptions on Legal and regulatory framework

Figure 9 presents stakeholders' perceptions on Tanzania's legal and regulatory framework for renewable energy. The three most pressing concerns, each cited by **20%** of respondents, as barriers to renewable energy development are:

i. **Absence of binding targets**: The government has not established clear and enforceable for renewable energy targets, leaving no strong commitment to guide or accelerate progress

ii. **Lack of Renewable Portfolio Standard (RPS) mandates:** There are no legal requirements obligating utilities or other entities to source a defined share of energy from renewable sources, thereby reducing the pressure to scale up clean energy generation.

iii. **No Dedicated Agency:** Without a specialized institution tasked with coordinating, regulating, and promoting renewable energy, sectoral efforts remain fragmented and less effective.

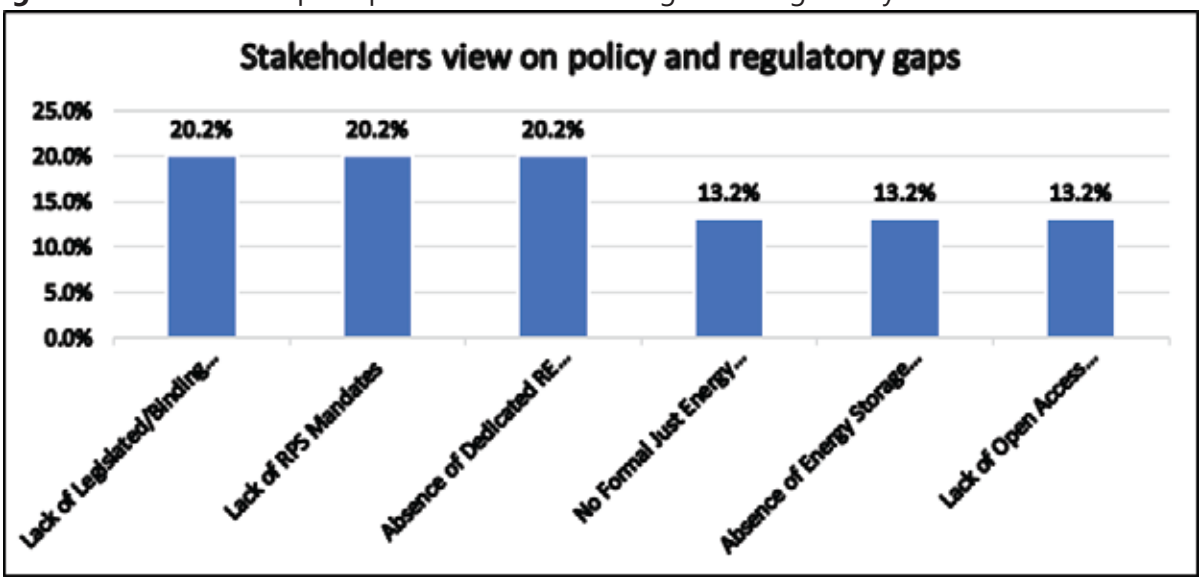
iv. Beyond the above concerns, stakeholders highlighted additional **No Just Energy Transition framework:** There's no structured plan to ensure that the move toward clean energy is fair and socially inclusive and protects vulnerable groups, such as workers in traditional energy sectors and low-income communities.

v. **No policy on energy storage:** Clear regulations and incentives for energy storage technologies such as batteries are lacking. This gap undermines efforts to enhance grid reliability, integrate intermittent renewables, and strengthen energy security

vi. **Limited open access to the grid**: Private developers face restrictions in accessing transmission and distribution networks, which discourages competition and investment. In cases where the national grid extends into areas already served by Small Power Producer (SPP) - mini-grids, the absence of clear interconnection, compensation, and integration policies creates uncertainty. As a result, SPP-led projects risk displacement, loss of customer bases, and reduced revenue streams, making investors cautious about supporting future mini-grid initiatives.

Without clear policies on grid interconnection, compensation, or integration, SPPs risk losing their customer base and revenue streams, making investors wary of supporting future mini-grid projects.

Figure 9: Stakeholders' perceptions on Tanzania's legal and regulatory framework

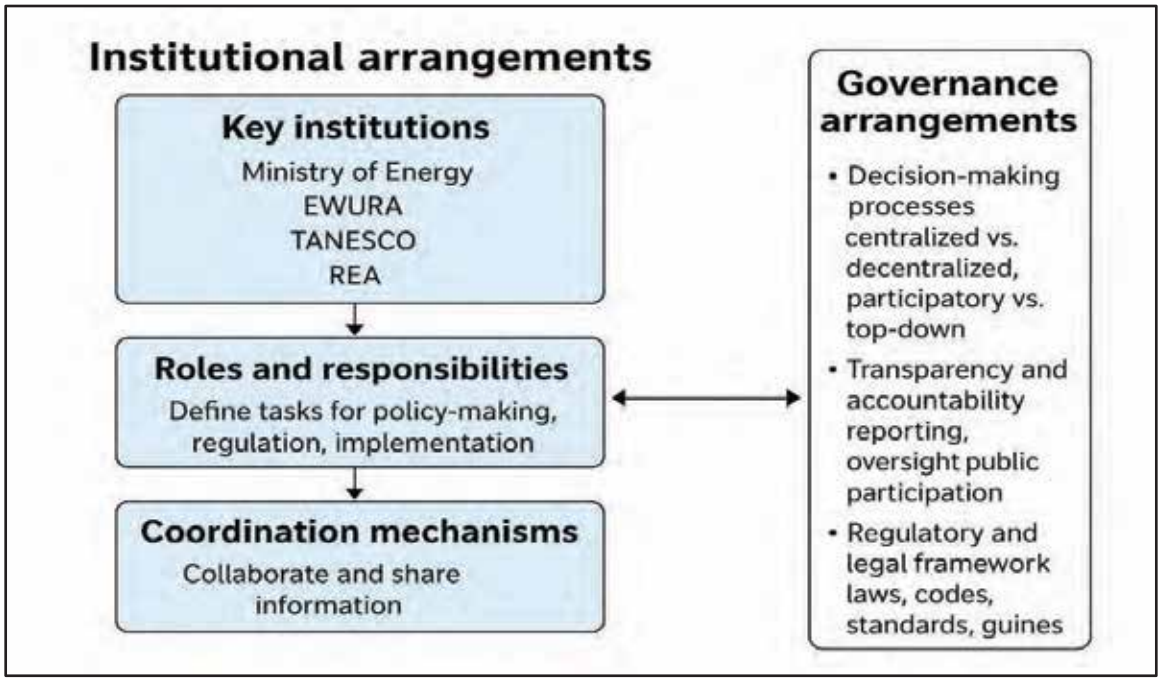


In brief, RETs present vast opportunities for Tanzania, but their uptake is slowed by policy uncertainty, limited financing, and weak technical capacity. Stakeholders emphasize that clear targets, stronger investment frameworks, and capacity building are essential to unlock their potential and drive a cleaner, more resilient energy future emphasis.

4.3.1.6. Stakeholders' Perceptions on Institutional and Governance Framework

When asked how the institutional arrangements and governance affect renewable energy development, stakeholders emphasized that clear coordination among institutions, streamlined regulatory procedures, and strong governance are essential for effective policy implementation, investment attraction, and scaling up of RETs. Overall, both institutional design and governance quality significantly shape the pace and success of renewable energy adoption in Tanzania (**Figure 10**).

Figure 10: Tanzania energy sector institutional and governance arrangement

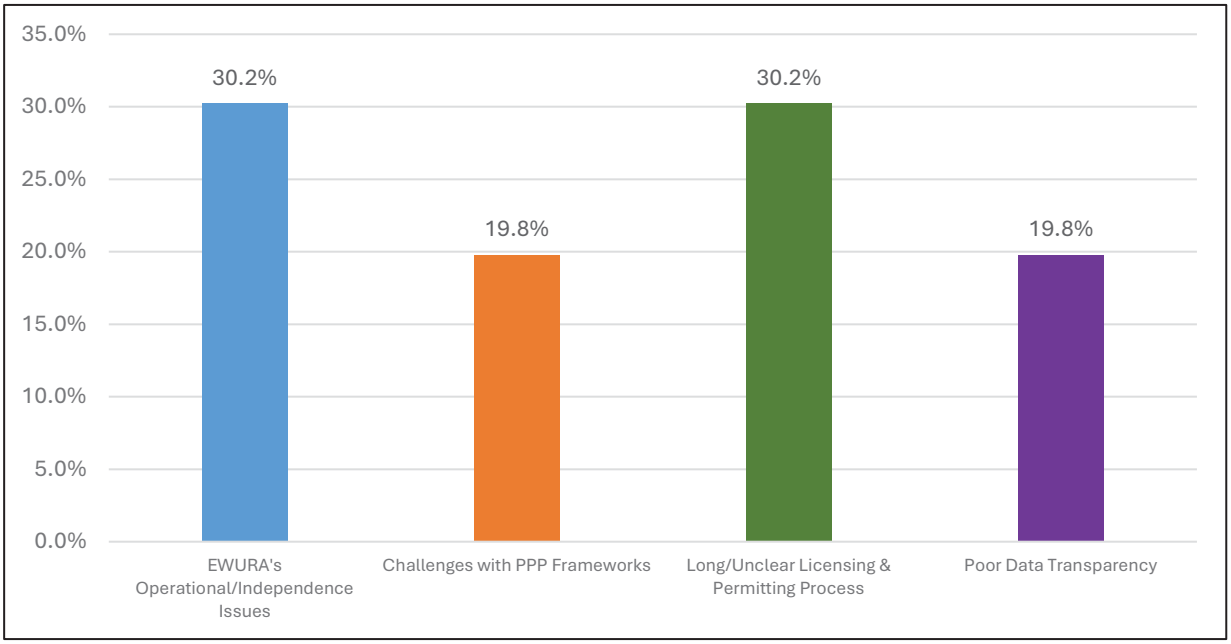


Institutional and governance arrangements play a pivotal role in ensuring effective regulation, transparent processes, and trust in public institutions. Understanding stakeholders' perceptions is therefore crucial for pinpointing areas that require reform or strengthening. As shown in **Table 11 & Figure 11,** stakeholders highlighted both strengths and weaknesses in the current institutional and governance framework, offering insights into where improvements are most urgently needed to accelerate the adoption and scaling of Renewable Energy Technologies (RETs).

Table 11: Stakeholder's perceptions of RET's institutional and governance arrangements in Tanzania

Issue	Stakeholder Concern (%)	Implication
EWURA's Operational Independence	30%	Lack of trust in regulatory decisions; potential political interference
Unclear Licensing & Permitting	30%	Delays, high transaction costs, reduced investment appeal
Challenges with PPP Frameworks	20%	Poor PPP uptake; underutilized private capital
Poor Data Transparency	20%	Low accountability; data-driven decision-making is hindered

Figure 11: Stakeholders perception of Institutional and governance arrangement



The stakeholders' feedback on key governance and institutional issues affecting the regulatory landscape highlights priority concerns that, if addressed, could enhance efficiency, accountability, and investor confidence: The listed concerns for various institutions are as follows:

i. EWURA's Operational Independence – 30%

A significant portion of stakeholders expressed concern regarding the operational and decision-making independence of EWURA. The concern suggests that:

- There may be undue external influence on regulatory functions.
- The regulator's autonomy to act on broader public and sectoral interest may be compromised.
- Stakeholders are questioning the impartiality and reliability of regulatory decisions.
- Independence should cover institutional, financial, operational and decision-making aspects, ensuring insulation from political authorities and vested stakeholders.

Such perceptions can weaken EWURA's institutional credibility and deter trustworthy engagement between private and public sectors, ultimately affecting investor confidence.

ii. Long and Unclear Licensing & Permitting Procedures – 30%

Another 30% of respondents raised concerns over delays and ambiguities in licensing and permitting processes. Specifically:

- Stakeholders experience time-consuming and non-transparent approval processes.

- Lack of clear guidelines and standards creates uncertainty and increases compliance costs.
- The inefficiency affects project timelines, execution, and investment planning.

This issue points to a need for streamlining and simplifying administrative procedures to improve service delivery.

iii. Challenges with PPP Frameworks – 20%

Public-Private Partnerships (PPPs) are vital for infrastructure development and service delivery. However, 20% of stakeholders identified challenges such as:

- Weak or unclear legal and institutional frameworks governing PPPs.
- Insufficient institutional capacity to structure and manage partnerships effectively particularly in risk sharing allocation.
- Limited clarity on roles, responsibilities, and long-term obligations between partners.

These challenges can discourage private investment and reduce opportunities for innovation in public service delivery and limit the effectiveness of PPPs in advancing renewable energy projects.

iv. Poor Data Transparency – 20%

Access to accurate and timely information is essential for transparency, accountability, and sound decision-making. Stakeholders highlighted the following concerns:

- Difficulty in accessing regulatory or sector performance data such as cost reflective tariff.
- Lack of open data systems or proactive disclosure practices for critical information, including planned projects, resource assessments, and feasibility studies.

Such limitations undermine trust in regulatory institutions, constrain evidence-based planning, and hinder meaningful stakeholder participation in the renewable energy sector.

The overall findings reveal two top concerns:

- The lack of operational independence of EWURA, and
- The lengthy or unclear processes involved in licensing and permitting.

These issues suggest significant challenges in both the exercise of regulatory authority and the management of administrative procedures.

Further, 20% of stakeholders highlighted secondary concerns, including:

- Inadequate public-private partnership (PPP) frameworks, and
- Poor transparency and access to data.

Together, these primary and secondary concerns underscore both **institutional** and **procedural gaps** that must be addressed to strengthen governance effectiveness and build greater confidence among stakeholders.

Institutional Capacity refers to the collective ability of an institution to perform its role effectively drawing on its resources, skills, and capabilities to manage and implement its

functions efficiently and achieve its goals. Strengthening institutional capacity is therefore essential to overcoming these challenges and enhancing overall regulatory performance.

4.3.1.7. Analysis of Stakeholder Perceptions

The results suggest that, while Tanzania's governance structure clearly defines institutional roles on paper, in practice it creates fragmented mandates, overlapping responsibilities, and weak cross-sectoral coordination. These constraints undermine policy implementation and slow the scaling up of renewable energy initiatives.

Moreover, while Tanzania's renewable energy framework provides a foundational legal and regulatory structure, there is still no dedicated Renewable Energy Act. Instead, implementation is guided by broader sectoral laws such as the Electricity Act (2008, amended 2020), EWURA Act (2006, amended 2022) and Rural Energy Act (2005).

Investor confidence is further constrained by uncertainty in tariff frameworks and limited availability of bankable Power Purchase Agreements (PPAs) for projects above 10 MW. These factors hinder the mobilization of long-term finance for large-scale renewable energy projects. Similarly, the absence of appropriate risk mitigation instruments, clear competitive procurement rules, and detailed guidance on green finance or carbon markets restrict investment inflows. Support for geothermal direct-use applications, mini-grid, and off-grid solutions also remains limited, despite their potential role in expanding rural access and fostering inclusive growth (WB, 2024).

Without a stable and investor-friendly regulatory framework, the development of large-scale renewable energy projects remains slow, thereby limiting opportunities to expand electricity access and diversify the national energy supply mix. The limited institutional and financial support for mini-grids and off-grid systems further constrains rural electrification and productive energy use of energy, both of which are vital for job creation, agricultural productivity, small-scale enterprise growth, and local economic development.

Addressing these structural and policy gaps would enable Tanzania to accelerate renewable energy deployment, stimulate private sector investment, and position the renewable energy sector as a driver of economic growth, employment, and improved living standards across the country.

4.3.2. Objective 2: The Current State and Advancement of Renewable Energy Technologies in Tanzania as Compared to Global Trends

Responses from 28 individuals provide an insightful snapshot of renewable energy technologies (RETs) in Tanzania, contextualized against global developments. According to the data from respondents, hydropower, solar, and biomass are the leading renewable energy sources, identified by **82%, 64%, and 54%** of respondents, respectively.

Currently, renewables account for an estimated 68% of Tanzania's main grid electricity generation mix. However, this figure is heavily skewed by the inclusion of large-scale hydropower as renewable energy. Excluding hydropower, other renewables collectively contribute less than 4% to the energy mix underscoring a significant gap between policy ambition and actual diversification. Looking ahead, the Tanzanian government has set an ambitious target to raise the renewable share to 75% by 2030. This goal is anchored in Mission 300 (National Energy Compact, 2025), which outlines plans to add approximately 1,973 MW from a diversified portfolio of energy sources: solar (463 MW), wind (500 MW), geothermal (153 MW), and large hydro (880 MW). This forward-looking commitment signals recognition of the

need to diversify beyond hydropower and align more closely with **global energy trends**, where solar and wind have emerged as the fastest-growing sources due to rapidly declining technology costs and scaling innovations.

In comparison with global trends, the development of RETs in Tanzania is lagging behind. Global, renewable energy capacity exceeded 4,448 GW in 2024, representing a 15.1% increase from the previous year. Solar PV and wind continue to lead to this expansion, with annual growth of 31.2% (452 GW) and 11.1% (113 MW), respectively (IRENA, 2025).

In Tanzania, however, renewable energy development is advancing at a slower pace and remains concentrated in a few technologies. Solar energy adoption is rising, though primarily through rural electrification initiatives such as mini-grids and standalone systems, with utility-scale solar projects only beginning to emerge. Wind energy development is even less advanced, constrained by the absence of comprehensive resource assessments and limited policy incentives for developers. Geothermal energy holds an estimated potential of over 5,000 MW, but progress remains in the exploratory stage, with preparations underway for well drilling to confirm resource viability. Globally, hydropower is a mature and widely deployed technology though increasingly considered vulnerable to climate change impacts on water resources. In contrast, in Tanzania, hydropower remains the dominant renewable source, contributing about 67.3% of the national main-grid electricity mix. This heavy reliance underscores the urgent need for greater diversification of Tanzania's renewable portfolio to align with global energy transition dynamics and enhance resilience against climate variability.

4.3.2.1. Stakeholders' Perceptions on how Tanzania's renewable energy (RE) Sector Compares with Global Trends across Key Areas

Table 12 presents stakeholders perceptions of how Tanzania's renewable energy (RE) sector compares with global trends across key areas. Overall, Tanzania is seen as underperforming across most dimensions of renewable energy development.

More than 35% of respondents rated the country's growth in RE capacity, geothermal energy, investment and financing as either "far below" or "below" global standards. Wind energy development received the lowest rating, with more than half of respondents (53.57%) viewing it as progressing much slower than in other regions. Similarly, bioenergy, along with the policy and regulatory framework, was rated poorly, underscoring to persistent challenges in both technology adoption and regulatory effectiveness.

Table 12: Stakeholder Perceptions of Tanzania's Renewable Energy Trends Compared to Global Developments

Area of Comparison	Tanzania's Trend vs. Global Trends	% of respondents
Policy & Regulatory Framework	Below	29
Growth Rate of RE Capacity	Far below	36
Solar Energy	Below	25
Wind Energy	Much slower	54
Hydropower	Similar	25
Geothermal Energy	Far below	36
Bioenergy (Biogas, Biomass)	Below	50

Investment & Financing	Below	36
Future Outlook	Similar	46

Source: Field data

However, there is some optimism: hydropower and the future outlook were rated as "similar" to global trends by between 25% and nearly 50% of respondents, highlighting areas of relative strength and stability within Tanzania's RE sector. These results suggest that, despite notable gaps in areas such as wind, geothermal, and bioenergy, the country retains a foundation on which to build. Overall, these findings underscore the need for targeted interventions in policy implementation, financing mechanisms, and technological diversification to better align Tanzania's renewable energy development with international benchmarks.

Regarding the prioritization of renewable energy technologies, respondents identified **solar photovoltaic (PV)** as the top priority, citing its abundance, suitability for off-grid and mini-grid applications, and broad accessibility (**Table 13**). Hydropower ranked second, appreciated for its technological maturity, cost-effective energy production, and considerable untapped potential to supply base load power. In third place, bioenergy was highlighted as a socially acceptable pathway for transitioning away from unsustainable biomass use. Geothermal energy followed, recognized for its potential to provide consistent and reliable baseload electricity, though development remains slow. Wind energy ranked lowest, viewed as promising in select regions but constrained by limited data availability and inadequate technological readiness.

This prioritization reflects both the perceived feasibility and strategic significance of different technologies in Tanzania's renewable energy landscape, while also highlighting the practical and infrastructural challenges that influence investment and policy choices and decisions.

Table 13: Prioritization of Renewable Energy Technologies

Priority Rank	RET	Key Reasons for Prioritization
1 (Highest)	Solar PV	Abundant resource, ideal for off-grid/mini-grids, widely available and accessible.
2	Hydropower	Mature technology, cost-effective production, significant unexploited potential, and huge base load capacity.
3	Bioenergy	Addresses current reliance on unsustainable biomass, socially safe transition.
4	Geothermal	Potential as a baseload source, consistent power generation, huge potential.
5 (Lowest)	Wind	Promising resources in certain regions, require more comprehensive data and technology.

Source: Field data

4.3.2.2. Stakeholders' Perceptions on RE Future Outlook

The overall sentiment regarding Tanzania's renewable energy future is optimistic, though stakeholders expressed reservations about the ability of RETs to drive productive activities in remote communities. Respondents provided a broad range of recommendations (Table 14) to strengthen sector development and implementation, which can be grouped into several key areas:

- **Policy and Governance:** Establish a dedicated Ministry for Renewable Energy and develop a comprehensive policy framework that incentivizes private sector participation. Policies should also extend beyond electricity to include non-electricity RETs, such as solar water heating
- **Capacity Building and R&D:** Invest in local expertise through technical skills training research and innovation, with particular emphasis on improving access to reliable data.
- **Financing & Investment:** Create a conducive investment environment by attracting private sector players and leveraging diverse funding sources, including climate finance, concessional loans, and carbon credit mechanisms.
- **Grid Infrastructure:** Modernize the national grid to better integrate intermittent sources like solar and wind by deploying flexible generating systems, energy storage solutions, and dynamic pricing models.
- **Public Awareness:** Implement nationwide education and awareness campaigns to increase demand for RETs and promote community acceptance of renewable technologies.

Taken together, these measures point to a future where Tanzania can leverage its abundant renewable resources to meet growing energy needs, attract sustainable investments, and align more closely with global energy transition pathways.

Table 14: Summary of Recommendations for Advancing Renewable Energy in Tanzania

Recommendation Category	Specific Actions
Policy and Governance	Establish a dedicated Ministry for Renewable Energy to streamline institutional coordination and oversight. Develop and enforce a clear, supportive policy and regulatory framework that provides incentives for private sector participation and ensures effective implementation across both electricity and non-electricity RETs (e.g., solar water heaters).
Financing and Investment	Encourage private sector participation by creating a predictable and attractive investment climate. Blend public, private, and donor funding to reduce risks and expand capital availability. Establish green financing institutions and mechanisms, , such as renewable energy banks or guarantee funds, to provide tailored financial support for renewable projects, while leveraging climate finance and carbon credit opportunities.
Capacity Building and R&D	Strengthen local research institutions to improve data access, knowledge generation, and policy relevance. Invest in

	innovation and technical training programs to build a skilled renewable energy workforce capable of supporting design, installation, operation, and maintenance of diverse RETs.
Grid Infrastructure	Upgrade grid infrastructure with modern energy storage systems (e.g., battery storage and green hydrogen) to accommodate intermittent renewable sources. Introduce dynamic pricing models and enable demand-side management to enhance flexibility, efficiency, and reliability of power supply.
Public Awareness	Conduct nationwide awareness campaigns to educate communities on the benefits, applications, and cost-effectiveness of renewable energy technologies (RETs), while stimulating demand and social acceptance to accelerate adoption.

Stakeholder recommendations for strengthening Tanzania's renewable energy sector highlight several critical areas for action. **Policy and governance reforms**, including the establishment of a dedicated ministry for Renewable Energy, were identified as essential to provide strategic direction and regulatory clarity. On **financing**, respondents emphasized the need to attract greater private sector investment and establish green financing mechanisms that blend public, private, and donor resources**. Capacity building** through investment in local research, innovation, and technical training was seen as a foundational pillar for sustainable sector development.

To address existing **grid and infrastructure limitations**, stakeholders recommended integrating of storage technologies such as battery systems and green hydrogen, alongside adopting smart grid features like dynamic pricing and demand management. Finally, **public awareness** emerged as a key area, with calls for nationwide education campaigns to increase community engagement and stimulate demand for renewable energy technologies (RETs).

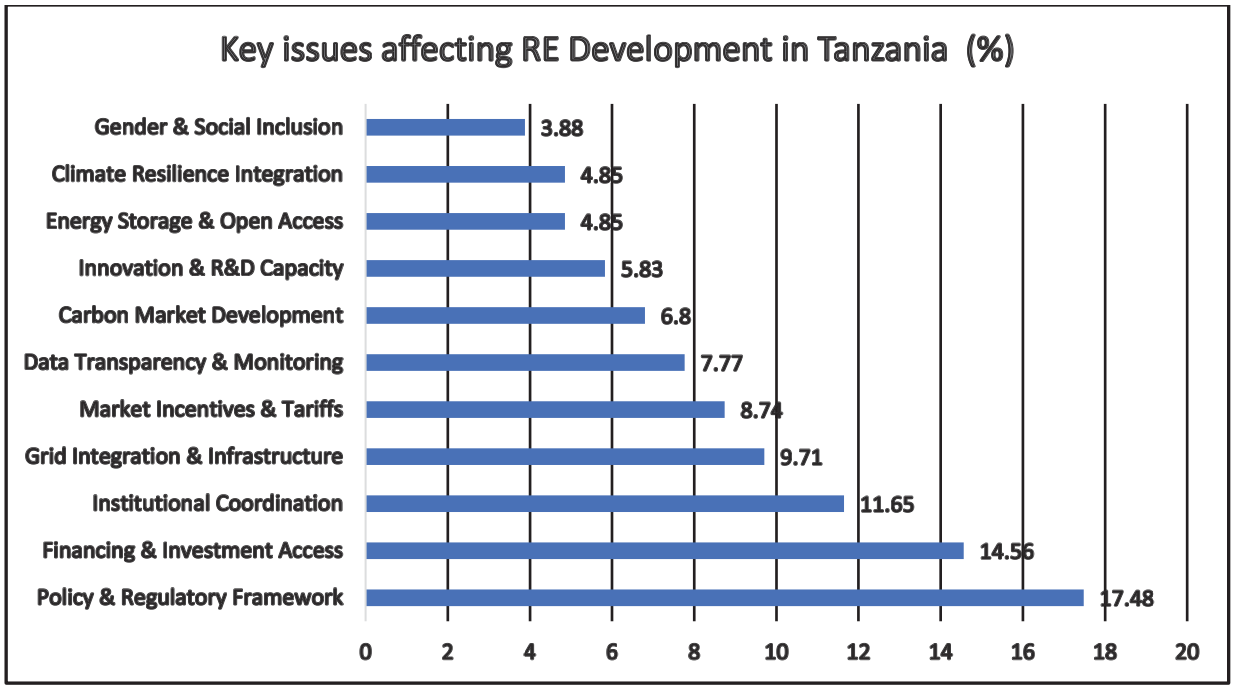
4.3.3. Objective 3: Causes, Main Barriers and Challenges of Low Exploitation and Adoption of RETs

This section presents the analysis of the results and findings of the study on the causes, main barriers and challenges of low exploitation and adoption of renewable energy technologies. **Figure 11** presents the key issues affecting renewable energy (RE) development in the country, as identified through stakeholder feedback. The most frequently cited challenge was the policy and regulatory framework, which, accounted for **17%** of total mentions. Respondents pointed to unclear provisions, inconsistent application, and weak enforcement of existing policies as major obstacles, reducing both investor confidence and sector stability. This was followed by issues related to financing and investment access (**15%**), and institutional coordination (**12%),** which reflect systemic barriers in mobilizing capital and aligning sectoral efforts. Other recurring themes included grid integration and infrastructure limitations, lack of market incentives, and data transparency gaps, all of which constrain effective planning and private sector participation.

Stakeholders also noted several emerging issues that will increasingly shape the renewable energy landscape, including carbon market development, innovation and local research capacity, energy storage, and social inclusion. These concerns highlight a growing recognition

of the need for a more integrated and forward-looking approach to renewable energy development. Interpreted within the Tanzanian context, the results reveal a multifaceted set of challenges that collectively slow down the country's renewable energy (RE) transition.

Figure 12: Key issues affecting renewable energy (RE) development in Tanzania



Source: Field data

4.3.3.1. Key Issues Affecting RET Development in Tanzania

(a) Policy and Regulatory Framework

Tanzania has committed to increasing the share of renewable energy in its electricity generation mix to **75% by 2030** through its *National Energy Compact* and related energy plans. However, this target is articulated primarily in policy documents and political statements rather than in binding legal instruments, which reduces its enforceability and undermines investor confidence. As one respondent observed, *"The NEP doesn't speak to the future, it's silent on the technologies we need now"*. The National Energy Policy (NEP 2015) remains the central guiding document for the sector, yet it shows significant gaps. It does not adequately address emerging and rapidly evolving technologies such as electric mobility, energy storage, green hydrogen, or the development of value chains for critical minerals.

This policy lag creates uncertainty for developers and investors seeking to align with future-oriented technologies and signals the need for comprehensive updates to align national energy policy with global energy transitions.

Globally, over 80 countries have enacted dedicated renewable energy laws with enforceable targets (IEA, 2025). For instance, the European Union requires member states to achieve 42.5% renewable energy in final energy consumption by 2030. In contrast, Tanzania's commitment to reach 75% renewable energy in the generation mix by 2030 (IEA, 2025) remains aspirational rather than legally binding, creating uncertainty for both investors and developers.

The absence of a competitive procurement framework coupled with delays in inspection and licensing, particularly by TANESCO further compounds implementation challenges. As one developer lamented, *"We waited over a year for grid connection approval, and still there are no clear timeline."* Such regulatory inertia undermines private sector confidence and slows the overall pace of the energy transition.

(b) Financial and Investment Barriers to Renewable Energy Deployment in Tanzania

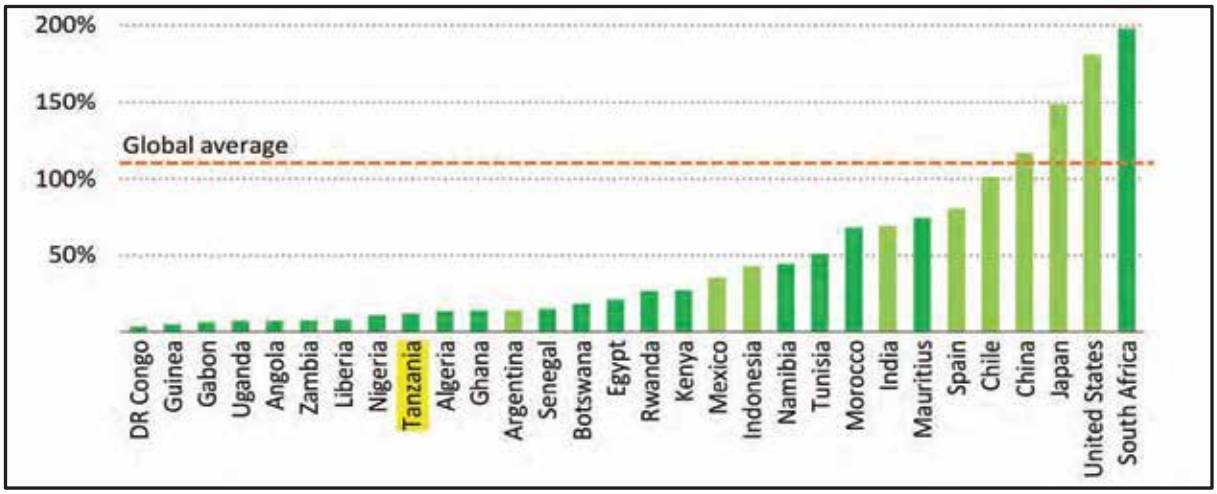
Tanzania, like many other African countries, suffer from an over-reliance on hard currency financing for clean energy projects, while local currency financing remains both scarce and prohibitively expensive. Financial constraints were among the most frequently cited barriers during stakeholder interviews. Achieving the ambitious target of 100% renewable energy by 2050 will require an estimated USD 9 billion in annual investments (World Future Council, 2018) . Yet, access to affordable financing remains a critical challenge. Local commercial banks typically charge interest rates between 11% and 20%, far above global averages for clean energy project financing.

As illustrated in **Figure 13,** Tanzania's capital markets remain far below global benchmarks in terms of stock market capitalization and access to long-term domestic finance. This weak financial ecosystem limits the flow of local capital into renewable energy, particularly constraining debt financing for large scale infrastructure- and decentralized off-grid projects.

These structural constraints are particularly evident in Tanzania, where capital markets are relatively shallow, and financial intermediation remains limited. *Consequently,* the cost of capital is high, *and local banks and investors exhibit significant* ***risk aversion*** (TICGL, 2025). Furthermore, many Tanzanian banks lack the in-house technical capacity to independently assess renewable energy project proposals, resulting in delays in capital deployment. As one bank representative observed, *"We rely on external consultants to assess RE proposals, it's costly and slows down decision-making."*

This dependence on external expertise, combined with the absence of essential risk mitigation instruments, such as credit guarantees, partial risk insurance, or foreign exchange hedging tools, discourage investment and limits access to concessional finance. Consequently, Tanzania's current financial ecosystem remains risk-averse and structurally constrained, impeding the scaling up of renewable energy investments that are critical to achieving the country's energy transition goals.

Figure 13: Financial system development indicator for selected countries



Globally, renewable energy financing is increasingly facilitated through blended finance models, with average interest rates between 3–7% (IEA, 2023)**.** Countries such as India and Chile have successfully mobilized private capital through instruments like green bonds and public-private partnerships. By comparison, Tanzania's financial ecosystem remains underdeveloped and risk averse.

A closer examination reveals several practical challenges faced by local financial institutions, including perceived risks in rural markets, extended project payback periods, limited revenue potential in low-income communities, and the absence of standardized financing models. These factors collectively constrain the capacity of local banks to support renewable energy deployment effectively.

4.3.3.2. Perceived Risk of Rural Markets

Lenders and investors often perceive rural energy markets as high-risk due to several factors:

- Low population density, which increases infrastructure costs per customer.
- Limited formal credit history or financial documentation among rural customers making it harder to assess repayment capacity.
- Challenges in monitoring and enforcing loan agreements or utility payments in remote areas.

As a result, banks and investors either avoid these markets or apply higher risk premiums such as increased interest rates or stricter collateral requirements, making projects less bankable and slowing the deployment of renewable energy solutions in rural areas.

Further, renewable energy projects, particularly off-grid solar systems and mini-grids, often face **extended payback periods** due to several factors:

- High upfront capital costs (CAPEX),
- Low operating costs, but
- Long timelines (5–10+ years) required to recoup the initial investment.

In contrast, many financial institutions prefer shorter loan tenors and quicker returns. This mismatch between project cash flow and available financing terms makes it difficult for developers to secure suitable funding. Moreover, investors may be hesitant to commit to long-term infrastructure projects in markets perceived as politically or economically unstable.

4.3.3.3. Limited Revenue Generation in Low-Income Communities

Many rural electrification initiatives target low-income households which often have:

- Limited disposable income, and
- Low **energy** demand beyond basic needs such as lighting and phone charging.

This significantly constrains the revenue potential for energy service providers, reducing the overall commercial viability of projects. Without the capacity to generate strong and predictable cash flow, such initiatives struggle to secure commercial financing and instead remain **heavily reliant** on grants or subsidies.

4.3.3.4. Lack of Standardized Financing Models

As the renewable energy sector in Tanzania is still emerging, several challenges persist (see **Table *15***):

- Absence of standardized loan products, due diligence templates, and risk assessment tools tailored to renewable energy projects.
- Limited track record of successful projects, which heightens caution among financial institutions.
- Few replicable project structures that can be scaled across different geographies.

In the absence of standardized models, each project requires customized financial structuring, which increases transaction costs and slows deal flow. These inefficiencies discourage both local banks and investors from actively engaging in the sector.

Table 15: Key challenges affecting renewable energy financing in rural markets

Challenge	Effect on Financing
Perceived risk of rural markets	Results in higher interest rates, stricter collateral, requirements, or exclusion of rural projects altogether
Long payback periods	Creates a mismatched with the short-term lending preferences of local banks, limiting access to suitable financing.
Limited revenue in low-income areas	Reduces project bankability by weakening commercial viability and repayment capacity
Lack of standardized financing models	Raises transaction costs and slows deal flow, discouraging investment at scale

Source: Field data

4.3.3.5. Institutional Fragmentation over Function

Institutional fragmentation remains a persistent challenge in Tanzania's energy sector. Multiple agencies including EWURA, MoE, REA, TANESCO, and local governments, hold overlapping mandates, which often results in delays, duplication of effort, and inefficiencies. Notably, local governments are frequently excluded from early project development, reducing their ability to contribute to land use planning and community engagement.

The **Electricity Regulatory Index for Africa 2024 (ERIA, 2024)** highlights this issue. While Tanzania has formal regulatory frameworks in place, the **Regulatory Outcome Index (ROI)**, which measures the extent to which regulatory actions achieve sector goals such as access, reliability, and investment climate shows mixed results. The gap stems largely from weak institutional coordination.

The Electricity Regulatory Index for Africa 2024 (ERIA, 2024) highlights this issue. While Tanzania has formal regulatory frameworks in place, the Regulatory Outcome Index (ROI), which measures the extent to which regulatory actions achieve sector goals, such as access, reliability, and investment climate shows mixed results. The gap stems largely from weak institutional coordination.

A major driver of this inefficiency is the limited involvement of local governments in planning processes. As one district official explained: *"We only hear about RE projects after they have been licensed; there is no formal channel for prior involvement."*

This exclusion undermines local ownership, hinders effective land use integration, and weakens the alignment of renewable projects with broader community development priorities, ultimately constraining the sector's regulatory effectiveness.

The ERIA 2024 data correlates Tanzania's relatively low ROI with institutional fragmentation, highlighting how poor coordination reduces transparency, weakens accountability, and slows down project implementation. This stands in contrast to countries like Kenya, which records higher ROI scores due to more centralized and streamlined regulatory frameworks.

For example, Kenya's Energy and Petroleum Regulatory Authority (EPRA) consolidates regulatory functions, ensuring clearer mandates and more cohesive stakeholder engagement. Similarly, Germany's Federal Network Agency (*Bundesnetzagentur*) provides a unified governance structure with robust mechanisms for transparency and coordination. These institutional designs promote:

- Efficient decision-making,
- Early involvement of local stakeholders,
- Reduced duplication of efforts, and
- Greater regulatory predictability.

Such frameworks contribute to higher ROI scores by enabling timely project approvals, consistent policy enforcement, and stronger investor confidence.

Addressing institutional fragmentation in Tanzania by clarifying agency roles, integrating local governments into the planning, licensing, and permitting processes, and improving inter-agency coordination could significantly enhance ROI. Strengthening these regulatory outcomes is essential for accelerating the energy transition and effectively achieving national renewable energy targets.

Integration and Technical Standards: Infrastructure Bottlenecks

Tanzania faces significant infrastructure and regulatory challenges in integrating renewable energy into its national grid, particularly from distributed sources such as mini-grids and rooftop solar. The country's electricity grid remains technically constrained, with limited flexibility and outdated standards that restrict the absorption of variable renewable energy (VRE) such as solar and wind.

Currently, **TANESCO,** the vertically integrated state utility, retains monopoly control over grid operations, including interconnection agreements. Mini-grid developers frequently report unclear or inconsistent procedures for interconnection. As one operator explained, *"We have the capacity to supply nearby villages, but TANESCO won't allow grid connection, it's a deadlock."* Such resistance stifles innovation and slows the deployment of reliable, clean energy solutions. In addition, the absence of real-time balancing systems and demand response mechanisms poses further barriers. These tools are critical for managing variability in renewable generation and enabling higher shares of intermittent sources to be integrated into the grid effectively.

Globally, countries are rapidly upgrading their grid systems to accommodate higher shares of renewables. According to Our World in Data (2024), solar and wind now account for over *13% of global electricity generation*, a growth trend supported by investments in smart grids, energy storage, and flexible transmission infrastructure. Examples from Brazil and South Africa provide valuable lessons for Tanzania:

- Brazil has implemented clear interconnection codes and promotes distributed generation through net metering and digital monitoring systems. Its regulatory agency, ANEEL, has adopted technical standards that allow distributed generators to feed power into the grid safely and predictably.
- South Africa, despite facing challenges, has initiated grid modernization programs under its Integrated Resource Plan (IRP) (DMRE, 2023). These include transmission upgrades, technical guidelines for integrating variable renewable generation, and procurement frameworks that account for grid constraints.

These global practices show that with the right mix of regulatory clarity and infrastructure investment, distributed renewable energy can be integrated seamlessly into national grids, strengthening energy security and accelerating decarbonization.

The implications for Tanzania are significant. Delays in adopting modern interconnection standards and grid codes pose a substantial barrier to scaling up clean energy. The country risks falling behind regional and global peers unless it:

- Introduces transparent, time-bound procedures for mini-grid interconnection.
- Invests in grid flexibility measures, including smart metering, energy storage, and advanced control systems.
- Clarifies TANESCO's role and incentivizes collaboration with independent power producers (IPPs) and mini-grid developers.

Strengthening the enabling environment for grid integration is critical not only for achieving Tanzania's renewable energy targets but also for ensuring that the broader economy fully benefits from the ongoing energy transition.

4.3.3.6. Data Transparency and Monitoring

Effective energy planning depends on robust data systems, yet Tanzania currently lacks a centralized, publicly accessible renewable energy data portal. Monitoring, Reporting, and Verification (MRV) systems are fragmented, limiting the credibility of carbon market participation and hindering evidence-based policymaking.

A stakeholder observed: *"We don't even know how much solar is actually being generated as there's no reliable data."*. This lack of transparency undermines investor confidence and restricts adaptive management of the energy sector.

Globally, over 70 countries maintain open-access energy data platforms, allowing for real-time tracking and performance evaluation (IRENA, 2025). MRV systems are standard in regulated carbon markets in regions such as the EU, Canada, and South Korea. To align with international best practices, Tanzania's data infrastructure must evolve to support transparent monitoring, informed policymaking, and strategic decision-making across the renewable energy sector.

Carbon Markets and Climate Resilience: Untapped Potential

Tanzania's carbon market currently operates on a voluntary basis, with limited regulatory oversight and low pricing around USD 10 per ton. Certification costs exceed USD 50,000, making participation prohibitive for small scale developers. Additionally, climate risks such as drought, are not systematically integrated into energy planning.

As one respondent noted: *"We have the forests, the solar, the wind but no system to monetize it through carbon credits."* Despite registering over 70 carbon market projects, only a few are operational, and the country has realized just 3% of expected revenue (UONGOZI Institute, 2025).

By contrast, the global carbon credit market was valued at USD 851 billion in 2022, with countries such as Colombia and Indonesia establishing national carbon exchanges. Tanzania's underdeveloped carbon infrastructure constrains its ability to leverage climate finance and enhance resilience to climate-related risks, representing a significant untapped opportunity for supporting the country's renewable energy transition.

Gender and social inclusion: Marginalized Voices

Gender and social inclusion remain peripheral in Tanzania's renewable energy strategy. Women constitute a small fraction of the RE workforce, and gender considerations are not systematically integrated into policy frameworks. Few initiatives support women-led enterprises or promote inclusive financing.

As one female entrepreneur shared, *"We're trained in solar installation, but there's no funding or follow-up, most of us drop out."* This lack of institutional support perpetuates inequality and limits the broader social impact of the renewable energy sector.

Globally, women comprise 32% of the renewable energy workforce, and over 50 countries have implemented gender-responsive policies (IRENA Gender Report, 2024). For Tanzania, prioritizing gender and social inclusion is essential to ensure a just and equitable energy transition, maximizing both economic and societal benefits.

4.3.3.7. Bridging the Gap

The field interviews reveal a complex web of structural, financial, and institutional barriers that hinder renewable energy adoption in Tanzania. Compared to global benchmarks, the country faces significant deficits in policy enforcement, financing mechanisms, grid readiness, data transparency, and social inclusion.

Yet, the opportunities are equally compelling. With abundant natural resources, growing demand, and international support, Tanzania is well-positioned to accelerate its energy transition, provided it undertakes bold reforms and invests in systemic capacity building. As one stakeholder aptly put it, *"We don't lack potential, we lack the systems to unlock it."*

Upon further analysis, respondents provided valuable insights into the structural and operational challenges impeding the advancement of renewable energy in Tanzania (**Figure *14***). Their feedback underscores a series of interrelated issues that constrain investment, delay project implementation, and hinder community adoption of clean energy technologies as follows. Key challenges include:

Limited Financing Mechanisms as the Foremost Barrier: The absence of accessible green financing options, coupled with high upfront capital costs, restricts participation of both private developers and local communities. Nearly half of respondents (approximately **45%**) identified lack of funding and limited access to finance as the most critical barrier to renewable energy deployment. This finding aligns with broader sectoral analyses, which point to high domestic interest rates **(11–20%)**, limited availability of long-term capital, and a lack of concessional financing options. Local banks generally lack the technical expertise to assess renewable energy projects independently, forcing developers to rely on costly external consultants. Moreover, the absence of risk mitigation tools, such as credit guarantees or hedging mechanisms, disproportionately affects small and medium-sized project developers, further constraining sectoral growth.

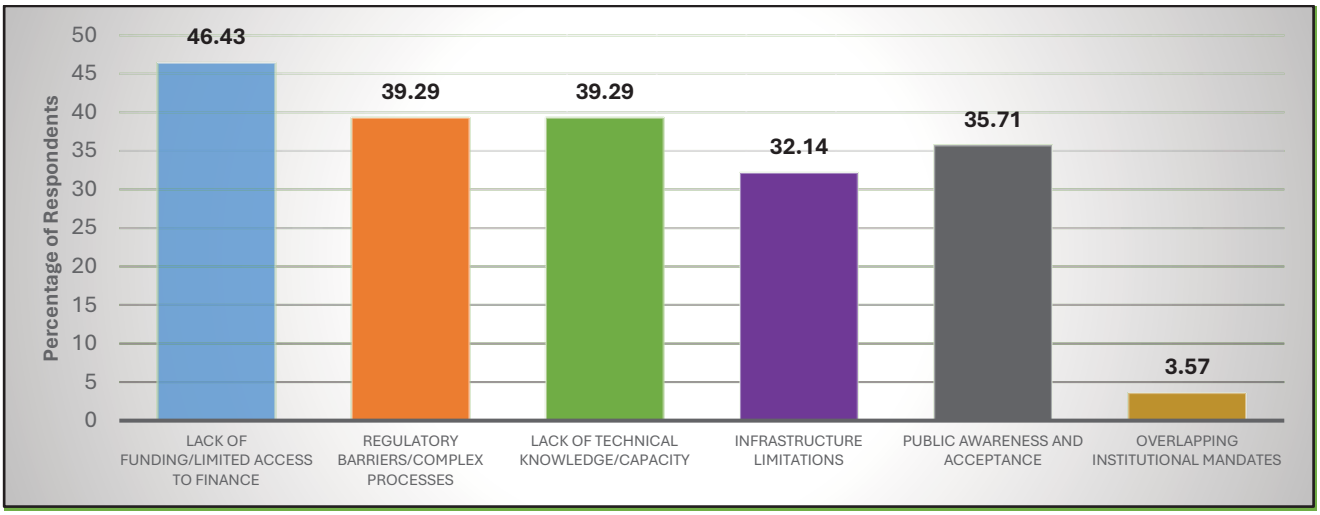
Policy and Regulatory Enforcement Complexity and Technical Capacity Gaps: Inconsistent application of policies and unclear regulations undermine investor confidence and slow down sector growth. The second major area of concern relates to regulatory complexity and technical capacity deficits. Approximately **40%** of respondents cited bureaucratic delays, unclear permitting procedures, and inconsistent regulatory enforcement, particularly in relation to grid interconnection approvals from TANESCO and licensing requirements overseen by EWURA. Almost equally (around **39%**), stakeholders pointed to a shortage of technical expertise across both public institutions and the private sector. These gaps weaken the ability to design, evaluate, and implement renewable energy projects effectively, limiting innovation and diminishing investor confidence.

Infrastructure and Public Engagement: Infrastructure constraints were cited by approximately **32%** of respondents. Key concerns include weak transmission capacity, delayed grid extensions, insufficient planning for energy storage, outdated transmission and distribution networks, low rural grid coverage, and limited grid flexibility to accommodate distributed generation such as mini-grids, all of which hamper large-scale renewable energy integration. Simultaneously, about **35%** of respondents pointed to **low public awareness and acceptance** of renewable energy technologies. This is often attributed to **limited stakeholder and community engagement, weak consultation processes**, gender disparities, low levels of energy literacy, and insufficient support for local enterprises. Collectively, these factors undermine community buy-in and threaten the long-term sustainability of renewable energy projects.

Institutional Coordination: A Latent Challenge: Although frequently highlighted in academic and policy literature, **overlapping institutional mandates** were cited by only **4%** of respondents. This suggests that while **institutional fragmentation** among entities such as the Ministry of Energy, EWURA, REA, TANESCO, and local governments remains a challenge, it is perceived more as a **latent or indirect barrier**. Its impacts are often experienced through delays in project approvals, duplication of roles, and lack of accountability rather than being viewed as a primary obstacle in itself.

- **Data and information gaps** – Lack of reliable, transparent, and up-to-date data on energy demand, resources, and project performance makes planning and investment decisions more difficult.

Figure 14: Structural and Operational Bottlenecks in Renewable Energy Deployment



Source: Field data

4.3.3.8. Analysis & Interpretation of results

The following section provides a comprehensive interpretation of the field interview responses from *Objective 3*, focusing solely on the deeper meanings and implications of the issues raised. Rather than merely restating the findings, this analysis distils their strategic significance, highlighting how each barrier shapes the trajectory of renewable energy adoption in Tanzania and revealing the systemic impacts that emerge across the sector.

The comparative table below (**Table 16**) situates Tanzania's renewable energy (RE) development against global benchmarks across key dimensions. The results reveal reveals a mixed landscape: while Tanzania has articulated ambitious political intent, such as the commitment to achieve 75% renewable energy in the generation mix by 2030, it continues to lag significantly behind international best practices in several critical areas.

These include policy enforcement, financing, infrastructure readiness, data transparency, and social inclusion. This contrast underscores the urgent need for structural reforms and systemic capacity building if Tanzania is to translate political vision into tangible outcomes.

(i) Policy Frameworks: Legal Gaps Limit Investor Confidence

In contrast to more than 80 countries that have adopted dedicated RE legislation, Tanzania continues to rely on broad policy documents such as the National Energy Policy (2015) and the Electricity Act (2008). While these instruments provide overarching guidance, they lack the legal enforceability and specificity required to drive sectoral transformation. Moreover, they do not adequately address emerging technological and market developments, including energy storage, electric mobility, value chain development for critical minerals, green hydrogen, and distributed energy solutions. The absence of a binding and forward-looking legal framework creates uncertainty for investors, limits long-term planning, and undermines the credibility of

Tanzania's renewable energy targets. Without stronger legal anchors, policy commitments risk being perceived as aspirational rather than actionable, ultimately weakening investor confidence and slowing the pace of renewable energy adoption.

(ii) Financing: High Costs and Limited Capital Access

Tanzania requires an estimated **USD 9 billion annually** to achieve full RE transition by 2050. However, the domestic financial landscape remains highly restrictive. Local financial institutions are generally reluctant to finance RE projects and typically offer loans at interest rates ranging from **11–20%**, far above the global average of **3–7%** observed in countries that successfully leverage blended finance models. This financial mismatch constitutes a major barrier to scaling renewable energy, particularly for local and community-based developers who lack access to concessional or patient capital. The absence of standardized financing tools and de-risking mechanisms such as credit guarantees, insurance instruments, or currency hedging, further reduces project bankability. Without addressing these structural financing gaps, Tanzania risks slowing the pace of investment and falling short of its long-term energy transition targets.

(iii) Grid Integration: Infrastructure Not Ready for Scale

Tanzania's transmission and distribution infrastructure remains outdated, with interconnection processes, particularly for mini-grids, often slow, bureaucratic, and opaque. Globally, solar and wind already contribute more than 13% of electricity generation, supported by increasingly flexible, digitized, and capable of integrating variable renewables.

In contrast, Tanzania's grid readiness lags significantly. TANESCO's dominance in the power sector, combined with limited technical capacity and insufficient investment in modernization, hampers the integration of distributed generation and slows the expansion of off-grid integration. Without substantial upgrades in grid infrastructure, digital monitoring systems, and interconnection procedures, the country will struggle to scale renewable energy deployment to meet its long-term targets.

(iv) Data Transparency: Information Gaps Limit Market Functionality

Unlike more than 70 countries that maintain centralized RE platforms, Tanzania lacks a public, integrated data portal covering renewable projects, tariffs, grid capacity, and investment pipelines. This absence of such a system creates significant inefficiencies across the sector.

For investors, the lack of reliable and accessible data hampers due diligence, raises transaction costs, and deters long-term commitments. For policymakers and regulators, weak data systems constrain evidence-based planning, monitoring, and accountability. For citizens and communities, the lack of transparency undermines trust, limits informed participation and weakens demand-side engagement. Ultimately, without stronger data infrastructure, Tanzania risks slowing innovation, discouraging private investment, and missing opportunities to align with global best practices in renewable energy governance.

(v) Carbon Credit Revenues: Missed Climate Finance Opportunities

Tanzania currently captures only about **3%** of the potential value it could generate from the carbon credit market. This underperformance reflects institutional challenges in monitoring, reporting, and verification (MRV) systems, as well as limited access to international carbon exchanges. Globally, voluntary and compliance carbon markets are projected to exceed USD 851 billion, highlighting the scale of untapped potential for Tanzania. Strengthening MRV capacity, establishing clearer regulatory frameworks, and improving connectivity to global carbon trading platforms could enable the country to unlock substantial new financing streams. These revenues could play a pivotal role in supporting renewable energy deployment, enhancing energy access, and accelerating progress toward national and global climate goals.

(vi) Gender Inclusion: A Missing Pillar in Just Energy Transition

The RE workforce in Tanzania remains heavily male-dominated, with limited participation of women in planning, technical, and leadership roles. This imbalance reflects structural barriers, including limited access to training, financing, and entrepreneurial opportunities for women-led enterprises. Globally, women account for about **32%** of the renewable energy workforce, underscoring Tanzania's lag in advancing gender equity within the sector. Failure to integrate gender-responsive policies not only perpetuates inequality but also constrains the sector's innovation potential, social acceptance, and long-term sustainability. Ensuring women's meaningful participation is therefore not just a matter of fairness but a strategic imperative for achieving an equitable and inclusive energy transition.

Table 16: Summary of Tanzania's Renewable Energy Readiness versus Global Perspective

Dimension	Tanzania Status / Stakeholder Insight	Global Benchmark / Best Practice
RE Policy	No dedicated RE policy. The NEP 2015 provides limited guidance and lacks enforceable targets.	Over 80 countries have enacted standalone RE laws with binding targets, fostering investment certainty (IEA, 2025).
Annual Investment Need	Approximately USD 9 billion/year is required to achieve 100% RE by 2050. Financing gap is a critical concern, with 46% of respondents citing finance as the main barrier).	Global clean energy investment reached USD 495 billion in 2023, largely supported by concessional finance and strong policy support
Interest Rates	Domestic financing remains expensive (11–20%). Banks lack RE expertise and rely heavily on external consultants.	Global blended finance models reduce interest to 3–7%, supporting scale-up RE deployment.
Grid Integration	Weak grid infrastructure: mini-grid developers face resistance from TANESCO. Lack of clear grid codes and interconnection rules. 32% of respondents cited infrastructure as a key limitation.	Countries like Brazil and South Africa leverage smart grids and transparent interconnection codes. Solar and wind now make up 13% of global electricity supply.

Dimension	Tanzania Status / Stakeholder Insight	Global Benchmark / Best Practice
Data Transparency	No centralized digital RE portal; limited access to reliable grid and project data.	Over 70 countries maintain real-time, open-access energy portals to improve planning and investor confidence.
Carbon Credit Revenue	Only 3% of expected carbon market value realized due to institutional gaps in MRV (Measurement, Reporting, and Verification) and market access.	The global carbon market reached USD 851 billion With several countries leveraging offsets to finance renewable projects (World Bank, 2023).
Gender Inclusion	Minimal female participation in RE workforce: structural and cultural barriers persist.	Women represent 32% of the global RE workforce, with gender- responsive programs improving inclusivity.
Regulatory Complexity	40% of respondents cited licensing delays, especially from EWURA and TANESCO. Processes are complex and non-transparent, discouraging private sector entry.	Global best practice includes streamlined "one-stop shops" and fast-track RE licensing (e.g., in Kenya).
Technical Capacity Gaps	39% of stakeholders cited lack of skills in RE design, evaluation, and implementation. Public institutions and banks often lack capacity to assess projects.	Vocational training, certification systems and global RE capacity-building initiatives are strengthening skills and sector resilience (IRENA, 2023).
Public Awareness	Public acceptance and awareness cited by 36% of respondents. Limited community engagement and energy literacy slow adoption.	Awareness campaigns and participatory planning in countries (e.g., India, Nepal) have increased off-grid adoption and community buy-in.
Institutional Coordination	Only 4% cited this directly, but institutional fragmentation delays projects. Multiple agencies (MoE, REA, EWURA, and TANESCO) have overlapping mandates.	Centralized RE agencies or inter-ministerial task forces (e.g., Germany, Kenya) streamline coordination and governance.

4.3.4. Objective 4: New Opportunities for RETs

This section synthesizes insights from stakeholder interviews, field observations, and global comparative data to identify high-impact renewable energy technologies (RETs) with the greatest potential for deployment in Tanzania. To ensure clarity, technologies were clustered by application type, such as utility-scale systems, decentralized solutions, productive-use technologies, and institutional/community-based models. Each cluster was then assessed against global benchmarks to determine its strategic relevance, scalability, and readiness within the Tanzanian context.

A frequency-based prioritization method was applied, measuring how often specific technologies were cited across interviews and written responses. This approach provides a proxy for feasibility, alignment with national energy needs, and the degree of stakeholder interest. Technologies mentioned most frequently are identified as near-term priorities with high implementation potential, while those less frequently cited signal longer-term innovation opportunities. By combining qualitative insights with comparative global evidence, the helps map emerging opportunities, highlight persistent implementation gaps, and inform policy formulation and investment targeting in support of Tanzania's energy transition.

4.3.4.1. Clustered Technology Assessment

i. Grid-Connected Utility Scale Technologies

Solar PV (Utility-scale): Stakeholders consistently identified solar PV as a top-priority technology, citing Tanzania's strong solar resource base, with average insolation of–7 kWh/m^2/day) and 2,800–3,000 sunshine hours annually. Current flagship development includes the Kishapu Solar Farm, (planned capacity of 150 MW) with the first 50 MW under active construction. Deployment is constrained by protracted land acquisition processes, limited grid integration capacity, and outdated regulatory frameworks. Stakeholders emphasized the urgent need for grid modernization and streamlined permitting procedures to unlock investment. Job potential is estimated at approximately 4,000 positions, with climate benefits including displacement of fossil fuel generation and reduced CO_2 emissions. SMART targets include commissioning 150 MW by 2026 and an additional 300 MW by 2028.

Wind Energy: Wind energy was referenced in five separate stakeholder responses. Tanzania has an estimated 29 GW of wind potential, with viable development zones in Singida, Makambako, and Kititimo. Despite this potential, no commercial IPPs are currently operational. The Geo Wind 50 MW project is licensed but is still seeking funding. Respondents highlighted the limited availability of wind resource data and slow licensing processes as major barriers.

Job creation is projected at around 3,000 positions, with climate benefits including grid diversification and displacement of diesel- based generation. SMART targets include licensing two IPPs by 2026 and commissioning 200 MW by 2030.

Concentrated Solar Power (CSP): CSP was mentioned in four stakeholder responses. It is currently not included in national energy plans, and no pilot activity has been initiated.

Respondents highlighted that central Tanzania records high direct normal irradiance (DNI) levels exceeding 2,000 kWh/m^2/year, making CSP's suitable for applications such as industrial heat loads. Key challenges include the perception of high capital costs and limited local technical capacity to design, implement, and maintain such systems. Estimated job creation potential is around 2,500 positions, while climate benefits are linked to the substitution fossil fuels. A feasibility study and demonstration plant are recommended by 2029.

Small and Medium Hydropower: Respondents identified over 400 MW of unexploited potential in small and medium hydropower resources across Tanzania. Private sector engagement, however, remains constrained by low tariffs averaging USD 0.07/kWh, stringent equity requirements, and persistent licensing delays. The Tosamaganga Small Hydropower Project (SHPP) was frequently cited as a clear illustration of regulatory bottlenecks that hinder timely implementation. Despite these barriers, stakeholders emphasized that the technology holds strong job creation potential and offers the added benefit of dispatchable, reliable clean

energy compared to intermittent sources. SMART targets include commissioning 100 MW of small and medium hydropower capacity by by 2030.

ii. Decentralized and Rural Electrification Technologies

Mini-Grids (Rural): Mini-grids were mentioned in seven stakeholder responses, underscoring their central role in advancing rural electrification. Tanzania currently hosts approximately 200 operational mini-grids, the majority of which have been established through donor-support. Respondents noted that scale-up has been constrained by overlapping challenges, including grid expansion into mini-grid territories, declining tariff, that undermine project viability, and weak levels of private sector investment. The Rural Energy Agency (REA) has prioritized mini-grid deployment for remote islands and underserved regions. Job creation potential is estimated at around 2,500, positions, while climate benefits are associated with reduced dependence on biomass for household energy. SMART goals include deploying 10 new mini grids by 2027 and extending access to 1 million households by 2028.

Diesel Hybrid Micro-grids: Five stakeholder responses noted that fewer than 20% of Tanzania's micro-grids are currently hybridized, with mostly still operating on diesel-only generation. Existing tariff structures were cited as a major factor discouraging the integration of renewable energy components into these systems. Respondents emphasized that hybridization offers significant environmental benefits, with the potential to reduce emissions by 40–60% per project. Job creation potential is estimated at approximately 2,000 positions. SMART targets include increasing the share of hybridized micro-grids to 25% by 2028.

Floating Solar (FPV): Floating solar photovoltaic (FPV) technology was referenced in four stakeholder responses. To date, no national pilot projects have been initiated, and feasibility studies remain absent. Respondents identified Tanzania's large dams and reservoirs as highly suitable sites for FPV deployment, given the dual benefits of electricity generation and water resource management. Job creation potential is estimated at approximately 1,000 positions while climate benefits include land preservation and reduced water evaporation. Stakeholders recommended commissioning a feasibility study by 2026, followed by 20 implementations of at least 20 MW of FPV capacity by 2028.

Solar Water Pumping: Solar water pumping was highlighted in six stakeholder responses as a viable solution for expanding off-grid water access particularly in rural areas. Current adoption levels remain below 2%, although the technology has been referenced in national irrigation plans.

Key challenges include high upfront installation costs and limited data sharing between agencies and private operators, which constrains coordinated scale-up. Job creation potential is estimated at approximately 1,800 positions, while climate benefits include displacement of diesel-powered pumps and reduced reliance on fossil fuels. SMART targets include expanding solar water pumping coverage by 50% in rural areas by 2027.

iii. Productive Use and Industrial Applications

Industrial Rooftop Solar: Industrial rooftop solar was mentioned in five stakeholder responses with adoption levels currently estimated at less than 3%. A 570 kW pilot project in Morogoro was cited as a reference case. Respondents emphasized high that high capital expenditure (CAPEX) requirements and absence of targeted fiscal or policy incentives have slowed uptake among industrial players. Job creation potential is estimated at around 2,000 positions, while climate benefits include reduced dependency on the national grid and lower greenhouse gas

emissions. SMART targets include raising adoption to 10% by 2027 and reaching 100 MW of installed capacity by 2029.

Solar Cold Storage: Solar-powered cold storage was highlighted in five responses with current deployment limited pilots to small-scale pilot projects in agricultural zones. Respondents noted that high upfront costs and the absence of dedicated support programs continue to constrain wider adoption. Cold storage is recognized for its potential to reduce post-harvest losses, strengthen food security, and support improved nutrition outcomes. Job creation potential is estimated at around 1,000 positions, with climate benefits tied to include reduced food waste and associated emissions. SMART targets include the installationof500 solar units by 2027.

Renewable Energy for Productive Use (PURE): PURE was mentioned in six responses, with programs led by TaTEDO, REEEP, and IFAD supporting applications such as solar-powered irrigation, milling, and refrigeration. Respondents emphasized that limited access to financing and low awareness among end-users remain key barriers to scale-up. Job creation potential is estimated at approximately 4,500 positions, while climate benefits include significant reductions in emissions and deforestation through the substitution of fossil fuels and biomass. SMART targets include scaling up PURE initiatives to 20 districts by 2028 and supporting 5,000 small and medium enterprises (SMEs) by 2029.

iv. Institutional and Community-Based Technologies

Biogas for Institutions: Biogas for institutional use was noted in five responses, with fewer than 100 functioning systems currently operating in schools and prisons. Respondents highlighted key challenges including limited technical skills for maintenance, irregular feedstock availability, and inadequate follow-up support. Job creation potential is estimated at approximately 1,200 positions, while climate benefits include reductions in deforestation and indoor air pollution through the substitution of firewood and charcoal. SMART targets include doubling the number of installations by 2026 and achieving 20,000 institutional systems by 2030.

Solar Water Pumping and Cold Storage (Community Use): Solar water pumping and cold storage were repeatedly cited for their importance in supporting rural health facilities, schools, and agriculture value chains. Respondents emphasized that existing initiatives are largely donor-supported pilots with limited mainstreaming into national programs and policies. Key challenges include high upfront costs, limited technical capacity, and the absence of long-term financing mechanisms to sustain adoption. Job creation and climate benefits are considered moderate, primarily through reduced diesel dependence, lower post-harvest losses, and improved community resilience. SMART goals are aligned with broader sectoral development targets including scaled integration into rural electrification, irrigation, and food security programs by 2028.

v. Emerging and Transformative Technologies

Green Hydrogen: Green hydrogen was referenced in five responses with stakeholders emphasizing its long-term transformative potential. Currently, no pilot projects or feasibility studies have been initiated, though Memoranda of Understanding (MoUs) have been signed with actors such as ZESTAs and TEEMO. Respondents highlighted significant policy, infrastructure, and technical capacity gaps that need to be addressed before large-scale development can occur. Job creation potential is estimated to exceed 10,000 in the long term given opportunities across production, storage, transport, and export value chains. Climate

benefits include providing zero-emission fuel source for industry and transport, alongside potential foreign exchange earnings through regional and international trade. SMART targets include completing feasibility studies by 2027 and establishing an initial 10 MW capacity by 2030.

E-Mobility + Solar Charging: E-mobility and solar charging were cited in six responses, with stakeholders noting early progress through urban pilot projects and donor-led initiatives. Tanzania currently has more than 5,000 electric vehicles (EVs) in operation, the majority being two- and three-wheelers with charging, primarily supported by solar powered stations. Despite this progress, respondents emphasized persistent policy gaps, insufficient charging infrastructure, and limited private investment as barriers to scale-up. Job creation potential is estimated at approximately 5,000 by 2030, driven by vehicle assembly, charging infrastructure, and maintenance services. Climate benefits include a significant reduction in fossil fuel use and associated emissions, alongside improved urban air quality. SMART targets include deploying 10,000 EVs and establishing 100 solar-powered charging stations nationwide by 2030.

Waste-to-Energy (WTE): Six responses highlighted WTE as a dual solution for both waste management and energy generation. Currently, Tanzania produces an estimated 10 MW from industrial waste, while municipal-level projects remain in in pilot stages. The technology demonstrates strong co-benefits, including creation of approximately 3,000 jobs and significant climate benefits through methane capture and reduction. Moving forward, the SMART targets include launching three city-scale WTE plants by 2028 which would position Tanzania as a leader in waste valorisation within East Africa.

The frequency of repetition across field responses serves as a proxy indicator for the level of stakeholder prioritization, the perceived technical and financial feasibility, and the strategic relevance of each renewable energy technology (RET). This approach provides critical insights into which technologies are most top-of-mind among practitioners, developers, financiers, and policymakers.

Out of the 15 renewable energy technologies assessed, the table below summarizes how often each was mentioned in interviews and written submissions (**Table 17**).

Table 17: Emerging renewable energy opportunities: stakeholder prioritization by technology cluster

Technology Cluster	Frequency of Mention	Percentage of Total Technologies (%)
Mini grids (rural)	7	47
RE for Productive Use	6	40
Solar Water Pumping	6	40
Waste-to-Energy	6	40
E-Mobility + Solar Charging	6	40
Solar PV (Utility-scale)	6	40
Solar Cold Storage	5	33
Diesel Hybrid Micro-grids	5	33
Biogas for Institutions	5	33
Industrial Rooftop Solar	5	33

Technology Cluster	Frequency of Mention	Percentage of Total Technologies (%)
Wind Energy	5	33
Floating Solar (FPV)	4	27
CSP (Solar Thermal)	4	27
Small & Medium Hydropower	4	27
Geothermal Direct Use	4	27

4.3.4.2. Priority Renewable Energy Technologies in Tanzania

Stakeholder responses indicate that Tanzania's most promising renewable energy technologies (RETs) include rural mini-grids, productive use of energy (e.g., solar irrigation and milling), solar PV (utility-scale and rooftop), solar water pumping, and solar-powered cold storage. These technologies were mentioned most frequently (ranging from **33% to 47%** of all responses), reflecting their strategic alignment with the country's rural electrification goals, economic development priorities, and available solar resources. The strong emphasis on productive use applications and decentralized solutions highlights a clear stakeholder preference for energy access models that not only provide electricity but also stimulate local livelihoods, strengthen value chains, and enhance rural resilience. This contrasts with approaches focused solely on centralized grid expansion and suggests that distributed renewable energy is increasingly viewed as both a development and energy security strategy.

4.3.4.3. Emerging but Less Prioritized Technologies

Meanwhile, technologies such as floating solar (FPV), concentrated solar power (CSP), geothermal direct use, and wind energy were mentioned less frequently about **27–33%** of responses., This suggests that while these RETs are recognized, they currently face lower perceived feasibility or remain limited by awareness and practical demonstration in the Tanzanian context. Nevertheless, these emerging RETs present significant long-term potential particularly for addressing industrial heat loads, supporting urban clean energy transition, and grid diversifying the national grid mix. To realize this potential, Tanzania will require clearer policy frameworks, enhanced technical capacity, and targeted pilot-scale investments to demonstrate viability and build investor confidence.

The frequency distribution of stakeholder responses therefore provides a dual insight: it identifies technologies that are **ready for near-term scaling** (mini-grids, productive-use solar, solar water pumping, and cold storage) while also outlining strategic innovation areas that can shape Tanzania's medium- to long-term energy transition. **Table 18** below summarizes the strategic actions required to overcome barriers and unlock opportunities across different renewable energy technologies.

Table 18: Strategic actions to overcome barriers and unlock RE opportunities

Technologies	Strategic Priority (Frequency %)	Barrier	Recommendation	Proposed Action
Mini-grids, Solar PV, Small Hydro	Mini grids (47%), Solar PV (40%)	Regulatory delays in licensing and grid connection	Streamline regulatory and interconnection processes	Establish one-stop permit desk, digitalize approval workflows, delegate some approvals to LGAs
Productive Use RE, Solar Pumping, Cold Storage, E-Mobility	RE for Productive Use (40%), Solar Pumping (40%), E-Mobility (40%)	High upfront costs and limited access to concessional finance	Expand concessional finance, credit guarantees, and blended finance	Partner with DFIs, introduce soft loans, build bank capacity to assess RE proposals
Waste-to-Energy, Biogas, Industrial Solar	Waste-to-Energy (40%), Biogas (33%)	Weak carbon market infrastructure and certification costs	Strengthening carbon market mechanisms	Finalize grid emission factors, set up national MRV system, support project developers
Mini-grids, Solar Water Pumping, Institutional Biogas	Mini-grids (47%), Biogas (33%), Solar Pumping (40%)	Poor inter-agency coordination and limited LGA involvement	Empower LGAs in RE project planning and implementation	Develop LGA RE engagement guidelines, require early-stage consultations
E-Mobility, Industrial Solar, Biogas	E-Mobility (40%), Industrial Rooftop Solar (33%), Biogas (33%)	Misaligned vocational training and outdated curricula	Align TVET programs with RE sector skills demand	Update curricula, create industry-linked training hubs, offer certification programs

4.3.4.4. Forward-Looking Opportunities in a Global Context

However, the emerging opportunities for renewable energy technologies (RETs) in Tanzania when assessed against global parameters and aligned with the strategic objectives outlined in Tanzania's Vision 2050 paint a far more forward-looking and optimistic picture. This perspective highlights not only Tanzania's abundant natural endowments but also the transformative role that renewables can play in advancing the country's long-term energy security, climate resilience, and inclusive economic development.

Table 19 summarizes these opportunities by comparing Tanzania's current status with global benchmarks, identifying the most critical gaps, and highlighting areas with the greatest potential for strategic investment and policy focus.

Table 19: New opportunities of RETs in Tanzania compared with global parameters

Global Parameter	Tanzania's Current Status	Gap / Challenge	Opportunity for Tanzania	Attributing Factors
Solar PV (Utility-scale)	150 MW project by TANESCO; additional sites under competitive bidding	Slow land acquisition; limited grid integration capacity	Potential for 1000+ MW due to high solar irradiation	Land access; grid proximity; demand growth
Mini grids (rural)	REA targets remote island mini grids; donor funding in place	Grid expansion & price drop slow private investment	Decentralized electrification for >2 million people	Energy access gaps; donor interest
Floating Solar (FPV)	No national FPV pilot initiated; feasibility still under review	Lack of feasibility studies; absence of regulatory framework	Potential on large dams and reservoirs	Water availability; space constraints
Wind Energy	Several wind sites identified: no commercial wind IPPs operational	Limited wind resource data; slow licensing process	Viable projects in Singida, Makambako, and Kititimo	Verified resource; developer interest
Geothermal Direct Use	Mbeya pilot underway; CAG review limited to single site	Lack of comprehensive audit & monitoring tools	Direct heat use in agriculture & industry feasible	Available heat resource; market need
Industrial Rooftop Solar	Very few companies use captive solar; mostly pilot initiatives	Limited incentives & high upfront costs	Great savings potential for manufacturing firms	Daytime load; tariff savings
Solar Water Pumping	Adopted in off-grid areas; limited to small village-scale projects	Insufficient data sharing (RUWASA); high installation costs	Effective for off-grid clean water access	Diesel cost; water need; productivity gain
Solar Cold Storage	Very limited pilots in agriculture zones	High cost; few programs supporting deployment	Reduces post-harvest losses in remote areas	Post-harvest loss; food safety demand
Biogas for Institutions	Few functioning systems in schools and prisons	Operation & maintenance challenges; poor uptake	Institutional cooking energy shift from firewood	Organic waste; cooking cost saving
E-Mobility + Solar	Urban pilots underway; grid integration in early stages	Policy gap on EVs and charging infrastructure	Reduced fuel import burden; new industry growth	Urban transit; fuel import costs
RE for Productive Use	Scattered initiatives; not fully mainstreamed	Low financing access; limited awareness	Transform rural incomes via solar irrigation, mills	Agriculture demand; income potential
Diesel Microgrid Hybridization	Hybrid projects are rare; most are diesel-based	Tariff structures discourage hybridization	Lower costs, cleaner alternatives possible	Existing infra; emission pressure

Global Parameter	Tanzania's Current Status	Gap / Challenge	Opportunity for Tanzania	Attributing Factors
Green Hydrogen	Not yet explored; not in NEP 2015	Policy & technical knowledge gaps	Potential export opportunity with RE surplus	Global demand; RE resource surplus
Waste-to-Energy (WTE)	Not implemented; no city has WTE strategy	Urban council inexperience; lack of technical support	Turn urban waste into clean power	Urban waste growth; landfill stress
CSP (Solar Thermal)	Not included in national plans; low awareness	Perceived as costly; no pilot activity	Great for industrial heat loads	High solar resource; industrial loads

Source: Field data

4.3.4.5. Socio-Economic and Environmental Co-Benefits of RETs in Tanzania

The opportunities identified in the renewable energy technology (RET) landscape for Tanzania extend well beyond the energy sector. Stakeholder responses reveal that a robust RET strategy holds substantial potential to generate broad socio-economic and environmental benefits. Among these, job creation and the attraction of Foreign Direct Investment (FDI) were the most frequently cited, each mentioned by 11% of respondents. This highlights the sector's role as a catalyst for inclusive economic growth supporting entrepreneurship, fostering industrial diversification, and advancing long-term human capital development energy security and environmental gains also emerged as recurring themes. The diversification of the energy mix was noted as a critical step toward national energy independence (7%), while environmental co-benefits such as enhanced carbon market participation, reduced air pollution, and improved public health were cited by a similar proportion of stakeholders. Taken, together, these insights underscore the dual value of RETs: as both an enabler of Tanzania's national development agenda and a contributor to global climate action.

In summary, the research reveals a clear, multi-dimensional opportunity for Tanzania to leverage RETs a driver of sustainable development. By capitalizing on the low entry costs and high scalability of solar technologies, advancing emerging frontiers such as green hydrogen and waste-to-energy, and localizing key segments of the renewable energy value chain, Tanzania can accelerate its energy transition while simultaneously generating lasting economic, social, and environmental dividends.

The identified opportunities are not limited to the energy sector; they extend to significant socio-economic and environmental benefits that are seen as direct outcomes of a robust RET strategy. The following points, derived from the frequency of responses, illustrate the perceived broader impacts:

- **Job Creation and FDI:** The potential for job creation and the attraction of Foreign Direct Investment (FDI) were the most frequently mentioned benefits, each cited by 3 out of 28 respondents (11%). This reflects a strong perception that RETs can serve as a primary engine for inclusive economic growth while also fostering long-term human capital development.

- **Energy Security and Environmental Gains:** The diversification of the energy mix to strengthen energy security was mentioned by 2 respondents (7%). Similarly,

environmental benefits, including the potential to earn carbon credits, reduce air pollution, and improve public health were cited by an equal share (7%). These findings underscore the dual role of RETs in driving national development while also advancing global climate action.

4.3.5. Objective 5: Cost Benefit Analysis of Exploiting and Adopting RETs

4.3.5.1. Analytical Framework

This analysis evaluates renewable energy technologies (RETs) in comparison with fossil fuels and traditional biomass across economic, environmental, and social dimensions. The framework applies a multidimensional lens to capture both direct financial implications and wider developmental outcomes. Key parameters assessed include:

i. Cost Dynamics of Energy Technologies: Capital Intensity vs Long-Term Value

Renewable energy technologies (RETs) vary widely in capital intensity, yet most offer significantly lower lifecycle costs compared to fossil fuels systems. Technologies such as solar photovoltaic (PV) and biomass stand out for their cost-effectiveness, driven by fuel-free operation, declining equipment costs, and minimal maintenance requirements. In contrast, options, such as geothermal and waste-to-energy (WTE) entail higher upfront investments but yield long-term economic and environmental returns through avoided fuel costs and reduced externalities.

For example, Tanzania's 50 MW Kishapu Solar PV Plant was developed at a cost of approximately $43.1 million, reflecting the competitiveness of solar energy in the current market. Similarly, a proposed 200 MW wind project is estimated at $180 million while the large scale 2,115 MW Julius Nyerere Hydropower Plant (JNHPP), represents a capital expenditure (CAPEX) of roughly $2.9 billion. Although such projects involve substantial initial costs, RETs benefit from low operating expenses, stable generation costs, and reduced exposure to global fuel price volatility over time.

In contrast, fossil fuel infrastructure, for example, the proposed $42 billion LNG plant demands continuous fuel procurement and remains highly vulnerable to international market fluctuations. Traditional biomass, while inexpensive at the point of use, carries heavy environmental and social costs, including deforestation, household air pollution, and lost productivity due to time spent collecting fuelwood**. Table 20** presents a comparative analysis of the capital costs and economic impacts of various energy technologies, illustrating the relative advantages of RETs in long-term value creation.

Table 20: Comparative cost and economic impact of energy technologies

Energy Source / Technology	Capital Costs (CAPEX)	Operating Costs & Market Risks	Lifecycle / Economic Impact
Solar PV	~$1,200/kW, 50MWp: $43.1M	Very low, no fuel costs	~$800/kW saved over 25 yrs, ideal for grid/off-grid
Wind	~$1,800/kW, 200MW: $180M	Low, weather-dependent	~$600/kW saved, stable long-term returns
Hydro	~$2,000/kW, 2,115MW: $2.9B	Low, seasonal variability	~$1,000/kW saved, long lifespan

Energy Source / Technology	Capital Costs (CAPEX)	Operating Costs & Market Risks	Lifecycle / Economic Impact
Geothermal	~$3,500/kW	Very low, stable output	High CAPEX, low O&M, long-term savings
Biomass	~$500–2,000/kW	Low feedstock cost	Decentralized savings, rural energy access
Waste-to-Energy (WTE)	~$50–150M/plant	Avoided landfill & fuel costs	High CAPEX, environmental benefits
Green Hydrogen	~$1,000–2,000/kW	Emerging tech, high O&M	Strategic long-term value, decarbonization potential
E-Mobility	High vehicle cost	30–70% lower fuel & maintenance	Long-term savings, air quality improvement
Fossil Fuels (Natural Gas)	LNG Plant: $30–42B	High volatility, fuel-dependent	Risk of stranded assets, economic vulnerability
Traditional Biomass	Very low, minimal equipment	High, seasonal price swings	Unsustainable, deforestation, lost productivity

ii. Levelized Cost of Energy (LCOE)

Renewable Energy Technologies (RETs) offer substantially lower energy costs over time compared to fossil fuels typically 40–60% cheaper on a lifecycle basis. Technologies such as solar, wind, and hydropower now deliver electricity at an average of 0.05–0.10 cents per kWh, reflecting both technological advancements and declining capital costs. Geothermal and biomass further strengthen the energy mix by providing competitive baseload options ensuring reliability alongside affordability. While waste-to-energy (WTE) and green hydrogen currently remain more expensive, green hydrogen production costs are estimated at $5–8 per kg - rapid innovation and economies of scale are expected to drive significant cost reductions over the next decade. At the consumer level, RETs deployment translates into **direct** household and enterprise savings. RET For example, solar mini-grids reduce household % household electricity expenditures by an estimated USD 5–20 per month, while electric vehicles (EVs) lower fuel expenses by up to 70% compared to conventional internal combustion vehicles. These trends demonstrate the growing economic competitiveness and affordability of renewable energy in both urban and rural Tanzanian contexts.

iii. Operations & Maintenance Costs

Renewable Energy Technologies (RETs) significantly lower operations and maintenance (O&M) costs than fossil fuel–based systems (**Table 21**). This cost advantage stems from the absence of fuel handling, fewer moving components, and longer equipment lifespans. Among RETs, solar and wind technologies have the lowest O&M costs primarily limited to periodic cleaning, inverter replacement, and minor component checks. Biomass and geothermal systems, while more maintenance-intensive due to feedstock management and subsurface operations, still maintain predictable and manageable cost profiles relative to thermal power plants. In contrast, fossil fuel technologies such as coal, diesel, and natural gas plants—require continuous maintenance associated with combustion systems, emissions control equipment, and fuel logistics, resulting in higher recurring costs and greater operational complexity.

For instance, it is estimated that a 1 GW solar deployment in Tanzania could generate annual maintenance cost savings exceeding $35 million, compared to equivalent fossil-based generation. These savings scale proportionally with national electrification targets, underscoring the long-term fiscal benefits of prioritizing renewable infrastructure. **Table 21** provides a comparative overview of typical O&M cost ranges across major energy technologies.

Table 21: operations & maintenance costs comparison of RETs vs fossil fuel benchmarks

Technology	O&M (USD/kWh)	Fossil Fuel Benchmark	Net Benefit
Solar PV	$0.05–$0.10	$0.15–$0.25	~$0.10/kWh saved
Wind	~$0.08	$0.15–$0.25	~$0.07/kWh saved
Hydro	~$0.06	$0.15–$0.25	~$0.09/kWh saved
Geothermal	~$0.09	$0.15–$0.25	~$0.06/kWh saved
Biomass	~$0.08–$0.12	$0.15–$0.25	~$0.05/kWh saved
WTE	~$0.10–$0.15	N/A	Competitive with landfill costs
Green Hydrogen	$3–$8/kg H_2	Grey H_2: ~$1–$2/kg	Strategic de-carbonization value
E-Mobility	$0.10–$0.15/km	Petrol: ~$0.20–$0.30/km	~$0.10/km saved

Source: Field data

iv. Environmental and Socioeconomic Impacts of Energy Technologies

Renewable Energy Technologies (RETs) deliver substantial environmental, social, and health benefits. They produce minimal greenhouse gas emissions and significantly reduce air and water pollution compared to fossil fuels which account for nearly 80% of Tanzania's CO_2 emissions and impose heavy health and ecological costs. Traditional biomass, still the dominant energy source in rural areas, contributes to deforestation and severe indoor air pollution, disproportionately affecting women and children.

Transitioning to clean energy sources such as solar PV, wind, and ocean current energy could enable Tanzania to avoid up to 56 million tons of CO_2 emissions by 2050, while generating estimated annual health cost savings of about $1.2 billion. Technologies such as biomass and waste-to-energy (WTE) offer dual benefits of renewable power generation and improved waste management. Geothermal and hydropower provide stable, low-emission baseload energy, supporting grid reliability and long-term sustainability.

Emerging solutions like green hydrogen and e-mobility further strengthen Tanzania's clean energy transition. Green hydrogen offers export potential and can diversify national energy resources, while e-mobility reduces urban air reduces and enhances public health outcomes. Beyond environmental gains, RETs stimulate foreign and domestic investment, create green jobs, and expand rural energy access. In contrast, continued dependence on fossil fuels and unsustainable biomass use poses serious long-term environmental, social, and economic risks (see **Table 22**).

Table 22: Comparative impacts of energy technologies in Tanzania

Energy Source	CO_2 Reduction	Economic Impact	Health & Social Impact	Environmental Impact
Solar PV	~1,500 tons/MW/year	High: FDI, jobs, rural enterprise. ~$1.2B/year saved in health costs.	High: Improves energy access in underserved rural areas, enhancing quality of life and enabling productive uses of energy (PUE) in agriculture and small businesses. This drives localized economic growth and raises living standards.	Zero emissions, ecosystem protection
Wind	~1,800 tons/MW/year	High: Local manufacturing & O&M. Clean air, rural access		Minimal footprint, no fuel use
Hydro	Negligible	High: Grid stability, long lifespan. Clean water management		Low emissions, seasonal variability
Geothermal	~90–95% lower than gas	Medium: Strategic baseload power		Long-term sustainability
Biomass	Carbon-neutral	Medium: Rural energy & waste use. Soil enrichment, waste diversion		Sustainable if managed well
Waste-to-Energy	~90% landfill reduction	Medium: Urban sanitation & energy		High CAPEX, strong environmental gains
Green Hydrogen	Zero emissions (RE-based)	Medium: Strategic industrial and export potential	Supports industrial decarbonization	Clean fuel, scalable with RE
E-Mobility	~30–70% lower emissions	Medium: Urban jobs, reduced oil imports	Improved air quality, lower respiratory illness	Reduces transport emissions, supports grid efficiency
Ocean Current Energy	Zero emissions	Emerging: Coastal energy diversification	Reliable power for coastal communities	Minimal ecological disruption, predictable output
Fossil Fuels	Major source of emissions	Medium: Industrial power	Limited rural benefit, health risks	High emissions, market volatility
Traditional Biomass	Very low – high emissions	Low: Charcoal trade	High respiratory illness burden	Severe deforestation, ecosystem loss

Source: Field data

v. Job Creation & Human Capital

Renewable Energy Technologies (RETs) generate substantially more employment opportunities per megawatt than fossil fuels, particularly during the construction, installation, and maintenance phases. This makes them a powerful engine for inclusive economic growth and workforce development across both urban and rural areas.

Solar PV supports approximately 10 jobs per MW, while wind energy creates around 15 jobs per MW, offering strong employment potential in manufacturing, installation, and operations. Biomass, waste-to-energy (WTE), and green hydrogen demonstrate even greater promise, generating an estimated 20–25 jobs per MW, largely through small and medium-sized enterprises (SMEs) that stimulate local economies and strengthen supply chains. Although hydropower and geothermal are less labour-intensive during their construction stages, they provide stable, long-term employment in operations and maintenance, particularly in remote regions.

Electric mobility (e-mobility) is also emerging as a major job creator, advancing oil independence while creating roughly 5,000 jobs for every 10,000 electric vehicles (EVs) deployed. These opportunities span vehicle manufacturing, charging infrastructure development, and maintenance services.

Overall, RETs could generate over 50,000 direct jobs by 2030, with strong participation from women-led solar SMEs and rural communities, reinforcing inclusive growth and equitable access to green economy opportunities.

In contrast, fossil fuel technologies typically generate only 3–5 jobs per MW, underscoring the superior capacity of RETs to expand employment, strengthen local value chains, and build human capital for a low-carbon economy (**Table 23**).

Table 23: Employment impact of renewable energy technologies vs fossil fuels

Technology	Jobs/MW	Fossil Fuels	Net Benefit
Solar PV	~10	~3–5	2–3× more jobs
Wind	~15	~3–5	3× more jobs
Hydro	~5	~3–5	Comparable
Geothermal	~20	~3–5	4–5× more jobs
Biomass	High rural engagement	Low	High rural employment, 4–8× more jobs
WTE	~50/plant	N/A	Urban job creation
Green Hydrogen	~20–25/MW	N/A	Strategic industrial jobs
E-Mobility	~0.5/EV	N/A	~5,000 jobs for 10,000 EVs

vi. Energy Security & Price Stability

Renewable energy technologies (RETs) play a pivotal role in strengthening Tanzania's energy security by reducing dependence on imported fuels and shielding the economy from global price volatility. Technologies such as solar, wind, and hydropower offer complete fuel

independence and stable generation costs, together saving the country an estimated $500 million annually in avoided fuel imports and price fluctuations. Geothermal and biomass resources contribute to long-term energy reliability and rural resilience, providing steady baseload power and supporting local energy autonomy.

Meanwhile, waste-to-energy (WTE) and green hydrogen technologies enhance industrial diversification and export potential, aligning with Tanzania's broader clean industrialization agenda. The rapid expansion of e-mobility further strengthens national energy security by reducing oil imports dependency and supporting local value addition in transport electrification.

In contrast, continued reliance on fossil fuels exposes the economy to foreign exchange risks, supply disruptions, and volatile global markets, undermining both fiscal stability and long-term energy affordability (see **Table 24**).

Table 24: Energy independence and economic resilience through RETs

Technology	Fuel Imports	Price Volatility	Net Benefit
Solar, Wind, Hydro	None	Stable	~$500M/year saved on fuel import
Geothermal	None	Stable	Long-term reliability
Biomass	Local feedstock	Stable	Rural resilience
WTE	Waste-based	Stable	Circular economy
Green Hydrogen	Domestic RE	Strategic	Export potential
E-Mobility	Electricity-based	Stable	Reduced oil imports

vii. Financial Metrics (IRR, NPV, Payback Period)

Renewable Energy Technologies (RETs) demonstrate superior financial performance compared to compared to fossil fuel–based systems, offering higher Internal Rates of Return (IRR), greater Net Present Value (NPV), and shorter payback periods (see **Table 25**). These advantages are driven by declining technology costs, minimal fuel expenses, and lower operational risks over the system's lifetime.

In addition to favourable project economics, Renewable Energy Technologies (RETs) attract broader financing opportunities through concessional loans, climate finance, and green investment facilities. These include international funding mechanisms, blended finance arrangements, and targeted incentives that reduce capital costs and enhance project bankability. By contrast, fossil fuel projects face increasing financing constraints, higher risk premiums, and diminishing investor confidence due to global decarbonization trends.

Table 25: Economic metrics of clean energy investments vs fossil fuels

Technology	IRR	Payback	NPV
Solar PV	~15%	~6 yrs	>$2.5B
Wind	~13%	~7 yrs	>$2B
Hydro	~12%	~8 yrs	>$1.5B
Geothermal	~10–12%	~10 yrs	>$1B

Technology	IRR	Payback	NPV
Biomass	~10–15%	~5–8 yrs	High rural ROI
WTE	~8–10%	~10–12 yrs	Urban sanitation value

viii. Capital Expenditure

Capital requirements for Renewable Energy Technologies (RETs) vary significantly across technologies, reflecting differences in resource availability, infrastructure needs, and project scale. Biomass and solar PV are among the most affordable options, with investment costs starting at approximately $500 and $1,200 per kilowatt (kW), respectively. Their relatively low entry barriers make them attractive for decentralized and community-based energy solutions.

In contrast, geothermal and waste-to-energy (WTE) systems entail much higher upfront investments due to intensive drilling, resource exploration, and specialized equipment requirements. Geothermal projects typically cost around $3,500 per kW, while large scale waste-to-energy (WTE) facilities may demand tens of millions of dollars per plant depending on capacity and technology type.

Green hydrogen and e-mobility also involve high initial capital costs, reflecting their emerging status and the need for substantial infrastructure development, including electrolysis systems, hydrogen storage, and nationwide charging networks. However, these technologies hold significant long-term potential for cost reduction through economies of scale and technological innovation.

4.3.5.2. Analysis & Interpretation

The analysis of the economic benefits of Renewable Energy Technologies (RETs) in Tanzania is primarily theoretical, constrained by the limited availability of commercial-scale data within the country. As a result, most estimates are derived from benchmark costs reported in the literature and projections provided by a small number of local and international developers.

While these modelled outcomes offer valuable insights into the potential of RETs to enhance economic performance, energy security, and employment, they also underscore the need for comprehensive empirical data from ongoing and future renewable energy projects. Strengthening data collection and transparency across technology types, investment models, and performance outcomes will be essential for improving the accuracy and policy relevance of future assessments.

i. Economic Efficiency & Fiscal Prudence

The analysis indicates that Renewable Energy Technologies (RETs) deliver 40–60% lower lifecycle costs compared to fossil fuel–based generation. Technologies such as solar PV, wind, and hydropower are especially cost-effective, with Levelized Costs of Energy (LCOE) ranging between $0.05 and $0.10/kWh less than half the cost of coal or diesel generation.

Significance: In a context where energy affordability is essential for both household welfare and industrial competitiveness, RETs present a fiscally prudent pathway for expanding electricity access. Their lower operating costs help reduce government subsidies, enhance TANESCO's financial sustainability, and stabilize tariffs for small and medium enterprises (SMEs), thereby promoting economic growth through predictable and affordable energy pricing.

ii. Job Creation & Inclusive Growth

Renewable Energy Technologies (RETs) generate two to three times more jobs per megawatt than fossil fuels systems. Labour-intensive technologies such as solar PV and biomass are particularly well-suited to Tanzania's demographic realities, where youth unemployment and rural underemployment are pressing socioeconomic challenges.

Significance: With over 50,000 direct jobs projected by 2030, RETs can serve as a cornerstone of Tanzania's green jobs strategy. The strong participation of women-led in solar SMEs (around 40%) not only promotes gender equity but also advances Sustainable Development Goal (SDG) 5 and supports the Third Five-Year Development Plan (FYDP III) objective of inclusive broad-based economic growth.

iii. Energy Security & Foreign Exchange Savings

Renewable Energy Technologies (RETs) substantially enhance Tanzania's energy security by eliminating the need for fuel imports, resulting in estimated annual savings of an estimated $500 million. This benefit is particularly significant given Tanzania's continued reliance on imported diesel for off-grid generation and the volatility of global oil markets which exposes the economy to price and supply risks.

Significance: By reducing fuel imports, RETs strengthen the Tanzanian shilling, improve the balance of payments, and protect the economy from external shocks. Enhanced energy independence directly supports Vision 2025's objective of building a resilient and self-reliant national economy, underpinned by sustainable domestic energy resources.

iv. Health & Environmental Benefits

Transitioning to Renewable Energy Technologies (RETs) could yield annual health cost savings of approximately $1.2 billion by reducing air pollution and indoor emissions from kerosene and traditional biomass. Technologies such as solar PV and wind energy are projected to avoid up to 56 million tons of CO_2 emissions by 2050. RETs contribute to forest conservation by lowering reliance on biomass fuels, a major driver of deforestation in household energy use.

Significance: These environmental and health benefits directly support SDG 3 (Good Health and Well-being) and SDG 15 (Life on Land), while advancing Tanzania's climate commitments under the Paris Agreement. Cleaner air improves public health, reduces healthcare burdens, and enhances productivity, particularly in urban centres such as Dar es Salaam and Arusha.

v. Rural Development & Energy Access

Decentralized Renewable Energy Technologies (RETs), such as solar mini-grids and biomass systems, offer cost-effective solutions for rural electrification, where grid extension is prohibitively expensive. RETs could potentially electrify 8.3 million households by 2030, improving access to education, healthcare, and economic opportunities (SGD 1-4). These technologies also support industrial operations, such as sugar processing and mining: for instance, sugar industries utilize biomass by-products like bagasse to generate electricity for internal use, while mining companies increasingly adopt solar energy systems to power remote sites, lower operational costs, and enhance energy reliability.

RETs also facilitate SDG 6 – (Clean Water and Sanitation) deployment in water pumping systems across arid and semi-arid regions. Solar and wind-powered pumps provide a cost-effective, sustainable alternative to diesel-powered systems, enabling access to clean water for both domestic use and irrigation.

Significance: RETs are critical for achieving Sustainable Energy for All (SE4ALL) targets and SDG 7 (Affordable and Clean Energy). They empower rural communities, reduce reliance on kerosene and firewood, and enable productive applications such as irrigation, water pumping, refrigeration, and digital connectivity, thereby promoting inclusive and sustainable rural development.

vi. Investment Attractiveness & Financial Returns

Solar and wind projects in Tanzania offer internal rates of return (IRR) of 13–15%, with payback periods of 6–7 years. The Net Present Value (NPV) for solar and wind combined is projected to exceed $2.5 billion, reflecting strong long-term financial viability.

Significance: These financial metrics make RETs highly attractive to private investors, development banks, and climate finance institutions. Leveraging blended finance and concessional loans, Tanzania has the potential to mobilize over $1.1 billion in renewable energy investments, accelerating the country's transition to a low-carbon economy, while fostering sustainable growth and energy security.

vii. Carbon Market Potential & Climate Finance

Tanzania's renewable energy projects have the potential to generate up to $300 million annually in carbon credit revenue, particularly following the establishment of a national grid emission factor. Despite this opportunity, certification costs and weak market regulation continue to limit full participation in global and regional carbon markets.

Significance: Carbon finance represents a valuable new revenue stream for Tanzania's energy sector. Strengthening the National Carbon Management Centre (NCMC), reducing certification costs, and formalizing benefit-sharing mechanisms could unlock additional climate-aligned investments, advance low-carbon development, and directly support SDG 13 (Climate Action).

viii. Institutional Reform & Policy Alignment

The analysis identifies regulatory delays, land title bottlenecks, and financing gaps as major obstacles to Renewable Energy Technology (RET) deployment. These challenges undermine investor confidence and slow progress in expanding energy access and supporting industrial growth.

Significance: Overcoming these barriers through time-bound inspection protocols, integrated licensing systems, and risk mitigation instruments is critical. Aligning energy policy with Vision 2025, FYDP III, and Agenda 2063 will ensure that RETs are fully leveraged to support Tanzania's sustainable development trajectory, enhance investor confidence, and accelerate the country's transition to a low-carbon, inclusive economy.

ix. Strategic Technologies & Long-Term Value

Emerging Renewable Energy Technologies, including green hydrogen, electric mobility (e-mobility), and waste-to-energy (WTE), offer significant strategic value for industrial de-carbonization, urban sanitation, and transport electrification. While these technologies currently involve high capital costs, they position Tanzania to enhance future competitiveness in a rapidly evolving global energy landscape.

Significance: Targeted investment in pilot projects, feasibility studies, and early-stage deployment will prepare Tanzania for global energy transitions. For instance, green hydrogen, can support decarbonization of fertilizer and steel production, while e-mobility contributes to reduced urban air pollution and lower oil dependency, strengthening national energy security and public health outcomes over the long term.

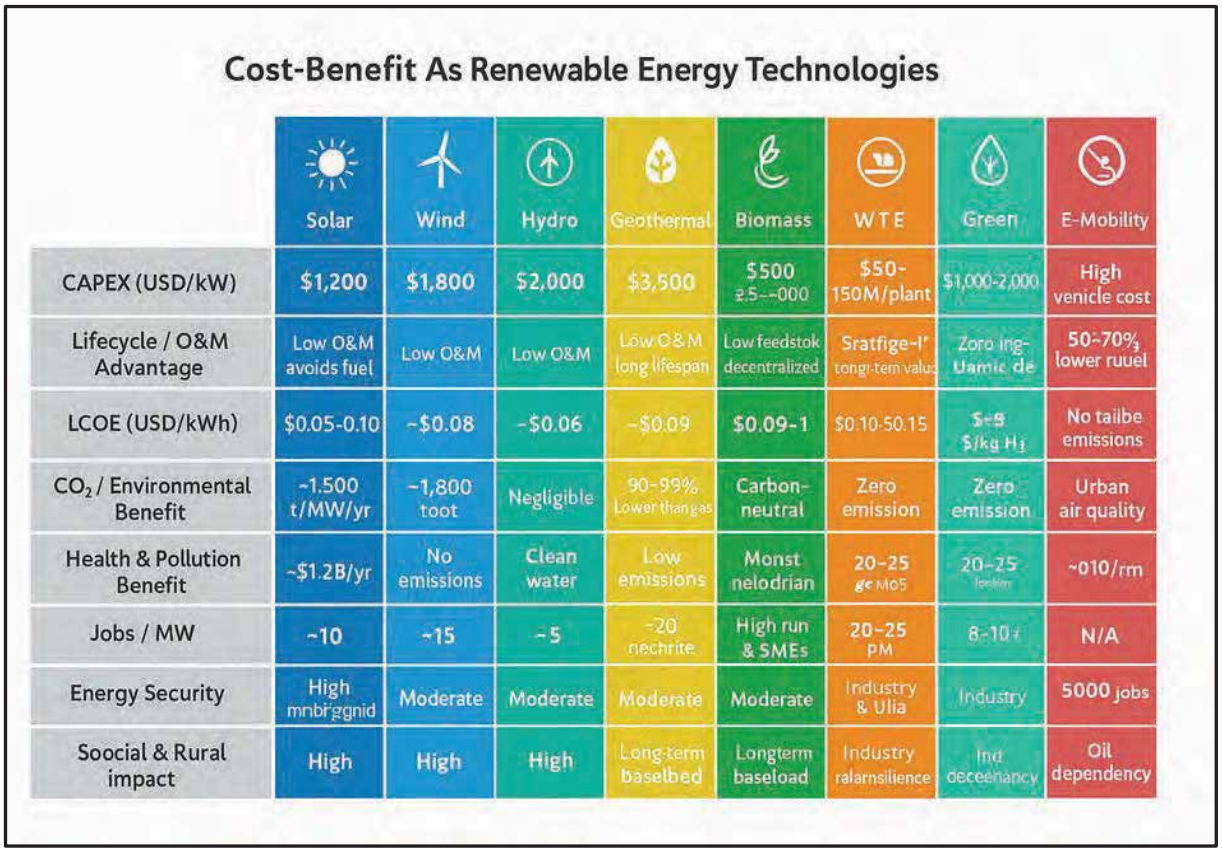
x. Aggregate National Impact

By 2030, Tanzania could realize over $18 billion in cumulative economic benefits from widespread adoption of Renewable Energy Technologies (RETs), including:

- $3.5B in fuel import savings
- $8.4B in avoided health costs
- $2.1B in carbon credit revenue
- $1.5B in wages from green jobs
- Over $2.5B in Net Present Value (NPV) from solar and wind projects

Significance: These figures illustrate that RETs are not only environmentally sustainable but also economically transformative. They provide a pathway to inclusive growth, fiscal stability, and enhanced global competitiveness. A comprehensive cost-benefit analysis of Renewable Energy Technologies (RETs) and e-mobility highlights strengths and trade-offs across eight key technologies: solar, wind, hydro, geothermal, biomass, waste-to-energy, green hydrogen, and electric mobility (e-mobility). This analysis considers s economic efficiency, environmental benefits, and broader societal impacts offering policymakers and investors a clear framework to prioritize interventions and accelerate Tanzania's transition to a **clean, resilient, and sustainable energy** system (see **Figure 15**).

Figure 14: Cost benefit of renewable energy



4.3.5.3. Discussion

This chapter synthesizes findings from data analysis, stakeholder consultations, and literature review to position Tanzania's renewable energy (RE) sector within the broader framework of sustainable economic transformation. It examines policy, institutional, regulatory, market, and socio-economic dimensions that shape the adoption and performance of Renewable Energy Technologies (RETs). The analysis integrates comparative lessons from Kenya, South Africa, Egypt, India, and the United States, offering cross-country insights into effective strategies for scaling renewable energy. These perspectives illuminate both the emerging opportunities such as job creation, carbon finance, industrial competitiveness and the persistent challenges including policy fragmentation, limited financing, and infrastructure constraints.

Collectively, these findings underscore the urgency of aligning Tanzania's RE agenda with its national development goals and global climate commitments under the Paris Agreement and the Sustainable Development Goals (SDGs).

i. Policy and Institutional Frameworks

Tanzania has established a strong policy and institutional foundation to guide renewable energy development. Key instruments including the Electricity Act (2008, amended 2020), the EWURA Act (2001, amended 2022), the Rural Energy Act (2005), and the National Renewable Energy and Energy Efficiency Strategies (2024–2034) reflect a clear political commitment to sustainable energy growth, private sector engagement, and environmental stewardship. These frameworks collectively provide direction for scaling Renewable Energy Technologies (RETs) while aligning with national development priorities and global climate objectives.

However, findings from stakeholder surveys highlight notable implementation weaknesses. Only 32.14% of respondents rated current policies as "very sufficient and well-implemented," whereas approximately 40% viewed them as partially sufficient or insufficient. This disparity underscores a persistent gap between policy formulation and operational execution. Contributing factors include fragmented institutional mandates, limited technical and administrative capacity, and bureaucratic delays in licensing and project approvals.

Strengthening coordination among key institutions such as the Ministry of Energy, EWURA, and the Rural Energy Agency (REA) and ensuring coherent implementation mechanisms will be critical to transforming Tanzania's policy ambitions into tangible outcomes. Institutional reforms emphasizing accountability, efficiency, and transparency are essential for fostering investor confidence and accelerating the country's energy transition.

Comparative insights

A regional and global comparison reveals valuable lessons for Tanzania's renewable energy transition.

- Kenya successfully leveraged its Feed-In Tariff (FiT) Policy (2008) and the establishment of the Geothermal Development Company (GDC) to mobilize large-scale investment in geothermal energy. Today, over 40% of Kenya's electricity is generated from geothermal sources, a testament to strong institutional leadership and investor-friendly incentives (IRENA, 2023).
- South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) illustrates the power of structured, transparent procurement mechanisms. Through competitive auctions, the country attracted over $20 billion in private investment and established more than 100 independent power producers (IPPs) within a decade (Eberhard & Naude, 2016).
- Tanzania, by contrast, has adopted sound policies but lacks binding renewable energy targets, well-defined procurement pathways, and robust incentive structures, to attract sustained private investment.
- **Implication:** Unless Tanzania strengthens implementation, mechanisms and consolidates institutional mandates under a unified national framework, the country risks underutilizing its abundant renewable energy (RE) potential. Streamlined governance, predictable incentives, and clear long-term targets are essential for transforming favourable policy rhetoric into measurable progress.

ii. Regulatory and Governance Challenges

Stakeholder perceptions underscore that governance and regulatory inefficiencies remain among the most significant barriers to renewable energy (RE) development in Tanzania.

Key challenges identified include:

- Limited independence of EWURA reported by (30% of respondents), contributing to uncertainty in licensing decisions and tariff- determination.
- Complex and unclear opaque permitting procedures, which increase transaction costs and cause prolonged project delays.

- Weak Public–Private Partnership (PPP) frameworks (20%), reducing investor's confidence and deterring private capital mobilization.
- Poor data transparency (20%), which limits effective due diligence, particularly for international financiers and carbon market.

Comparative insights

- India strengthened the Central Electricity Regulatory Commission (CERC) and empowered state-level regulators to enforce Renewable Purchase Obligations (RPOs), which catalysed rapid solar and wind deployment.
- Egypt's landmark Benban Solar Park (1.65 GW) succeeded largely due to streamlined permitting and the establishment of a one-stop-shop model managed by the New and Renewable Energy Authority (NREA) (World Bank, 2021).
- South Africa's REIPPPP stands out for its transparent procurement framework, predictable timelines, and well-defined institutional roles, which collectively enhanced regulatory credibility and investor confidence.

Implications

For Tanzania, regulatory coherence and institutional strengthening are indispensable for scaling up renewable energy investment. Enhancing EWURA's autonomy, simplifying licensing and permitting processes, and improving data transparency would significantly enhance project bankability, facilitate grid integration, and align Tanzania with best practices in regional and global renewable energy governance.

iii. Economic Development Challenges

Renewable energy is a strategic driver of Tanzania's long-term economic growth, industrialization, and rural transformation. The analysis identifies several socio-economic pathways through which Renewable Energy Technologies (RETs) contribute to sustainable development: **Job Creation:** Scaling up RE deployment could generate more than 50,000 direct jobs by 2030, primarily in installation, maintenance, and productive-use applications such as solar irrigation, agro-processing, and refrigeration.

In addition, insofar as rural electrification is concerned, mini-grids and solar home systems provide cost-effective access to electricity in underserved regions, enabling value addition agriculture, water pumping, small industries and digital connectivity. Recent concerns over energy security mean that substituting imported fossil fuels with domestic renewables could save approximately USD 500 million annually, strengthening the balance of payments and stabilizing the Tanzanian shilling.

Finally, participation in carbon markets and compliance with Environmental, Social, and Governance (ESG) standards enhances Tanzania's competitiveness in international trade and attract green investment.

Comparative insights

- **Kenya** leveraged its geothermal resources to stabilize electricity supply, reduce fuel imports, and catalyse growth in manufacturing and ICT sectors.

- **In the United States,** renewable energy industries have shown strong economic multiplier effects, with solar and wind significantly contributing to GDP growth and rural employment (DOE, 2023).
- **India's solar parks** have revitalized rural economies by powering irrigation, reducing diesel dependency, and expanding local job opportunities.
- **South Africa's** REIPPPP model integrated local economic development obligations, ensuring that renewable projects directly support community infrastructure, education, and health services.

Implication

For Tanzania, embedding explicit socio-economic development targets including local employment, industrial linkages, youth training, and gender within renewable energy (RE) policies will multiply the sector's benefits beyond energy supply. This approach aligns with the objectives of Vision 2025 and FYDP III, positioning renewable energy as both an economic and social transformation tool.

4.3.5.4. Systemic Barriers and Opportunities

Beyond policy formulation and regulatory reform, Tanzania's renewable energy (RE) expansion faces several systemic challenges that constrain implementation and investment. Addressing these structural barriers presents opportunities for transformative progress.

1. **Institutional Coordination** – Overlapping mandates among Ministry of Energy (MoE), TANESCO, Rural Energy Agency (REA), and EWURA create contribute to bureaucratic delays and fragmented planning.

   ***Comparative Insight*:** Kenya overcame similar issues by creating the Rural Electrification and Renewable Energy Corporation (REREC), a unified agency with a clear mandate for both rural electrification and renewable energy development.

   ***Opportunity*:** Establishing a central RE coordination unit or empowered inter-agency task force could streamline approvals, harmonize strategies, and enhance accountability.

2. **Financial Barriers** – High capital costs and commercial interest rates (11–20%) limit investor participation and project viability.

   Comparative Insight: Egypt and South Africa successfully deployed concessional financing, sovereign guarantees, and public-private partnerships (PPPs) to de-risk projects. India's large-scale solar auctions backed by long-term power purchase agreements (PPAs) attracted private investment and reduced tariffs.

   Opportunity: Expanding access to green credit lines, blended finance, and results-based subsidies can lower financing costs and increase private capital.

3. **Grid Integration** – Tanzania's transmission network is aging and limited, making it ill-equipped to absorb variable renewable energy inputs from solar and wind.

Comparative Insight: The United States invested heavily in smart grids and flexible transmission systems while South Africa's REIPPPP included grid upgrade investments to enhance system reliability.

Opportunity: Prioritizing grid modernization and regional interconnections will improve reliability, reduce curtailment risks, and enable higher renewable penetration.

4. **Data Transparency and Carbon Finance** – Tanzania currently captures only ~3% of its carbon finance potential due to limited measurement, reporting, and verification (MRV) systems and weak data availability.

   Comparative Insight: Egypt's national MRV framework and Kenya's participation in voluntary carbon markets demonstrate how robust data systems can attract climate finance and improve investor confidence.

   Opportunity: Strengthening the National Carbon Management Centre (NCMC) and developing an integrated RE data and MRV platform could unlock hundreds of millions in climate-aligned investment.

5. **Social Inclusion and Gender Mainstreaming** – Women remain underrepresented across Tanzania's RE workforce and decision-making structures.

   Comparative Insight: India's women-led solar entrepreneurship programs and Kenya's mini-grid cooperatives showcase inclusive models that expand participation and social impact.

   Opportunity: Implementing gender-responsive policies, vocational training, and financing for women-led SMEs can make the RE sector more equitable and community-driven.

4.3.5.5. Strategic Considerations

Drawing from both domestic findings and comparative international experiences, several strategic priorities emerge to accelerate Tanzania's renewable energy transition and maximize socio-economic returns:

- **Policy Reform:** Establish binding renewable targets, streamline licensing, and permitting procedures, and adopt auction-based procurement frameworks similar to South Africa's REIPPPP and India's solar auctions to enhance transparency, competitiveness, and cost efficiency.
- **Financial Innovations:** Expand access to concessional financing, carbon revenue mechanisms, and blended finance to de-risk projects. The Benban Solar Park model in Egypt provides a proven example of mobilizing large-scale private investment through stable policy and credit guarantees.
- **Institutional Strengthening:** Reinforce EWURA's regulatory autonomy, digitize licensing and tariff approval process, and consider establishing a dedicated Renewable Energy Coordination Agency to unify mandates and accelerate project approvals.
- **Capacity Development:** Align technical and vocational training with the evolving needs of the RE sector. Kenya's geothermal workforce programs offer a strong model for developing specialized technical expertise and local manufacturing skills.

- **Technology Prioritization:** Prioritize solar PV, mini-grids, and productive-use applications, in the near term for maximum energy access and job creation. Simultaneously, pilot green hydrogen and electric mobility (e-mobility) to prepare for long-term decarbonization and industrial competitiveness
- **Socio-Economic Integration:** Embed local job creation, gender inclusion, and community benefit mandates within RE projects, drawing from South Africa's REIPPPP model where social investment obligations strengthened community services and rural development outcomes.

4.3.5.6. Contribution of Renewable Energy to Economic Development in Tanzania

Tanzania: A High-Potential, Nascent Market

Tanzania's renewable energy sector remains in its formative stage, currently contributing less than 2% to the national GDP. Despite this modest starting point, the sector's long-term potential is significant. Projections suggest its contribution could rise to between **1**.5% and 10% of GDP by 2043 signalling a transformative shift toward a more resilient and diversified economy. This transition is expected to generate over $18 billion in cumulative economic benefits by 2030, driven by key savings and new revenue streams. Among these, $3.5 billion in avoided fossil fuel imports and $8.4 billion in reduced health costs, attributable to decreased dependence on biomass for cooking stand out as critical socioeconomic gains. To catalyse this growth, the government aims to attract $4.039 billion in private sector investment. Additionally, renewable energy expansion is projected to yield $500 million annually in tax revenues by 2035 and $300 million per year from carbon credits. Collectively, these inflows are positioned to serve as a vital financial engine supporting Tanzania's broader development goals and its vision for a sustainable, low-carbon economy.

4.3.6. Global and Regional Case Studies: Models for Success

4.3.6.1. China: Scaling Renewables for Economic Transformation

As the global frontrunner in renewable energy, China exemplifies how large-scale, state-backed investment can drive economic transformation. In 2023, the country's clean energy manufacturing sector alone contributed approximately 5% to national GDP growth, underscoring the sector's central role in industrial expansion and export competitiveness. China also leads globally in renewable energy employment, accounting for an estimated 7.4 million jobs, or 46% of the global total. Many of these positions are concentrated in solar PV (4.6 million) and wind power (800,000) industries, clear evidence of the direct correlation between sustained investment and large-scale job creation. Beyond domestic benefits, China has strategically leveraged its manufacturing capacity to dominate global renewable energy technology and equipment exports. This has not only strengthened its trade balance but also established the country as a key driver of the global clean energy supply chain, linking economic growth with technological leadership and climate resilience.

4.3.6.2. South Africa: A Model for Job-Driven Renewable Energy Development

South Africa presents one of Africa's most compelling examples of renewable energy as a catalyst for inclusive, job-centred growth. Through its flagship Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the country has demonstrated how transparent governance and private-sector participation can accelerate the energy transition. The REIPPPP has attracted billions of dollars in private investment, effectively channelling market capital toward national socio-economic objectives. As a result, the Programme is projected to create is projected to generate up to 2 million jobs by 2024, with approximately 1.7 million in solar industry alone, making it a cornerstone of South Africa's green industrialization agenda.

Beyond employment, REIPPPP has diversified the economy by reducing dependence on coal, fostering energy security, and positioning South Africa as a continental leader in renewable energy procurement and policy innovation. Its success underscores the potential of transparent, competitive frameworks in driving both sustainable growth and social inclusion.

4.3.6.3. Kenya: Harnessing Geothermal Energy for Sustainable Economic Growth

Kenya stands as a regional frontrunner in harnessing geothermal energy, demonstrating the economic power of a focused, resource-specific strategy. By prioritizing geothermal development, the country has attracted substantial domestic and foreign investment, establishing a robust foundation for long-term energy and economic resilience. The geothermal sector has emerged as a major driver of employment, creating thousands of jobs across construction, installation, and maintenance phases, while making measurable contributions to GDP growth. It also serves as a reliable source of fiscal revenue through taxes, royalties, and export earnings, reinforcing the government's capacity to fund national development priorities. Beyond its direct financial impact, Kenya's geothermal dominance enhances energy security and industrial competitiveness. By reducing reliance on hydropower, which is increasingly vulnerable to climate variability, the country has stabilized electricity supply for both industries and households. This strategic focus exemplifies how aligning natural resource endowments with targeted investment can yield sustainable economic and social dividends.

4.3.6.4. Portugal: Leveraging Renewable Energy for Economic Diversification

Portugal provides an instructive model for a middle-income economy seeking to integrate renewable energy into their broader economic transition. By 2024, Portugal's renewable energy sector employed approximately 50,000 people and contributed around 5% to national GDP underscoring its growing role as both an economic and industrial pillar. Beyond domestic energy security, Portugal has successfully positioned renewables as an export-oriented industry. Annual exports of renewable technologies and electricity are valued at roughly €500 million ($540 million), generating important foreign exchange earnings and strengthening the nation's balance of payments (BoP).

This dual focus meeting internal energy needs while cultivating global market competitiveness illustrates how strategic investment in renewables can diversify an economy, stimulate high-value employment, and enhance macroeconomic stability. Portugal's experience thus offers valuable lessons for countries aiming to move from energy import dependency toward sustainable, innovation-driven growth.

4.3.6.5. Comparative Insights: Positioning Tanzania within the Global Renewable Energy Landscape

Tanzania's renewable energy sector, though still in its formative stages, holds the potential to become a central driver of the nation's economic transformation. A comparison with global leaders such as China, South Africa, Kenya and Portugal (**Table 26**) reveals that Tanzania's projected gains in GDP growth, employment generation, and investment attraction, are both substantial and strategically aligned with internationally proven success models. By leveraging its abundant largely untapped renewable resources while adopting best practices from these frontrunners, Tanzania can accelerate progress toward its development goals. Such an approach would not only support the achievement of its ambitious energy and economic targets but also foster a more resilient, diversified, and sustainable economy, capable of withstanding global market and climate-related shocks.

Table 26: Comparative Economic Parameters within the Global Renewable Energy Landscape

Economic Parameter	Tanzania	China	South Africa	Kenya	Portugal
GDP Contribution	Projected 1.5% to 10% by 2043.	5% of GDP growth in 2023 (from clean energy manufacturing)	Major contributor to GDP through investment.	Contributes to GDP by attracting investment.	Contributed 5% to GDP in 2024.
Job Creation	Potential for thousands of jobs from projects.	7.4 million jobs in 2023.	Projected 2 million jobs by 2024.	Created thousands of jobs.	50,000 jobs in 2024.
Investment	Targeting $4.039 billion in private investment.	Received ~750 billion USD of global renewable energy investment in 2023.	Successful REIPPPP model attracts private investment.	Attracts significant investment, boosting GDP.	Exports valued at €500 million ($540 million) annually.
Dominant Sector	Nascent, with focus on diverse resources.	Solar PV and wind.	Solar and wind.	Geothermal.	Wind, solar, and biomass.
Indirect Benefits	Fuel import and health cost savings.	Technology and equipment exports.	Economic diversification from fossil fuels.	Enhanced energy security; reduced climate vulnerability.	Economic diversification; new export revenues.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

This study provides a comprehensive assessment of the landscape surrounding Renewable Energy Technologies (RETs) in Tanzania, highlighting both the progress made and the persistent structural, financial, and institutional challenges that constrain their widespread adoption. While Tanzania has established several policy and institutional frameworks—such as the National Energy Policy (2003)—supporting renewable energy development, the implementation gap remains significant. The absence of clear, actionable guidelines has resulted in fragmented coordination among key ministries and agencies, contributing to delays and inefficiencies in project execution.

A central barrier identified is the limited availability of long-term, low-interest financing, compounded by the high upfront capital costs associated with RETs. For instance, the prohibitive cost of a 5kW solar photovoltaic system remains inaccessible to many small enterprises. Local financial institutions continue to perceive renewable energy projects as high-risk, thereby restricting credit access and deterring private sector engagement.

The study also reveals a widespread knowledge and capacity deficit across the energy value chain. From policymakers to local communities, there exists limited technical understanding of RET operations, maintenance, and their broader socio-economic benefits. This gap has contributed to a reliance on short-term, donor-driven initiatives rather than coherent, nationally coordinated strategies.

Technologically, Tanzania possesses considerable potential for solar and wind energy, particularly in its central and northern regions. However, the national grid infrastructure—especially in rural areas—remains underdeveloped, limiting the integration and scalability of decentralized renewable systems. The lack of grid readiness undermines energy reliability and constrains the expansion of off-grid solutions.

Despite these challenges, the study identifies promising growth opportunities. Rising private sector interest in off-grid technologies, coupled with strong political commitment to clean energy, provides a favourable foundation for accelerating RET adoption. The development of a more supportive regulatory and financial ecosystem—featuring risk-sharing mechanisms, concessional financing, and transparent policy enforcement—could significantly enhance Tanzania's capacity to leverage RETs as a catalyst for inclusive and sustainable economic transformation.

5.1. Conclusions

Tanzania possesses a substantial and largely untapped potential to harness renewable energy as a catalyst for economic development and expanded energy access. The country's policy foundations are well established, yet the pace of progress remains constrained by the persistent disconnect between policy design and implementation. For Tanzania to realize its renewable energy ambitions, it must address fragmented financing mechanisms, enhance technical and institutional capacity at all operational levels, and stimulate the growth of vibrant domestic market for Renewable Energy Technologies (RETs). The study concludes that the successful integration of RETs will depend on a coordinated, multi-stakeholder approach involving government, private investors, and international development partners. Creating a predictable and enabling investment environment, one that mitigates effectively mitigates risks and

promotes innovation, will be essential to unlock long-term, inclusive and sustainable growth in the renewable energy sector.

5.2. Policy Recommendations

Based on the study's findings, the following specific and practical recommendations are proposed to strengthen the contribution of Renewable Energy Technologies (RETs) to Tanzania's economic development:

5.2.1. Policy and Institutional Strengthening

i. **Develop a National RETs Roadmap:** Formulate a comprehensive, long-term roadmap with clearly defined and measurable targets for RET adoption across key sectors, such as rural electrification, industrial development and social infrastructure). This roadmap should include phased milestones, investment priorities, and performance indicators to guide coordinated implementation.

ii. **Establish a "One-Stop Shop" for RETs:** Create a centralized, single-window office dedicated to coordinating all licensing, permitting, and regulatory approvals for RET projects. Streamlining these processes would significantly reduce bureaucratic hurdles and attract more private investment. Streamlining these processes would reduce bureaucratic delays, enhance transparency, and attract both domestic and international private investment.

iii. **Issue Clear Implementation Guidelines:** Develop and disseminate practical guidelines for executing existing RET policies to ensure alignment among government ministries, regulatory agencies, and development partners. These guidelines should clarify institutional roles, timelines, and accountability frameworks to facilitate consistent policy application and effective project delivery.

iv. **Develop a Dedicated Renewable Energy Policy and/or Department:** Formulate a standalone renewable energy policy to unify strategic goals, regulations, and incentives, and/or establish a dedicated department within the Ministry of Energy to oversee its planning, coordination, and implementation, ensuring sustained institutional support for Tanzania's energy transition.

v. **Introduce technology-neutral incentives:** Encourages adoption of a variety of RETs, including solar, wind, biomass, and non-electricity technologies like solar water heating.

vi. **Strengthen feed-in tariffs (FiTs) and net metering:** Makes small-scale and distributed generation financially attractive, incentivizing households and businesses to adopt renewable energy.

vii. **Streamline licensing and permitting**: Reduces administrative delays, increases efficiency, and encourages quicker deployment of projects.

viii. **Promote public-private partnerships (PPPs)**: Leverages private sector expertise and financing capacity for large-scale and innovative renewable projects.

5.2.2. Financial and Investment Mechanisms

i. **Establish a Dedicated RETs Investment Fund:** Create a national renewable energy investment fund ideally structured as a public-private partnership to provide

concessional financing, grants, and low-interest loans targeted at RET projects. Priority should be given to small-scale and off-grid solutions that directly enhance rural electrification and local enterprise development. This fund would serve as a catalyst for mobilizing private capital and mitigating the financial risks associated with early-stage investments.

ii. **Introduce Targeted Tax Incentives:** Implement tax holidays and import duty reductions on renewable energy components to lower project costs and stimulate market growth. Additionally, extend value-added tax (VAT) exemptions to local manufacturers of RET equipment to encourage domestic production, technology transfer, and job creation within the clean energy value chain.

iii. **Leverage International Climate Finance:** Proactively engage with global climate finance institutions including the Green Climate Fund (GCF), the World Bank, and other multilateral partners to secure long-term funding for RET initiatives. Project proposals should be explicitly aligned with Tanzania's national climate strategies and sustainable development goals, strengthening eligibility and access to concessional financing.

iv. **Promote local currency financing mechanisms:** Reduces exchange rate risk for developers and TANESCO, and lower dependency on hard-currency loans, making projects more sustainable.

v. **Leverage blended finance, concessional loans, and guarantees:** Lowers perceived risk and cost of capital, attracting private investors.

vi. **Establish a dedicated renewable energy fund:** Provides seed funding or risk capital for small-scale and off-grid projects, stimulating local entrepreneurship and innovation.

vii. **SPP (Small Power Producers) continuity post-grid arrival**: Adopt mechanisms that facilitate existing decentralized and mini-grid producers to continue generation after the national grid reaches their area, ensuring long-term investment security and local energy resilience.

viii. **Enabling environment for large-scale RE projects (>10MW)**: Establish clear power purchase agreements (PPAs); and ensure regulatory certainty to attract domestic and foreign investors for large renewable energy projects.

5.2.3. Capacity Building and Technical Development

i. **Develop Vocational Training Programs:** Establish specialized vocational and technical training programs within universities, technical institutes, and community colleges to build a skilled workforce capable of installing, maintaining, and repairing solar, wind, and biomass systems. These programs should be designed in partnership with industry stakeholders to ensure alignment with current market needs, promote local employment, and enhance long-term sustainability of RET projects. By prioritizing hands-on, competency-based learning and certification, Tanzania can strengthen its human resource base, reduce reliance on foreign expertise, and foster inclusive participation in the growing renewable energy sector.

ii. **Promote Research and Local Adaptation:** Provide dedicated funding and institutional support to local research centres and universities to facilitate the adaptation of international Renewable Energy Technologies (RETs) to Tanzania's unique climatic, geographic, and environmental conditions. This approach will encourage homegrown

innovation, enhance the suitability and efficiency of RET solutions, and progressively reduce reliance on foreign technologies and expertise. Strengthening collaboration between research institutions, industry actors, and government agencies will ensure that technological development aligns with national priorities and supports the creation of a resilient, self-sustaining renewable energy ecosystem.

iii. **Launch Public Awareness Campaigns:** Implement nationwide public awareness initiatives, local media platforms, educational institutions, and community leaders to promote understanding of the economic, social, and environmental benefits of Renewable Energy Technologies (RETs). These campaigns should emphasize the long-term value of clean energy adoption such as cost savings, health improvements, and environmental protection while addressing common misconceptions that hinder uptake. By fostering informed participation and community ownership, Tanzania can accelerate behavioural change, strengthen local support for renewable energy initiatives, and create a more inclusive foundation for sustainable energy transition.

5.2.4. Market Mechanisms and Private Sector Engagement

i. **Introduce Domestic Manufacturing Incentives:** Provide targeted subsidies, tax reliefs, and prioritized land allocation companies establishing local assembly or manufacturing plants for renewable energy (RET) components. These incentives would stimulate the growth of a domestic renewable energy industry, enhance technology transfer, and create new employment opportunities within Tanzania's green economy.

ii. **Quality Management Framework for Equipment and Certification:** Develop and enforce national standards for RET equipment to ensure product quality, safety, and reliability. Establishing a transparent certification and accreditation system will build consumer confidence, protect the market from counterfeit or substandard imports and strengthen Tanzania's credibility as an investment destination for clean energy technologies.

iii. **Facilitate Business Linkages and Technology Transfer:** Organize sectoral trade fairs, investment forums, and matchmaking platforms to connect international technology providers with local firms and investors to foster strategic partnerships and technology transfer. Such interactions will promote strategic partnerships, capacity building, and technology localization, positioning Tanzania as an emerging hub for renewable energy innovation and enterprise development.

5.2.5. Technical and Infrastructure Development

i. **Expand and modernize grid infrastructure:** Supports integration of intermittent renewables, improves reliability, and accommodates future growth in generation capacity.

ii. **Deploy energy storage solutions (batteries, green hydrogen):** Balances supply and demand, stores excess energy, and stabilizes the grid.

iii. **Develop mini-grid and off-grid solutions:** Ensures electricity access in rural and remote communities, enabling productive use and local economic development.
Conduct comprehensive resource assessments: Identifies optimal locations for wind, solar, and geothermal projects, reducing development risk and improving efficiency.

5.2.6. International Collaboration & Knowledge Sharing

Learn from countries like India and Chile: Adopt successful strategies in financing, PPPs, auctions, and technology deployment to accelerate domestic innovation, manufacturing, financing and dissemination of technologies.

5.2.7. Industrial & Technology Development

i. **Introduce Domestic Manufacturing Incentives:** Provide subsidies, tax relief, and land allocation for companies establishing local assembly or manufacturing plants for RET components. Stimulates domestic industry, enhances technology transfer, and creates green jobs.

ii. **Leverage the RET Value Chain:** Promote the entire renewable energy value chain including mining of critical minerals, local manufacturing, assembly, and downstream services to generate jobs, enhance skills development, stimulate industrialization, and foster holistic renewable energy development and utilization.

CHAPTER SIX: PROPOSALS FOR FUTURE RESEARCH

Based on the findings of this study, several areas warrant further, in-depth research to enhance the evidence base and provide more targeted policy and investment guidance. The following proposed research topics aim to address key knowledge gaps identified in the current study:

6.1. Socio-Economic Impact and Community Engagement

- **Research Topic:** "*Assessing the Livelihood and Social Impacts of Decentralized Renewable Energy Projects on Rural Communities in Tanzania*."
- **Justification:** Although this report identifies off-grid and decentralized energy systems as major opportunities, there is limited empirical data on their broader socio-economic impacts. A comprehensive quantitative and qualitative assessment is needed to measure changes in household income, local entrepreneurship (e.g., small welding shops, charging stations), education access (e.g., through lighting), and the enhancement of health and food security. Such research would provide policymakers with evidence-based insights into how renewable energy can directly uplift rural livelihoods and reduce poverty.

6.2. Financial Mechanisms and Investment Models

- **Research Topic:** "*Comparative Analysis of Innovative Financing Models for RETs in Tanzania: A Study of Green Bonds, Carbon Credits, and Micro-Lending.*"
- **Justification:** Given the existing financing gap in Tanzania's renewable energy landscape, this research would undertake a comparative evaluation of innovative financing instruments, assessing their feasibility, scalability, and regulatory implications within the Tanzanian context. The study would outline a roadmap for mobilizing private capital and diversifying funding sources beyond conventional bank loans thereby supporting the development of a resilient and inclusive renewable energy finance ecosystem.

6.3. Technological Integration and Grid Modernization

- **Research Topic:** "*Technical Feasibility of Smart Grid Technologies and Energy Storage Systems for High-Penetration RETs in Tanzania's National Grid.*"
- **Justification:** With grid underdeveloped identified as a key constraint, this study would provide an engineering and economic feasibility analysis of integrating smart grid technologies and energy storage solutions. It would model the effects of incorporating high shares of intermittent renewables (solar and wind) on grid stability, reliability and cost efficiency, and evaluate the economic viability of battery storage and demand-response systems. The findings would guide infrastructure planning and modernization strategies critical for a low-carbon power sector.

6.4. Value Chain Development and Local Manufacturing

- **Research Topic:** "*Mapping the Domestic Value Chain for Renewable Energy Technologies and Identifying Opportunities for Local Manufacturing.*"
- **Justification:** To advance domestic industrial participation, this research would conduct a comprehensive value chain analysis to determine which RET components such as solar panel frames, batteries, or small wind turbine blades can be feasibly produced locally. It would assess the industrial capabilities, labour skills, technology gaps, and market

readiness, culminating in a strategic framework for developing a local renewable energy manufacturing industry. Such a study would provide actionable insights for fostering job creation, enhancing self-sufficiency, and reducing reliance on imports.

6.5. Integrative Summary

Collectively, these proposed research areas underscore the critical need for evidence-based decision-making to guide Tanzania's renewable energy transition. By deepening the understanding of socio-economic impacts, financing innovations, grid modernization, and local value chain development, future studies can provide actionable insights that strengthen both policy coherence and investment confidence. Such research will not only inform the design of more effective regulatory and financial frameworks but will also help Tanzania build a self-sustaining, inclusive, and competitive renewable energy sector. In doing so, the country will be better positioned to achieve its long-term goals of energy security, economic diversification, and sustainable development.

References

TICGL. (2025, June 11). *Lending Rates Ease to 15.16% Amid Stable Monetary Policy*. Retrieved from Tanzania Investment and Consultant Group Ltd: https://ticgl.com/lending-rates-ease-to-15-16-amid-stable-monetary-policy/

AEP. (2021, 6 16). *Tanzania: IDA finances the integration of solar energy into the Zanzibar grid*. Retrieved from Africa Energy Portal: https://africa-energy-portal.org/news/tanzania-ida-finances-integration-solar-energy-zanzibar-grid

AfDB. (2022). *Renewable Energy in Africa: Tanzania Country Profile*. Retrieved September 18, 2025, from https://www.afdb.org/en/documents/document/renewable-energy-in-africa-tanzania-country-profile-108853

allafrica. (2025, June 2). *Tanzania Daily News*. Retrieved from allafrica: https://allafrica.com/stories/202506020320.html

Business Insider. (2025, June 9). *Tanzania's first major solar power project nears completion, set to join national grid in October*. Retrieved from Tanzania's first major solar power project nears completion, set to join national grid in October

Cilliers, J. (2024). *ISS Africa Futures.* file:///C:/Users/u14600/Downloads/AFI-Geographic-Futures-Tanzania-Scenario-comparisons.pdf.

Clyde & Co. (2025). *Bankability of Independent Power Producers in Tanzania*. Retrieved September 20, 2025, from https://www.clydeco.com/en/insights/2025/04/bankability-of-independent-power-producers

Crossley, P. J. (2019). *Renewable Energy Law.*

Daily News. (2025, May 30). *Govt targets 75pc renewable energy by 2030, eyes 32tri/- funding*. Retrieved from Daily News: https://dailynews.co.tz/govt-targets-75pc-renewable-energy-by-2030-eyes-32tri-funding/

DMRE. (2023). *Integrated Resource Plan.* Department of Mineral Resources and Energy.

EAP. (2025). *Tanzania-National Energy Compact*. Retrieved September 20, 2015, from https://africa-energy-portal.org/reports/tanzania-national-energy-compac

ERIA. (2024). *The Electricity Regulatory Index for Africa 2024.* Abidjan, Côte d'Ivoire: African Development Bank.

EWURA. (2024). *Fact Sheet.* https://www.ewura.go.tz/wp-content/uploads/2024/10/EWURA-FACT-SHEET.pdf.

Green Building Africa. (2020, April 14). *Tanzania: Construction to Commence on 2.4 MW Wind Project*. Retrieved from https://www.greenbuildingafrica.co.za/tanzania-construction-to-commence-on-2-4-mw-wind-project/

Guo, Z. Y. (2023). *influencing factors of green energy transition: The role of economic policy uncertainty, technology innovation, and ecological governance in China*. Retrieved September 07, 2025, from https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2022.1058967/full

IEA. (2023). *Financing Clean Energy in Africa.* INTERNATIONAL ENERGY AGENCY.

IEA. (2023). *Renewable Energy Market Update Outlook for 2023 and 2024.* Paris: International Energy Agency.

IEA. (2025, May 24). *National Energy Compact*. Retrieved from International Energy Agency: https://www.iea.org/policies/25973-national-energy-compact

IEA. (2025, June 24). *National Energy Compact*. Retrieved from https://www.iea.org/policies/25973-national-energy-compact

ILO. (2024, October 1). *Jobs in renewable energy record highest annual growth rate, reaching 16.2 million.* Retrieved January 24, 2025, from https://www.ilo.org/resource/news/jobs-renewable-energy-record-highest-annual-growth-rate-reaching-162

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* Intergovernmental Panel on Climate Change.

IRENA. (2021). *Renewable Power Generation Costs in 2020.* Abu Dhabi: International Renewable Energy Agency.

IRENA. (2024). *Renewable energy jobs: Annual review 2024.* Abu Dhabi: International Renewable Energy Agency.

Joel Jaeger. (2021). *Explaining the Exponential Growth of Renewable Energy*. Retrieved November 18, 2024, from https://www.wri.org/insights/growth-renewable-energy-sector-explained

Mingming Zhang, Q. G. (2025). Renewable energy investment under the market-oriented transition of policies. *Energy Policy, Volume 204, September 2025,*(114683).

Molly Lempriere. (2024). *Wind and solar are 'fastest-growing electricity sources in history*'. Retrieved November 19, 2024, from https://www.carbonbrief.org/wind-and-solar-are-fastest-growing-electricity-sources-in-history

NBS. (2024). *Impact of Access to Sustainable Energy Survey 2021-2022*. Retrieved September 18, 2025, from https://microdata.nbs.go.tz/index.php/catalog/42/study-description

Nishati. (2024). *NATIONAL RENEWABLE ENERGY STRATEGY.* Dodoma: Nishati.

Planning Commission. (2024). *Tanzania Development Vision 2050.* URT.

REA. (2025, 21 8). *Access and Connectivity*. Retrieved from REA: https://rea.go.tz

Reuters. (2024, February 26). Retrieved from anzania switches on first turbine of hydro plant in World Heritage Site: https://www.reuters.com/business/energy/tanzania-switches-first-turbine-hydro-plant-world-heritage-site-2024-02-26/

SolarQuarter. (2025, September 12). *Tanzania Advances Towards Renewable Energy Future with EU And AFD Support*. Retrieved from Tanzania Advances Towards Renewable Energy Future With EU And AFD Support: https://solarquarter.com/

Sustainability Directory. (2023). *What Factors Influence Renewable Energy Choice?* Retrieved September 07, 2025, from https://energy.sustainability-directory.com/question/what-factors-influence-renewable-energy-choice/

UNDP. (2025). *Renewable Resources and Alternative Energy*. Retrieved from Private Finance for SDGs: https://sdgprivatefinance.undp.org/

URT. (2007). *National Adaptation Programme of Action (NAPA).* Dar es Salaam: Vice President's Office.

WB. (2024). *Improving Sustainability of the Power Sector and Accelerating Electricity Access in Tanzania: A Proposed WBG Roadmap* . Washington DC: World Bank.

World Bank. (2025). *Energy: Affordable, accessible energy is at the heart of development, driving job creation, growth, and shared prosperity*. Retrieved September 18, 2025, from https://www.worldbank.org/en/topic/energy/overview

World Bank. (2025, January 27-28). *Mission 300 Africa Energy Summit.* Retrieved from NATIONAL ENERGY COMPACT FOR TANZANIA: https://thedocs.worldbank.org/en/doc/7d09ddf2619513d85e489e2620252793-0010012025/original/M300-AES-Compact-Tanzania.pd

World Bank. (2025). *NATIONAL ENERGY COMPACT FOR TANZANIA.* Dodoma: Nishati.

World Future Council. (2018). *Financing 100% Renewable Energy for All in Tanzania: Climate Finance — Policy Brief 6/2018.* World Future Council.

REPOA HQs
157 Migombani/REPOA streets, Regent Estate, PO Box 33223,
Dar es Salaam, Tanzania.
Tel: +255 (22) 270 0083 Cell: +255 (0)784 555 655
Website: https://www.repoa.or.tz
Email: repoa@repoa.or.tz

Branch Office
2nd Floor Kilimo Kwanza Building
41105 Makole East, Kisasa,
Dodoma, Tanzania