

Research Report 26/1

February 2026

Clean Cooking Energy in Tanzania:

Current Status, Prospects
and Policy Implications

Emmanuel Maliti

Jambo Ramadhani



● ● UONGOZI
● Institute

Table of contents

List of Tables	iii
List of Figures	iii
List of Abbreviations	iv
Abstract	v
Acknowledgements	vi
1. Introduction	1
2. Study rationale	2
3. Study objectives	3
4. Conceptual framework	4
4.1 Clean cooking energy	4
4.2 Feasibility dimensions	4
5. Scope	6
6. Methodology	7
6.1 Data collection	7
6.2 Data analysis	7
7. Findings	8
7.1 Reliability	9
7.1.1 Electricity	9
7.1.2 Natural gas and LPG	12
7.1.3 Solar	12
7.1.4 Biogas	13
7.2 Accessibility	14
7.3 Scalability	16
7.3.1 Market potential	16
7.3.2 Supplier availability, distribution network and infrastructure	18
7.4 Affordability	24
7.5 Equitability	25
7.5.1 Electricity	25
7.5.2 LPG	25
7.5.3 Solar	25
7.5.4 Biogas	26
7.5.5 Adoption rates for male- versus female-headed households	28
7.5.6 Disparities between urban and rural locations	28
8. Efforts by key government institutions to promote clean cooking energy	29
8.1 Ministry of Energy (MoE)	29
8.2 Tanzania Electric Supply Company Limited (TANESCO)	29
8.3 Tanzania Petroleum Development Corporation (TPDC)	30
8.4 Electricity and Water Utilities Regulatory Authority (EWURA)	30
9. Efforts by non-state entities to promote clean cooking energy	31
10. Discussion	32

About UONGOZI Institute

The Institute of African Leadership for Sustainable Development, commonly known as UONGOZI Institute, is a regional leadership development hub operating under the Office of the President of the United Republic of Tanzania. The Institute was established in 2010 by the governments of Tanzania and Finland to strengthen the capacity of African leaders to deliver inclusive and sustainable solutions for their nations. To achieve its mission, the Institute delivers executive education programmes, facilitates policy dialogues, provides advisory services and technical support to public and private institutions, and conducts action-oriented research to support evidence-based policies and decisions.

Published by UONGOZI Institute © 2026. All rights reserved. No part of this work may be reproduced in any form without written permission of the publisher and the copyright holder.

UONGOZI Institute encourages dissemination of its works. Its website and Resource Centre contains a database of books, reports, papers and articles. Information and requests to reproduce publications: info@uongozi.or.tz

Disclaimer: The views expressed in this publication are those of the author(s). Publication does not imply endorsement by UONGOZI Institute, nor by the programme/project sponsors, of any of the views expressed.

Cover Photo: iStock | Seiya Tabuchi

11. Conclusions	33
12. Policy recommendations	34
12.1 General recommendations	34
12.2 Recommendations by dimension	35
12.2.1 Reliability	35
12.2.2 Accessibility	35
12.2.3 Scalability	35
12.2.4 Equitability	36
12.2.5 Affordability	36
13. References	37
Annexes	41
Annex 1: Benchmarking Tanzania’s electricity reliability with neighbouring countries	41
Annex 2: Electricity Accessibility and Connectivity	41
Annex 2a: Progress in electricity accessibility	41
Annex 2b: Progress in electricity connectivity	41
Annex 3: Market potential	42
Annex 4: Proportions of households using different cooking energy sources	42
Annex 5: Grid power generation capacity and availability status as of April 2025	43
Annex 6: Households connected with natural gas pipeline (TPDC) (as of June 2023)	43
Annex 7: Data files for computation of Net Present Values	43
Annex 7a: Input file	43
Annex 7b: NPV cost model - Electricity	44
Annex 7c: NPV cost model - LPG	45
Annex 7d: NPV cost model – Natural gas	46
Annex 7e: NPV cost model – Solar	47
Annex 7f: NPV cost model – Biogas	48
Annex 7g: NPV affordability summary [NPV of total cost (TZS)]	49
Annex 7h: Data sources for NPV calculations	49

List of tables

Table 1: Methodologies for data analysis	7
Table 2: Summary dashboard of findings	8
Table 3: Key observations on the regional SAIFI data for 2023/24	9
Table 4: Key observations on regional SAIDI data, 2023/24	11
Table 5: Key observations on regional CAIDI data	12
Table 6: Accessibility Rates (proxied by adoption rates)	14
Table 7: Challenges associated with accessibility of natural gas for cooking	15
Table 8: Growth in adoption rates between 2012 and 2022	16
Table 9: Likert scales on supplier availability, distribution network and infrastructure and/or technology required	19
Table 10: Adoption rates between male- and female-headed households	28
Table 11: Rural-urban divide in access to clean cooking energy	28

List of figures

Figure 1: Trend in SAIFI - National Level Averages	9
Figure 2: Trend in SAIDI - National Level Averages	10
Figure 3: Trend in CAIDI - National Level Averages	11
Figure 4: NPV over a 10-year horizon (TZS million)	24
Figure 5: Increase in NPV following cost escalation	24
Figure 6: Variations in regional usage of clean cooking energy (percentage of households)	27

List of abbreviations

°C	–	Degrees Celsius	NDCs	–	Nationally Determined Contributions
BVS	–	Block Valve Station	NGOs	–	Non-government organizations
CCBRT	–	Comprehensive Community-Based Rehabilitation in Tanzania	NPV	–	Net present value
CAMARTEC	–	Centre for Agricultural Mechanization and Rural Technology	PM25	–	Particulate matter with a diameter not exceeding 25 micrometres
CO ₂ e	–	Carbon dioxide equivalent	PAHs	–	Polycyclic aromatic hydrocarbons
CPR	–	Community and public relations	PPPs	–	Public-private partnerships
CEER	–	Council of European Energy Regulators	PV	–	Photovoltaic
CAIDI	–	Customer Average Interruption Duration Index	REA	–	Rural Energy Agency
DEWAT	–	Decentralised Wastewater Treatment Systems	SAIDI	–	System Average Interruption Duration Index
DGIS	–	Directorate-General for International Cooperation (of the Government of the Netherlands)	SAIFI	–	System Average Interruption Frequency Index
EWURA	–	Electricity and Water Utilities Regulatory Authority	SCADA	–	Supervisory Control and Data Acquisition
EPRA	–	Energy and Petroleum Regulatory Authority	SUA	–	Sokoine University of Agriculture
GRF-PRS	–	Ground reaction force – Pressure reduction station	SUDERETA	–	Sustainable Development and Environmental Restoration of Tanzania
JKT	–	Jeshi la Kujenga Taifa	SDG	–	Sustainable Development Goals
kg	–	Kilogram	SNV	–	Stichting Nederlandse Vrijwilligers
kWh	–	Kilowatt-hour	SCC	–	Social cost of carbon
LPG	–	Liquified petroleum gas	TDBP	–	Tanzania Domestic Biogas Programme
m ²	–	Square metre	TANESCO	–	Tanzania Electric Supply Company
MECS	–	Modern Energy Cooking Services (UK Aid)	TaTEDO-SESO	–	Tanzania Traditional Energy Development and Environment Organization – Sustainable Energy Services Organization
MMscf	–	Million standard cubic feet	TES	–	Thermal energy storage
MT	–	Metric tonne	TPDC	–	Tanzania Petroleum Development Corporation
MoE	–	Ministry of Energy	TZS	–	Tanzania shillings
MIGESADO	–	Mission for Gas and Environmentally Sustainable Development Organization	UDSM	–	University of Dar es Salaam
MoU	–	Memorandum of Understanding	UNIDO	–	United Nations Industrial Development Organization
MW	–	Megawatt	URT	–	United Republic of Tanzania
NBS	–	National Bureau of Statistics	USD	–	United States dollars
NGUMP	–	National Natural Gas Utilization Master Plan	VAT	–	Value added tax

Abstract

This study assesses Tanzania's transition to clean cooking energy sources (electricity, liquified petroleum gas (LPG), natural gas, solar and biogas) across the five dimensions of affordability, scalability, reliability, equitability and accessibility. Accessibility has risen from 2.5 percent of households in 2012 to 15.9 percent in 2022 [United Republic of Tanzania (URT) 2022]. However, meeting the national target that 80 percent of Tanzanians use clean cooking solutions by 2034 will require an unprecedented acceleration in progress that is four times faster than the current rate (URT 2024a). Affordability is the binding constraint, limiting uptake of clean energy sources in other dimensions. While LPG has driven most recent gains, expanded electrification has not translated into widespread electric cooking, reflecting appliance and tariff barriers. Solar and biogas offer low recurring costs, but high upfront costs constrain their affordability. Reliability has improved in the electricity sector, though regional disparities persist. Scalability is driven largely by LPG, more so in urban areas, while the scalability of solar, biogas and natural gas is constrained by thin supply chains and limited network reach. However, solar energy appears to be more feasible in off-grid areas and plays a compensatory role where electricity and/or LPG are limited. The study recommends a "systems approach" that moves beyond isolated interventions to simultaneously address both supply-side constraints, including infrastructure, distribution networks and regulatory frameworks, and demand-side barriers, especially affordability.

Acknowledgements

UONGOZI Institute wishes to first and foremost acknowledge the Government of the United Republic of Tanzania for its invaluable financial support, which funds the Institute's activities, including research initiatives such as this study. The Institute also extends sincere appreciation to the Ministry of Energy for its collaboration, the provision of a focal person, and facilitation of access to essential information and data. Furthermore, the Institute expresses gratitude to all key informant interviewees for their time and valuable insights. Special thanks are extended to Prof. Ninatubu Lema and Prof. Cuthbert Kimambo for reviewing the draft report. Their thoughtful feedback significantly enhanced the quality of this work.



1 | Introduction

Access to clean cooking energy remains one of the world's most pressing development challenges. Globally, nearly 2.1 billion people continue to rely on traditional biomass energy such as firewood, charcoal and agricultural residues for cooking, exposing them to household air pollution that contributes to an estimated 3.2 million premature deaths annually (WHO 2025). Despite clean energy efforts in Tanzania, traditional biomass is still the dominant and unavoidable part of Tanzania's energy mix. Approximately, 82 percent of households rely on firewood and charcoal for cooking (URT 2022). Due to this dependence on biomass dependence, Mainland Tanzania lost an estimated 469,420 hectares of forest annually over the period from 2015-2020 [URT 2017; Food and Agriculture Organization (FAO) 2020]. From 2013 to 2021, the loss of forest was equivalent to 528 metric tonnes (MT) of carbon dioxide equivalent (CO₂e) emissions with most of the tree cover loss occurring within natural forests (Ecohubmap 2024). If this rate of deforestation continues, Tanzania's forest cover could be completely depleted within the next 50 to 80 years [European Commission (EC) 2025].

The trend highlights that the challenge for Tanzania lies not only in the widespread reliance on traditional biomass energy, but also the unsustainable harvesting of wood fuel for cooking (World Bank 2024). Moreover, deforestation threatens biodiversity, degrades land, and contributes to climate change through increasing carbon emissions [EC 2025; URT 2018; International Monetary Fund (IMF) 2023]. Due to climate change, it is estimated that Tanzania's montane forests could shrink by 50 percent and microhabitat forests (e.g., thickets) by over 70 percent by the year 2085. Recognizing these interlinked challenges, the Government of the United Republic of Tanzania has

elevated clean cooking energy to a national priority. In May 2024, the Government launched the National Clean Cooking Strategy (2024-2034), which sets an ambitious target of achieving 80 percent access to clean cooking energy by 2034 (URT 2024a). The strategy emphasizes the transition toward cleaner energy, aligning the country's domestic policy with global commitments under Sustainable Development Goal 7 (SDG 7) and its Nationally Determined Contributions (NDCs) under the Paris Agreement. This study assesses the affordability, scalability, reliability, equitability and accessibility of five of the eight clean cooking energy sources identified in the National Clean Cooking Strategy (2024-2034) (NCCS) released by the Tanzania Ministry of Energy (MoE) in May 2024: electricity, LPG, natural gas, solar and biogas.¹ However, the study is not intended to evaluate the NCCS. Rather, it seeks to inform policy makers of the best options for accelerating the use of clean energy cooking sources.

The report is structured as follows: Section 2 outlines the study rationale, Section 3 presents the study objectives, followed by the conceptual framework in Section 4. Sections 5 and 6 describe the scope and methodological approaches applied in data collection and analysis. Section 7 presents the findings while Sections 8 and 9 discuss the efforts by key government stakeholders and non-state entities to promote clean cooking energy based on key informant interviews and the document review conducted by the study. Section 10 discusses the findings and Section 11 presents the research conclusions. Based on the evidence collected, Section 12 offers recommendations for the consideration of policy makers and other stakeholders.

¹The other three fuels and technologies identified as clean by the NCCS 2024-2034 are bioethanol, improved cookstoves and briquettes with standards acceptable by the Standards Regulatory Authority

2 | Study rationale

Despite increased policy attention on clean cooking energy, previous studies on the topic in Tanzania (for example, Aamaas et al. 2024) and more broadly in Sub-Saharan Africa often focused on a single dimension (e.g., affordability or accessibility) and thus lacked the broader multi-dimensional realities of clean cooking energy sources and their uptake. Furthermore, research providing nationwide evidence on how adoption patterns vary by region, gender and household income remains scarce. For instance, while Gill-Wiehl et al. (2021) document household preferences for LPG in specific communities in Tanzania, nationwide evidence on access patterns is limited.

To narrow the gap, this study applies a comprehensive multi-dimensional framework to assess five clean cooking energy options (electricity, LPG, natural gas, solar and biogas), against the five dimensions of scalability, reliability, equitability, accessibility and affordability.

The significance of this study emanates from the scale and urgency of the challenge. Data from the

Tanzania National Panel Survey (NPS) 2020-21 (URT 2022), which was collected between December 2020 and January 2022, found that only 15.9 percent of households in Tanzania use clean cooking energy, against the national target of 80 percent by 2034. The timing of this research is also highly relevant, coinciding with the launch of the NCCS 2024-2034, which has elevated clean cooking to a national priority. Thus, the study will inform decision makers on the clean cooking energy sources that are most scalable, reliable, equitable, accessible and affordable in different contexts (urban vs. rural, high-income vs. low-income regions). It also examines investment priorities to address bottlenecks in supply chains, distribution networks and enabling infrastructure for each energy source, and regional targeting strategies that identify underserved areas requiring urgent intervention.



Photo credit: Unsplash | Kwon Junho

3 | Study objectives

The main objective of this study is to assess the affordability, scalability, reliability, equitability and accessibility of five clean cooking energy sources in Tanzania: electricity, LPG, natural gas, solar and biogas. The specific analytical objectives under each of the five dimensions include:

- **Scalability:** Analyze historical adoption rates and growth trajectories; current market potential and untapped household demand; supplier availability, distribution networks, and infrastructure sufficiency.
- **Reliability:** Examine trends in System Average Interruption Frequency Index (SAIFI), System Average Interruption Duration Index (SAIDI) and Customer Average Interruption Duration Index (CAIDI) indices (for electricity); consistency of supply and compliance with mandatory stockholding regulations (for LPG); and operational and technical challenges and dependencies on external factors (for biogas and solar).
- **Accessibility:** Assess trends in the adoption rates as a proxy for economic accessibility; and physical barriers to access, including infrastructure coverage (e.g., grid access, gas pipelines).
- **Affordability:** Assess the total cash outflows that households incur over time for adopting and using clean cooking energy, including both upfront and recurring costs discounted to present value.
- **Equitability:** Assess diversity in adoption rates by region, gender of household head, and by household location (rural versus urban) to identify regions and demographic groups that are being disproportionately left behind in the clean cooking transition.

4 | Conceptual framework

4.1 Clean cooking energy

Electricity, LPG, natural gas, solar and biogas are classified as clean cooking energy sources due to their low release of toxic and hazardous pollutants (URT 2024a). They reduce exposure to harmful air pollutants [i.e., particulate matter with a diameter not exceeding 2.5 micrometres (PM_{2.5})], nitrogen oxides, sulphur oxides and polycyclic aromatic hydrocarbons (PAHs). These pollutants are known to pose significant health and safety risks. The use of these energy sources also contributes to mitigating deforestation and forest degradation.

In addition, clean energy sources are important in the energy transition in countries such as Tanzania, where a large majority (82%) of households use charcoal and firewood as their primary cooking fuel (URT 2022).² Consistent with the predictions of energy transition theory, the shift to clean cooking energy in Tanzania is unfolding in key phases: from experimentation (e.g., biogas pilot projects in rural areas) to policy change (adoption of the NCCS 2024-2034) and onward to diffusion (growing uptake of clean energy sources by households).

Moreover, the use of clean energy sources often provides higher technical performance, including reduction in stove preparation and cooking times. In some countries, electricity users spend on average 43 to 85 minutes less cooking time than primary wood energy users. Less cooking time, in some cases, may equate to less energy consumed, which, in turn, may equate to lower average expenditure and higher affordability [Energy Sector

Management Assistance Program (ESMAP) 2015]. However, these variations depend on stove design and user behaviour.

4.2 Feasibility dimensions

Despite the interlinkages between the five dimensions assessed by this study, they also represent distinct conceptual areas.³ Applying the concept of net present value (NPV), affordability refers to the total cash outflows that households incur over time for using clean cooking energy, including both upfront and recurring costs discounted to present value. Affordability is therefore a function of energy price, consumption level and household income. The analysis of affordability has implications on equitability (e.g., high access to clean cooking energy for higher income earners versus low-income earners) and scalability (e.g., affordable energy sources are more likely to scale than less affordable sources).

Scalability considers the potential for mass adoption without major barriers (see ESMAP 2023; Coldrey et al. 2023; Hosier et al. 2017). In addition to trends in adoption rates (e.g., the growth in the proportion of households using clean cooking energy), the scalability aspect factors in the supply availability (e.g., connection to the grid), the distribution network (e.g., the availability and reach of infrastructure such as natural gas pipelines) and infrastructure requirements (e.g., the capacity of LPG receiving and storage facilities). The distribution network also embeds the “feasibility for sustainability” aspects, in particular, the availability of maintenance support.

²These households are among the three billion people in the world using biomass solid energy for cooking [International Energy Agency (IEA) 2016].

³These dimensions are interlinked in several ways. For instance, underperformance in one area (e.g., reliability) can undermine adoption. Moreover, low reliability may reduce household willingness to invest in appliances, leading to low scalability. Also, accessibility is necessary but not sufficient; without affordability, physical access may not translate into actual use. While these interdependences are important, this study focuses on the distinct aspects of each individual dimension.

Reliability refers to the consistent and predictable supply of energy, free of service interruptions or outages. Frequent interruptions, for instance, will not only make the energy unreliable but also risk driving households to rely on a mix of cooking fuels or back to traditional biomass cooking energy, thereby derailing the energy transition (Schunder & Bagchi-Sen 2019; Dawit et al. 2022).

Focusing on adoption rates (defined as the proportion of households using clean cooking energy), equitability assesses whether adoption of clean cooking energy is

inclusive across regions, genders (e.g., male versus female-headed households) and locations (rural versus urban areas), ensuring no group is left behind. Finally, accessibility covers two aspects concurrently, that is, availability (e.g., in the case of electricity it is whether the grid is available in the area of households) and connectivity (whether households are actually connected) (Alia & Khan 2022). The gap between the two may be attributed to affordability constraints, i.e., affordability can limit effective access even where physical access exists (ESMAP & World Bank 2015; Fankhauser & Tepic 2007).

5 | Scope

The scope of this study is defined at three levels: geographical area, target group and type of clean cooking energy. Geographic coverage is at the national level, with the data disaggregated as much as possible between urban and rural areas and the 26 regions of Mainland Tanzania. The target group is the household with data disaggregated across different socio-economic groups, such as gender and income quantiles, when

available. The types of cooking energy analyzed are electricity, LPG, natural gas, solar and biogas. It is worth noting that the discussion of natural gas and LPG could not be separated in some parts of the analysis due to the nature of the available data, specifically, the national census data, which combines these two energy sources under a single category of 'gas' (URT 2024b).



Photo credit: Burn

6 | Methodology

6.1 Data collection

Data collection for this study involved a document review and key informant interviews (KIIs) conducted with representatives of three state stakeholders: Tanzania Electric Supply Company (TANESCO), Energy and Water Utilities Regulatory Authority (EWURA) and Tanzania Petroleum Development Corporation (TPDC). The document review covered census data provided by the National Bureau of Statistics (NBS), various

government reports, as well as reports from international organizations. Academic and grey literature also offered important insights that informed the study's analysis.

6.2 Data analysis

Table 1 presents the methodologies for data analysis used by the study team for each of the five dimensions assessed.

TABLE 1: METHODOLOGIES FOR DATA ANALYSIS

Dimension	Methodology for data analysis
Reliability	<p>Information on the reliability of the clean cooking energy is discussed descriptively with data drawn from existing literature. For electricity, reliability indices from EWURA are presented (EWURA 2025a). The indices are:</p> <ol style="list-style-type: none"> 1) SAIFI, which measures the average number of interruptions each customer experiences annually; 2) SAIDI, which measures the average outage duration in minutes that each customer experiences annually; 3) CAIDI, which measures the average duration in minutes that each outage lasts. <p>High values in these indices would suggest frequent and prolonged power interruptions, which can undermine the practicality of electricity as a dependable cooking energy source. Rather than relying on quantitative performance metrics, the reliability analysis for the remaining clean cooking energy sources drew on qualitative data: biogas was assessed through a synthesis of evidence from documentation, solar through descriptive and literature-based analysis, and natural gas and LPG through policy and regulatory review.</p>
Affordability	<p>Differences in affordability between the five energy sources are computed using the NPV of all cash outflows in using the cooking energy. NPV equals total cash costs incurred over 10 years (upfront, annual maintenance, and recurrent costs) discounted at 8 percent to compare the NPV for each energy option.</p> <p>The lower the NPV, the more affordable the energy option over the planning horizon. The key assumption in the model is a 10-year horizon, 8 percent discount rate, energy escalation varying from zero (base case) to varying percentages between the cooking energy options and zero salvage value. For inflation, the September 2025 inflation rate for the Consumer Price Index (CPI) category "Energy, Fuel and Utilities" of 3.7 percent was applied as the cost/tariff escalation rate (URT 2025).</p>
Equitability	<p>Disaggregated adoption rates were analyzed for Mainland regions, gender of household head and location (rural versus urban) when data were available.</p>
Accessibility	<p>Adoption rates are used as proxies for accessibility of the five energy sources. For electricity, however, the assessment of accessibility is extended beyond adoption rates to also include physical accessibility (grid system) and connectivity rates. The latter is particularly important, as grid access does not necessarily translate into household connections; electricity may be physically available in an area, yet households remain unconnected due to cost, infrastructure or other constraints.</p>

7 | Findings

The findings are presented for each of the five dimensions analyzed by the study. To begin, Table 2

summarizes the key findings for each energy source for each dimension.

TABLE 2: SUMMARY DASHBOARD OF FINDINGS

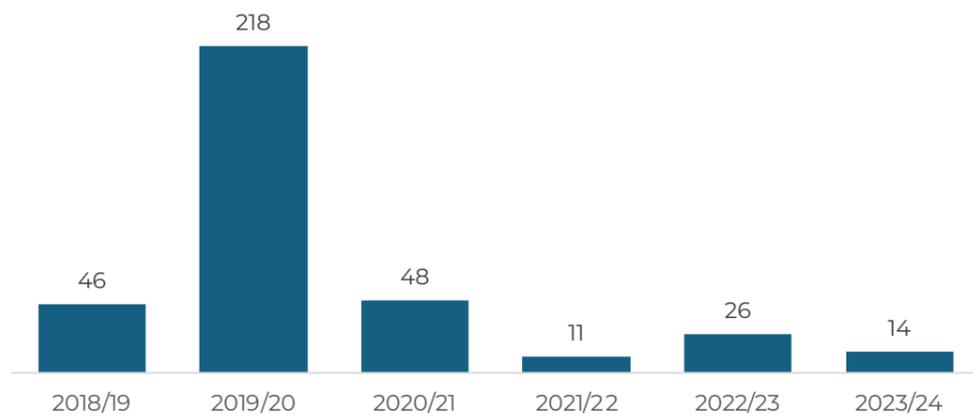
Dimension	Electricity	LPG	Natural Gas	Solar	Biogas	Highlights
Scalability	Medium to high	High	Medium	Low	Medium	LPG market growing rapidly; electricity expansion limited by last-mile connectivity; solar and biogas constrained by cost and niche contexts.
Affordability	Medium to high	Low	Medium	High	Low to medium	Solar is most affordable with no recurrent energy cost; electricity moderately affordable; natural gas medium; LPG least; biogas high upfront cost.
Accessibility	Medium	High (urban-biased)	Low to medium	Low	Low	LPG is widespread in cities but has limited rural reach; grid access for electricity is improving but connection lag persists; solar and biogas adoption rates are less than 3 percent.
Reliability	Medium	High	NA	Low	Medium	LPG supply stable; electricity grid improving but unstable in rural areas; solar depends on weather and technology.
Equitability	Low	Low	Low	Low	Medium	LPG and electricity concentrated in urban, higher-income areas; solar limited by technology and awareness; biogas potential in livestock-rich zones but minimal outreach.

7.1 Reliability

7.1.1 Electricity

System Average Interruption Frequency Index (SAIFI) spiked significantly to 218 interruptions in FY 2019/20; a rate close to 5 times higher than the previous year (Figure 1). Positively, SAIFI improved significantly in the two following years, dropping to 11 interruptions in FY 2021/22, pointing to a marked improvement in service reliability.

FIGURE 1: TREND IN SAIFI - NATIONAL LEVEL AVERAGES



Source: EWURA (2025a)

Data for 2023/24 indicate a wide variation in SAIFI across regions, from 93.07 interruptions in Tabora region to just 10.53 in Ilala region (Table 3). Regions with weak reliability include Tabora, Manyara, Simiyu and Shinyanga. These regions recorded more than 50 interruptions per customer per year in 2023/24, suggesting critical reliability concerns.

SAIFI has stabilized in recent years with small fluctuations. However, the slight rise from 11 in FY 2021/22 to 26 in FY 2022/23, before falling again to 14 in FY 2023/24, indicates that challenges remain in fully stabilizing the system. When compared to the neighbouring countries of Rwanda and Kenya, Tanzania recorded relatively lower SAIFI scores (see Annex 1).

The data also point to a persistent urban–rural divide in the quality of electricity service. Urban areas like Ilala and Dodoma experienced relatively low interruptions (around or below 15). In contrast, higher SAIFI values are largely concentrated in rural or semi-urban regions (e.g., Manyara and Simiyu).

TABLE 3: KEY OBSERVATIONS ON THE REGIONAL SAIFI DATA FOR 2023/24

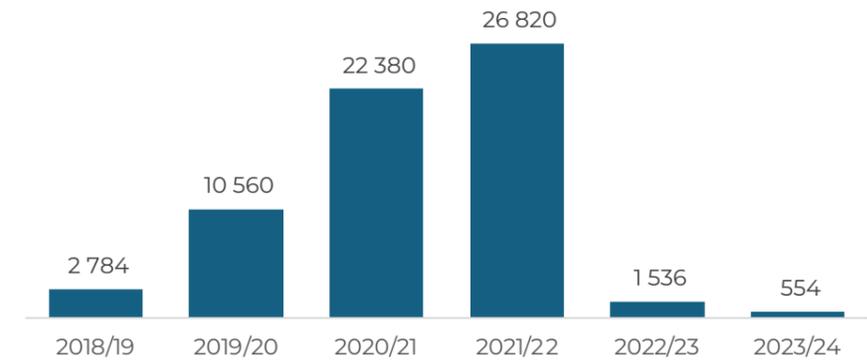
High SAIFI (Most interruptions)		Low SAIFI (Fewer interruptions)	
Tabora	93.07	Ilala	10.53
Manyara	84.30	Ruvuma	10.57
Simiyu	58.65	Kilimanjaro	11.31
Shinyanga	54.42	Dodoma	11.81
Mwanza	45.13		

Source: EWURA (2025a)

System Average Interruption Duration Index (SAIDI) The data reveal a significant deterioration in reliability between FYs 2018/19 and 2021/22, followed by a marked improvement in the two most recent years (Figure 2). During those four years, the System Average Interruption Duration Index rose by almost 10 times from 2,784 to 26,820 minutes. This period was followed by a dramatic improvement with the SAIDI declining by 98 percent from 26,820 minutes

in 2021/22 to 554 minutes in 2023/24. This is a significant achievement and is broadly consistent with international reliability benchmarks, which consider SAIDI levels below 100 hours (or 6,000 minutes) per year to be acceptable (African Development Bank 2022). Nevertheless, compared with neighboring Rwanda and Kenya, Tanzania still recorded relatively higher SAIDI levels (Annex 1).

FIGURE 2: TREND IN SAIDI - NATIONAL LEVEL AVERAGES



Source: EWURA (2025a)



Photo credit: Modern Cooking Facility for Africa

Data for 2023/24 show substantial regional disparities in the duration of electricity outages. The gap between Rukwa (4,228 minutes) and Kinondoni Kusini (106 minutes) represents a 40-fold difference in outage duration, underscoring major equity and performance

disparities across the electricity network (Table 4). Regions such as Singida, Tanga and Geita show SAIDI values between 800 and 1,300 minutes, indicating intermittent but noticeable reliability issues.

TABLE 4: KEY OBSERVATIONS ON REGIONAL SAIDI DATA, 2023/24

Longer outage durations (Higher SAIDI in minutes)		Shorter outage durations (Lower SAIDI in minutes)	
Rukwa	4,228	Kinondoni Kusini	106
Tabora	3,529	Kilimanjaro	194
Morogoro	2,949	Ilala	199
Kigoma	2,518	Dodoma	210
Songwe	2,296	Ruvuma	221

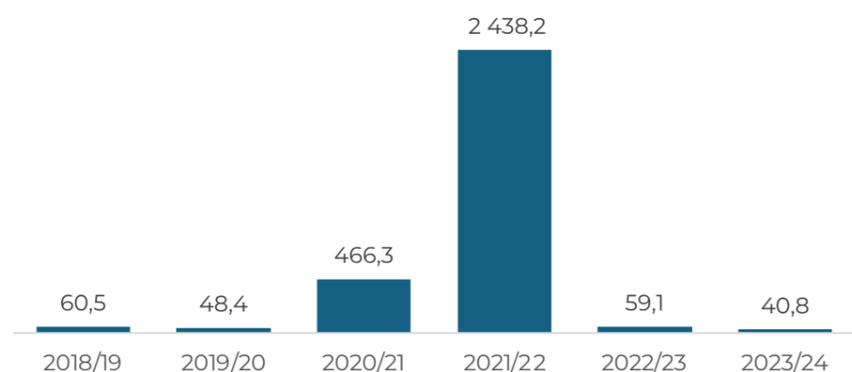
Source: EWURA (2025a)

Customer Average Interruption Duration Index (CAIDI)

Over the six-year period from 2018/19 to 2023/24, CAIDI values reveal a pattern of sharp deterioration between 2018/19 and 2021/22 followed by a strong recovery (Figure 3). A dramatic rise in the duration of interruptions occurred between 2020/21 and 2021/22 from 466.3 minutes (nearly 8 hours) peaking at 2,438.2 minutes (over 40 hours).

This period was followed by significant recovery, with CAIDI dropping sharply to 59.1 minutes in 2022/23, returning close to pre-crisis levels. By 2023/24, it had improved further to 40.8 minutes, indicating that outages became shorter and more manageable. Regional comparison points to higher CAIDI scores for Tanzania relative to the neighbouring countries of Rwanda and Kenya (Annex 1).

FIGURE 3: TREND IN CAIDI - NATIONAL LEVEL AVERAGES



Source: EWURA (2025a)

Again, data show significant regional variations. Morogoro, Songwe, Iringa, Rukwa and Mbeya top the list with CAIDI values above 90 minutes (Table 5). This means each power interruption in these regions lasts between 1.5 and 2.2 hours on average. Regions like Tabora, Simiyu, Mwanza, Temeke and Geita show moderate outage durations per incident (30-40 minutes), pointing to average restoration speed (i.e.,

bringing electricity back after an outage happens). The urban-rural divide persists as well. Urban districts generally have shorter interruptions per incident (e.g., Kinondoni: 6.58 minutes), while rural and interior regions struggle with prolonged downtime (e.g., Songwe: 110.21 minutes), reinforcing the need for equity-focused infrastructure investment.

TABLE 5: KEY OBSERVATIONS ON REGIONAL CAIDI DATA

Longer average outage per interruption (in minutes)		Shorter average outage per interruption (in minutes)	
Morogoro	131.7	Kinondoni Kusini	6.58
Songwe	110.21	Manyara	10.74
Iringa	103.1	Coast	14.03
Rukwa	96.74	Lindi	15.9
Mbeya	93.31	Kilimanjaro	17.14

Source: EWURA (2025a)

7.1.2 Natural gas and LPG

For LPG, there have been no reports of supply reliability issues (e.g., import delays) for cylinders filled with LPG in the local markets. To enhance supply security and ensure market stability, sector regulations require LPG importers and distributors to maintain a minimum stock that is equivalent to 15 days of average consumption. The 15-day stock buffer has helped cushion the market against potential disruptions in the international supply chain, port congestion or logistical delays that could otherwise lead to shortages or price volatility. Compliance with this regulation is monitored through regular reporting and inspections. This measure is part of a broader strategy to promote reliability and resilience in the LPG supply chain as demand continues to grow.

For natural gas, EWURA's annual natural gas performance reports do not include reliability metrics for pipeline-based natural gas supply to consumers (EWURA 2025b). Other countries have applied SAIDI, SAIFI and CAIDI style metrics, for example, those

adopted by the Council of European Energy Regulators (CEER). These metrics require per-customer or per-meter interruption records, and timestamp logs of supply interruptions, durations, affected customer counts, volume shortfall, etc. Natural gas companies would also need adequate Supervisory Control and Data Acquisition (SCADA)/telemetry/smart metering or logging systems to capture interruptions and flow disruptions.

7.1.3 Solar

Reliability in solar cooking is an engineering as well as context-related challenge. Solar energy offers a free source of heat for cooking, yet meals are often prepared at times when sunlight is unavailable, such as in the evening, or in places where sunlight cannot easily be used, like indoors. While technology has advanced in terms of reliability, the main challenge for these solutions is that they are more complex and unaffordable. For instance, Thermal Energy Storage (TES)⁴ units cost about USD 300 each, which is unaffordable for low-income earners [Smart Villages Research Group (SVRG) 2020].

⁴ TES units integrate storage materials into solar cookers to capture and retain heat from the sun, allowing for cooking during sunless periods like night or cloudy weather (Lentswe, Mawire and Shobo, 2021).

In Tanzania, projects have piloted systems that use less optimal, less complex but much more affordable components. For example, Modern Energy Cooking Services (MECS) and Smart Villages Initiative Limited have tested low-cost thermal storage cooking systems that use local materials to assess their performance. However, the results were not encouraging as these systems lost up to 50 percent of stored heat within four hours.

The main technical barrier lies in collecting and retaining sufficient solar energy efficiently, as locally built concentrators⁵ were large and impractical for household use (SVRG 2020). The overall conclusion is that while technology has advanced, they remain unaffordable to low-income earners. Consequently, this population is confined to technology with functionality that is weather dependent. Consequently, day-to-day reliability is limited (Mosses et al. 2023).

7.2.4 Biogas⁶

Tanzania and Sub-Saharan Africa in general maintain favourable conditions for biogas technology, including a suitable tropical climate, a dominance of agricultural activities, and interest in alternatives to expensive conventional energy services. In Tanzania, the populations of the northern regions of Arusha, Kilimanjaro and Manyara are predominantly livestock farmers and have been the targets for projects promoting household biogas use for cooking. Substantial investments by public, private and third-sector actors have driven the rapid expansion of biogas systems for cooking in Tanzania. Improved technology is addressing most of the reliability challenges and the country has an expanding network of suppliers for maintenance and operational know-how, particularly targeting institutional users. Globally, ongoing research is aimed at improving performance stability and developing “smart biogas systems” that incorporate sensors, remote monitoring and control systems. These



⁵A solar concentrator is a technology that enhances the efficiency of solar energy systems by focusing sunlight onto a small area to generate intense heat. Utilizing mirrors or lenses, solar concentrators have evolved from ancient applications, such as the use of convex lenses, to modern designs that include parabolic dishes, Fresnel reflectors, troughs and solar towers. These systems can be paired with photovoltaic cells to improve energy production or used to create steam for electricity generation. Notably, parabolic dishes function similarly to satellite dishes, while solar troughs can heat a working fluid, and solar towers utilize a field of reflectors to generate high temperatures efficiently (EBSCO 2024).

⁶Some details in the biogas section are sourced from Rupf et al. (2015) and Hewitt et al. (2022).

systems aim to detect anomalies early, thereby reducing downtime or failures. However, adoption of these advances in the field, especially among small household installations in Tanzania, is still uneven, and core challenges remain.

7.2 Accessibility

Adoption rates tend to reflect economic constraints. Households adopt the cooking energy sources they can afford. Thus, differing adoption rates across sources of cooking energy largely reflect variations in economic accessibility.

Overall, clean cooking energy remains largely inaccessible in Tanzania. The most recent data estimate that only 15.9 percent of households in Tanzania use clean cooking energy sources (2.19 million out of the 13.78 million households) (URT 2022). Accessibility is also highly uneven by location; 30.0 percent of urban households use clean cooking energy compared to just 6.7 percent of rural households (Table 6).

TABLE 6: ACCESSIBILITY RATES (PROXIED BY ADOPTION RATES)

	Rural	Urban	National	Rural	Urban	National
	% of households			No. of households		
Electricity (TANESCO)	1.3	8.6	4.2	108,628	466,205	578,633
Solar	3.2	1.4	2.5	267,392	75,894	344,424
Gas (LPG and natural gas)	2.1	19.9	9.1	175,476	1,078,776	1,253,705
Biogas	0.1	0.1	0.1	8,356	5,421	13,777
Total	6.7	30.0	15.9	559,851	1,626,295	2,190,539

Source: URT (2022)

LPG and natural gas⁷ have the highest uptake among clean cooking energy sources at 9.1 percent of households (around 1.25 million) in Tanzania. However, these two energy sources displayed the largest urban-rural gap among clean cooking energy sources; LPG and natural gas were used by 19.9 percent of urban households compared with only 2.1 percent of rural households. LPG specifically is highly preferred in some parts of Tanzania. For example, one area-based study found that 83 percent of households in four villages in Shirati, Rorya district in Mara region, used a mix of firewood, charcoal, LPG and/or kerosene (fuel stacking) for cooking but about 82 percent of respondents

expressed a preference for LPG (Gill-Wiehl et al. 2023). To advance accessibility, the Government of Tanzania, through the Finance Act, 2025 has exempted various components of clean cooking energy sources from value-added tax (VAT), such as LPG gas tanks or cylinders for cooking, solar panels, modules, solar charger controllers, solar inverters, solar lights, vacuum tube solar collectors and solar batteries (specifically designed for exclusive use in storage of solar power). However, as outlined in Table 7, several challenges continue to affect accessibility of natural gas for cooking.

⁷The discussion on accessibility to LPG and natural gas cannot be separated, as the two energy sources are reported jointly in census data, making it difficult to analyze them separately.

TABLE 7: CHALLENGES ASSOCIATED WITH ACCESSIBILITY OF NATURAL GAS FOR COOKING

Challenges	Discussion
1. Limited reach for the natural gas pipeline	The natural gas pipeline currently serves only 3 out of the 26 Mainland regions (Lindi, Mtwara and Dar es Salaam) and as of June 2025, only 1,514 households were connected to the pipeline. This limits access in underserved regions, reinforcing inequality in access to clean cooking energy.
2. Design limitations for the natural gas pipeline	The original design overlooked households situated along the pipeline corridor. Pipeline adjacency does not ensure access, because only households near a service tap (exit point) can connect.
3. High cost of accessories	While pipelines are locally manufactured, most essential accessories such as pressure reduction systems and meters are imported. The high cost of these components presents a significant barrier to household-level adoption of natural gas.
4. Inadequate coordination among utility stakeholders	The Memorandum of Understanding (MoU) among utility service providers to guide the coexistence of pipeline infrastructure remains in its infancy. Limited coordination continues to hinder timely and conflict-free installation of gas pipelines.
5. Regulatory delays and vested interests	The process of releasing pricing and third-party access regulations is often time-consuming. The delays discourage private investment and are perceived to be influenced by vested interests, undermining investor confidence.
6. Disputes in pricing methodologies	Variations in views persist over the approaches to regulate natural gas pricing, particularly among major consumer groups such as industries and TANESCO. These variations largely reflect differences in operational models and consumption patterns.
7. Public perception and safety concern	Many households remain skeptical about the safety of using natural gas for cooking, citing fears of accidents. These perceptions, often based on limited knowledge or negative past experiences, hinder broader adoption.
8. Households lacking designated space for cooking	More prevalent in rural areas where households lack designated kitchen rooms, which is a technical precondition for connection as necessitated by safety and installation requirements.

After gas, electricity ranks second in terms of economic accessibility for cooking. It is currently used by an estimated 4.2 percent of households with significantly higher usage in urban areas (8.6 percent) compared to rural areas (1.3 percent). This low adoption of electricity for cooking persists despite the fact that, as of 2019/20, the national grid reached 78.4 percent of households, and 37.7 percent of households were connected to electricity (Annex 2a and 2b).

Biogas has extremely low accessibility at 0.1 percent (less than 14,000 households) but access was the most equitably distributed of the five energy sources by location. Usage of solar energy is also extremely low, with only 2.5 percent of households using it for cooking. As with other clean cooking energy sources, a marked disparity in access between urban and rural areas persists; an estimated 1.4 percent of urban households used solar energy in 2022 compared to 3.2 percent of rural households.

Public awareness of solar as an energy source for cooking is widespread. However, several factors discourage successful adoption, including the high price of solar cookers, limited knowledge and experience on the use of technology, weather dynamics,

slow cooking times for staple foods, inability to cook at night, fluctuations in weather conditions and cultural norms that discourage outdoor cooking. There are also health-related constraints as the reflective surfaces of solar cooker panels can cause eye strain and headaches for users.⁸

7.3 Scalability

7.3.1 Market potential

Table 8 presents data on the market potential of clean energy based on trends in the adoption rates between 2012 and 2022 for the four clean cooking energy sources. Optimistically, a nearly ten-fold increase in the number of households using clean cooking energy was recorded over the decade from 223,513 households (2.5 percent of households) to 2,182,979 households (15.9 percent of households) which demonstrates some commitment and success in expanding access to clean cooking energy. However, if the national strategy target of 80 percent is to be achieved by 2034, it will require average annual gains of 5.3 percentage points, which is close to a four-fold increase over the annual 1.34 percentage points achieved over the period from 2012 to 2022.

TABLE 8: GROWTH IN ADOPTION RATES BETWEEN 2012 AND 2022

	Adoption rate (%)		Change in rate (%)	No. of households 2012		Absolute growth
	2012	2022		2012	2022	
Electricity	1.5	4.2	+2.7	135,763	575,982	+440,219
Solar	0.1	2.5	+2.4	5,772	340,153	+334,381
LPG	0.9	9.1	+8.2	78,709	1,254,229	+1,175,520
Biogas	0.0	0.1	+0.1	3,275	12,615	+9,340
Total	2.5%	15.9	+13.4	223,519	2,182,979	+1,959,460

Source: URT (2012 and 2022) and researchers' calculations.

⁸ These findings are based on data reported by Mosses et al. (2023), which focused on two areas in southern Unguja and the Kilimanjaro region. As such, caution should be exercised in generalizing the results to the national level.

Despite progress to date, over 84 percent of households (or 11.6 million households) still lack access to clean cooking solutions. As shown in Annex 4, the vast majority of these households use biomass options for cooking, principally firewood and charcoal. In marketing terms, this implies that the market for clean cooking energy remains largely untapped, but it is unrealistic to expect that clean cooking energy solutions will capture this entire market in the short term. Rather, the large share of biomass users implies that the transition will be gradual and need to accommodate more efficient/improved biomass technologies, such as efficient stoves, briquettes and the sustainable harvesting of timber. Integrating these technologies into transitional processes will help bridge the access gap before full modernization.

The pace of transition is further complicated by the sector's significant livelihood footprint, particularly in rural areas, where many households depend on charcoal production and the wood-fuel trade for jobs and cash income. Along the Morogoro–Dar es Salaam corridor, for example, charcoal operates as the main cash crop wherever road access is adequate. In such an area, typical household cash earnings range from USD 176 to USD 645 per year, with about 75 percent of farmers in charcoal producing zones identifying charcoal as an important income source (Malimbwi & Zahabu n.d.). A 2024 study estimated that Tanzania's charcoal value chain employs roughly two million people (William & Nyamoga 2024).

Among clean cooking energy sources, LPG has been the primary driver of increased adoption, with household usage rising from just 0.9 percent (approximately 78,709 households) in 2012 to 9.1 percent (over 1.2 million households) in 2022. LPG contributed over half (57.2 percent) of the growth in clean cooking energy usage over the period. Solar energy has demonstrated

similar strength (a 60-fold increase in household adoption) though starting from a low base. However, biogas adoption remains minimal, with marginal growth and usage still below 0.1 percent of households.

The issue of scalability in clean cooking energy is inherently intertwined with affordability, as financial constraints significantly influence the potential for large-scale adoption. On the production side, a major barrier lies in the high upfront investment required for LPG cylinders, which discourages rapid market expansion. This challenge is exacerbated by the low cylinder turnover ratio, which lengthens the payback period and diminishes the return on investment for suppliers.⁹ On the consumption side, households also face significant initial costs, particularly in purchasing LPG cylinders and accessories. This cost sensitivity has made the 6 kg cylinder more popular, as it is more affordable and has a faster turnover compared to larger cylinders. Overall, the average LPG consumption per capita in Tanzania remains as low at 3.5 kg per annum relative to, for instance, 7.0 kg in Kenya and 38 kg in Brazil per annum.¹⁰ These metrics signal substantial room for scalability, but only if such cooking energy is affordable, reliable and user-friendly.

Despite its significant potential to accelerate scalability of clean cooking, LPG is entirely imported, unlike other energy sources that are locally produced. This reliance on imports exposes the sector to external supply and price shocks, exchange rate fluctuations and logistical vulnerabilities. From a cooking energy security perspective, it is therefore important to promote a balanced energy mix in which locally produced alternatives play a dominant role to enhance resilience and reduce dependency on external markets.

Institutions are also increasingly providing a strong market for scaling clean cooking solutions. For

example, a number of institutions have adopted biogas technology with varying efficiency rates,¹¹ including the International School of Tanganyika (Efficiency rate: 94-99 percent); Mburahati Decentralised Wastewater Treatment Systems (DEWATs) (Efficiency rate: 82-98 percent) and Comprehensive Community-Based Rehabilitation in Tanzania (CCBRT) (Efficiency rate: 82-100 percent) (Tarimo et al. 2024).

Ongoing efforts in that area include Rural Energy Agency's (REA) Clean Cooking Support Programme which has issued grants to support clean cooking infrastructure in public and private institutions that serve more than 100 people per day. As of April 2025, beneficiaries include

the Tanzania Prisons Service and the National Service (Jeshi la Kujenga Taifa (JKT)). JKT training camps and prison institutions have begun using clean cooking energy. Moreover, 100 secondary schools have been fitted with clean cooking systems with plans ongoing to reach more schools.

7.3.2 Supplier availability, distribution network and infrastructure

Table 9 presents information for clean cooking energy across three scalability dimensions: supplier availability, distribution network and infrastructure sufficiency.



Photo credit: Unsplash | Raghav Modi

⁹ The turnover ratio in LPG cylinder investments generally refers to how frequently the cylinders are reused (filled, distributed and returned) within a given period, usually annually. It is a critical indicator for assessing the commercial viability, cash flow and return on investment (ROI) in LPG cylinder assets.

¹⁰ Tanzania data sourced from the interview for this study with the representative of EWURA; Kenya data from Energy and Petroleum Regulatory Authority (2024); Brazil data from Brandstaetter (2017).

¹¹ Efficiency rate refers to how well the biogas system performs at its intended job, expressed as a percentage. For example, an efficiency rate of 95-99% would mean the system is operating very effectively, that is, in removing and/or processing almost all of the targeted waste load (or achieving near-complete conversion).

TABLE 9: LIKERT SCALES ON SUPPLIER AVAILABILITY, DISTRIBUTION NETWORK AND INFRASTRUCTURE AND/OR TECHNOLOGY REQUIRED

	Supplier availability	Distribution network	Infrastructure/technology sufficiency		Supplier availability	Distribution network	Infrastructure/technology sufficiency
	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High		1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High
Electricity	High	High	Moderate to high	LPG	Moderate	Low to moderate	Low
	<p>The capacity of electricity generation plants connected to the national grid increased from 1,601.84 megawatts (MW) in 2020/21 to 4,031.71 MW in April 2025, representing a growth of 151.7 percent (Annex 5) [Ministry of Energy (MoE) 2025]. The peak electricity demand in the national grid has continued to increase, reaching 1,921.44 MW in April 2025 (MoE 2025).</p> <p>By 2022/23, in addition to TANESCO, there were another 8 entities conducting generation activities; 14 licensed entities generating electricity for their use; 3 entities generating electricity for sale in bulk to TANESCO; and 4 registered entities generating and selling electricity to customers from solar photovoltaic through mini grids (EWURA 2025a).</p>	<p>Grid access expanded from 67.5 percent in 2016/17 to 78.4 percent in 2019/20. The most significant gains were recorded in rural areas, where access increased by 20.5 percentage points, from 49.3 percent to 69.8 percent, driven by targeted rural electrification programmes (EWURA 2025a).</p> <p>Urban areas, by contrast, now enjoy near-universal access.</p>	<p>Although the grid reaches many areas, the last-mile infrastructure (such as transformers, service lines and low-voltage connections) is often inadequate or delayed. Moreover, the cost of internal wiring is also a significant expense unaddressed by the existing subsidy scheme, exceeding the cost of grid connection by seven-fold (Ruhinduka et al. 2025).</p> <p>As a result, despite improvements in access, actual household connectivity remains relatively low. By 2019/20, only 37.7 percent of households were connected to electricity, up modestly from 32.8 percent in 2016/17, a gain of just 5 percentage points. The connectivity gap is especially pronounced in rural areas, where only 24.5 percent of households were connected despite 69.8 percent having access. In contrast, urban connectivity improved from 65.3 percent to 73.2 percent, reflecting stronger uptake in areas with better infrastructure and higher income levels (EWURA 2025a).</p>		<p>Major suppliers include Oryx Energies, Lake Oil Group, Taifa Gas, Puma Gas, Manjis Gas Supply Company Limited, Lake Gas Limited and Total Energies. There exists a network of retailers, including small-scale vendors and branded outlets, responsible for selling LPG cylinders and related accessories to end users. They are, however, concentrated in urban areas.</p>	<p>The number of LPG distributors and retailers is expanding but mostly in urban areas. Despite these developments, the LPG market remains constrained by high investment costs in warehouses and distribution vehicles.</p> <p>Moreover, licensing requirements stipulate that prospective importers must have their own storage facilities, which presents a significant capital barrier and limits the entry of new players into the market. Ongoing progress includes the construction of an LPG cylinder production facility, which is expected to produce two million cylinders annually (The Citizen 2025).</p> <p>These challenges also present opportunities for scalability, including the expansion of the LPG distribution network and potential regulatory reforms, such as allowing investments in storage facilities that can be rented by importers, thereby lowering entry barriers and fostering greater competition in the market.</p>	<p>Currently, the Port of Dar es Salaam does not have sufficient capacity for receiving LPG. The port can only accommodate one vessel of up to 5,000 metric tonnes (MT) at a time, while the demand is approximately 17,000 MT, requiring 3 to 4 cargo ships at a time to meet demand. This capacity is far below that of ports in neighbouring countries. In addition, Tanzania has only 37 LPG refilling plants across the country, with a combined capacity of 2,214 MT, which is insufficient to meet growing demand, particularly in rural areas, where access is even more limited.</p> <p>Ongoing efforts are being made to address the gap, including the construction of the LPG Terminal Project in Tanga with a capacity of 40,000 cubic meters. The project is designed to accommodate Very Large Gas Carriers (VLGCs), which are currently unable to dock at Tanzanian ports (TanzaniaInvest 2025).</p>

	Supplier availability	Distribution network	Infrastructure/technology sufficiency
	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High
Natural Gas	Low	Low	Low
	Despite abundant availability of natural gas, the primary supplier of piped natural gas to households and institutions in Tanzania is TPDC. In 2023/24, the Corporation supplied a total of 6.66 million standard cubic feet (MMscf) to households and institutions (EWURA 2025b). The high investment cost of infrastructure is the leading barrier to crowding in private capital.	<p>The pipeline distribution network for natural gas is limited, available in three out of 26 regions (EWURA 2025b).</p> <p>The three distribution networks are: 1) Mtwara from Ground Reaction Force - Pressure Reduction Station (GRF-PRS) in Mtwara town which supplies residential houses in Mtwara; 2) Lindi from Block Valve Station-3 (BVS-3) PRS in Ruaha village to residential houses in Mnazi Mmoja; and 3) Dar es Salaam from BVS-15 PRS at Ubungo to Mikocheni Industrial area, University of Dar es Salaam (UDSM), Sinza and Mbezi trunkline (EWURA 2025b).</p> <p>Only 1,514 households (less than 0.1 percent of the households) and 15 institutions (hotels and universities) are currently connected to the natural gas pipeline (Annex 6) which is far below the potential of 13.78 million households in Tanzania (URT 2024b). In Dar es Salaam, only 880 out of 1,537,293 households (0.06 percent) are connected; in Mtwara, 425 out of 491,811 households (0.09 percent); whereas in Lindi, it is only 209 out of the 344,447 households in the region are connected to the natural gas network.¹²</p>	<p>The coverage of the existing pipeline and its design points to the need for significant investment in infrastructure to expand reach to households. The Government is currently designing the clean cooking energy fund. Once established it is expected that the fund will facilitate investments in the natural gas pipeline infrastructure.</p>

¹² These data were sourced from the interview for this study with the representative of TPDC.

	Supplier availability	Distribution network	Infrastructure/technology sufficiency
	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High	1 = Low; 2 = Moderate; 3 = High
Solar	Low	Low	Low
	There are few suppliers of the technology, with their presence largely confined to localized pilot projects. However, the energy supply potential is high, as Tanzania benefits from abundant and consistent solar radiation. Most regions enjoy 2,800-3,500 sunshine hours per year and roughly 90 percent of Tanzania falls into zones with high solar radiation, averaging 4.5 to 5.4 kWh/m ² /day with monthly average temperatures of 20-24 degrees Celsius (°C) (Villema et al. 2018).	There is limited distribution and maintenance network of solar systems particularly in remote areas (Leary et al. 2019).	While sunshine is free, the high upfront cost of solar cookers and imported components constrain scalability. The Photovoltaic (PV)-eCook system, which is more practically efficient than, for instance, the solar thermal cooking (e.g., works anytime), consists of several pieces of equipment including the PV array, charge controller and battery (Leary et al. 2019). Most low-income households cannot afford such systems without subsidies.
Biogas	High	Moderate	Moderate
	Biogas technology has been promoted in Tanzania for many years by many entities from the Government, academia and non-government organizations (NGOs). During that period a substantial network of suppliers and support service providers has been established.	There is limited distribution and maintenance network of biogas systems (after-sales support), particularly in remote areas (Tanzania Petroleum 2024). This is in contrast with energy such as LPG that have established supply chains.	While sunshine is free, the high upfront Significant improvement in the technology and infrastructure associated with biogas cooking facilities. Substantial infrastructure and upfront investment at the household level remains a constraint (MoE 2025). Households must construct or install a biodigester ¹³ (often an underground tank or prefabricated reactor), connect it to their kitchen via piping, and ensure a steady supply of feedstock (such as livestock manure and water). The high initial installation cost and complexity have been a key barrier to adoption.

¹³ The biodigester is the core “biogas factory” at the household level. It takes in feedstock (e.g., livestock manure mixed with water, sometimes food waste), processes the material to generate gas, which is delivered, through pipes, to the stove.



Photo credit: Unsplash | Marco Haensgen

7.4 Affordability

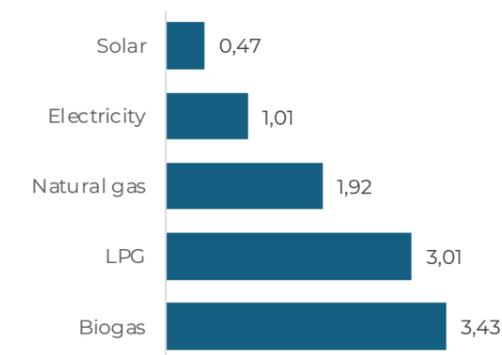
Solar emerges as the most affordable option, followed by electricity, natural gas, LPG and finally biogas, which is the least affordable (Figure 4). Solar is the most affordable because it has no recurring energy costs and only modest annual maintenance, yielding a very low NPV. Electricity has a mid-range upfront cost (lower than solar and biogas, higher than natural gas and LPG) but remains more affordable than LPG, natural gas and biogas. Biogas requires a high upfront investment to install the biodigester but has low ongoing costs. LPG usage requires continuous energy purchases, making it the costliest option based on current monthly expenditure.

However, affordability changes when tariff escalation is applied. In this case, the affordability of LPG and natural gas deteriorates by a larger percentage (15 percent increase in NPV from the base case) relative to the other energy sources (e.g., 9 percent and 4 percent for electricity and biogas respectively) (Figure 5). Thus, energy sources with high monthly recurrent costs become less affordable once price hikes are factored in. Upfront and recurrent energy costs also have different

implications for affordability when considering household cash pressures over the short or long term. In the short term, upfront cost is the key barrier, specifically for electricity, solar and biogas. These energy sources are the hardest to adopt despite good lifetime costs, especially for solar and electricity. In contrast, LPG and natural gas are more affordable in the short term if households can manage recurrent expenditure, as these sources have higher monthly outflows but lower upfront costs. For biogas, the risk shifts to the upfront finance and maintenance costs rather than monthly tariff volatility. Over the long-term, LPG and natural gas are the costliest due to recurrent costs (base case scenario¹⁴). Any inflation in LPG prices worsens the affordability of this energy source (see the sensitivity test results).

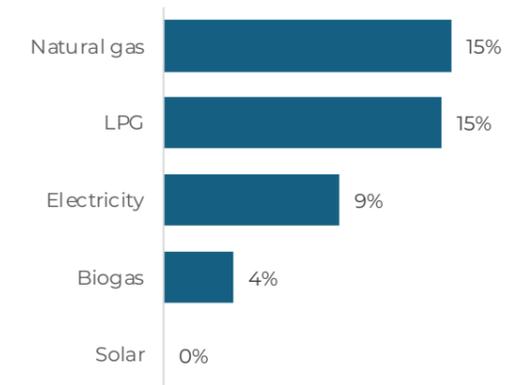
In the absence of concessional financing or targeted subsidies for equipment, the analysis indicates that low-income households may face an affordability trap, i.e., be steered toward higher-NPV (costlier over time) fuels simply because they cannot afford the upfront costs for lower-NPV options. See Annex 7 for the tables used to generate the NPVs.

FIGURE 4: NPV OVER A 10-YEAR HORIZON (TZS MILLION)



Source: Various sources (See Annex 7)

FIGURE 5: INCREASE IN NPV FOLLOWING COST ESCALATION



¹⁴ Base case scenario refers to no cost escalation.

7.5 Equitability

7.5.1 Electricity

Data from the latest wave of the National Panel Survey show significant disparities in usage of electricity for cooking between different regions of Mainland Tanzania (Figure 6a). Urban and more economically developed regions, such as Dar es Salaam, Arusha and Kilimanjaro, have relatively higher percentages of households using electricity for cooking. In contrast, less urbanized regions such as Katavi, Simiyu, Rukwa, Mtwara and Songwe have much lower usage rates. Electricity usage ranged from a low of 1.1 percent (3,609 households) in Rukwa to a high of 15.7 percent (241,355 households) in Dar es Salaam.

The concentration of electricity as an energy source for cooking in just a few regions reflects disparities in infrastructure, affordability and urbanization. However, these regional disparities highlight significant opportunities for expanding electricity usage for cooking in regions with very low adoption rates, considering that other clean cooking alternatives like LPG may not be viable in the short term.

7.5.2 LPG

LPG adoption in Tanzania is heavily skewed toward urban and wealthier regions (Figure 6b). Dar es Salaam alone accounts for almost a third of all LPG-using households in Tanzania. The regional disparities are in both the absolute number and proportion of households using LPG.

Urban centres that dominate LPG usage include Dar es Salaam (31.1 percent equivalent to 478,098 households), Arusha (28.6 percent equivalent to

175,015 households) and Kilimanjaro (16.8 percent equivalent to 83,064 households), which again points to urban bias in accessibility and infrastructure. Regions with higher LPG usage tend to have higher income levels and more diversified energy markets. Rural and remote regions (e.g., Kigoma, 1.6 percent; Rukwa, 1.9 percent; and Ruvuma, 2.2 percent) show extremely low adoption rates, reflecting inequitable distribution in access, affordability and supply chain. Low usage in poorer regions signals that the initial costs of LPG cylinders, refills and cookstoves are significant barriers to adoption.

7.5.3 Solar

The use of solar energy for cooking across Tanzanian regions is low and varies across regions, with adoption rates ranging from 0.7 percent to 4.5 percent. Rural regions like Kigoma (4.5 percent or 20,339 households), Manyara (3.8 percent or 15,152 households) and Katavi (3.8 percent or 8,125 households) reported the highest percentages (Figure 6c).

Urban areas, such as Dar es Salaam (0.7 percent or 10,761 households), Kilimanjaro (1.4 percent or 6,922 households) and Tanga (0.9 percent or 5,681 households) have the lowest percentages, despite higher infrastructure and income levels in these regions. The low uptake is possibly due to better access to other energy sources, such as electricity and LPG. These data suggest that solar energy for cooking may be more feasible in off-grid areas and play a compensatory role where access to electricity and/or LPG is limited. Thus, inequities in energy choice are shaped more by contextual availability and infrastructure rather than income alone.

7.5.4 Biogas

Unlike the other clean cooking technologies, biogas shows no strong regional clustering. The use of biogas as a cooking energy source is extremely limited across all regions, with no clear geographic pattern and no region reporting usage above 0.2 percent (Figure 6d). Only a few regions register a measurable number of households using biogas.

Nine regions reported zero usage, reflecting limited biogas infrastructure or dissemination programmes. Higher biogas usage in Arusha and Dar es Salaam could be due to better awareness, higher income levels and project-based interventions. Existing capacity in these regions and also increasing usage by institutions could be leveraged, with minimal additional investment, to support the clean cooking agenda.

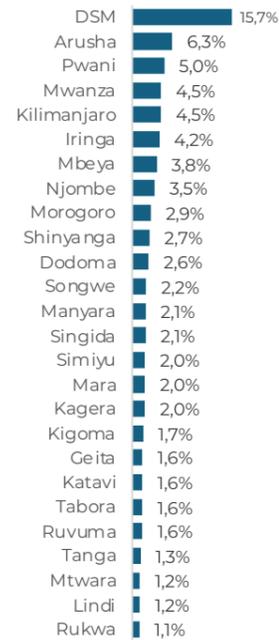
The equity concerns with biogas relate primarily to its overall unavailability rather than regional disparities, as the technology has achieved limited market penetration in the country (only 12,612 households out of 13.78 million households in Tanzania as per the 2022 survey data). The high upfront cost for biodigesters restricts adoption, especially in less wealthy and rural regions.



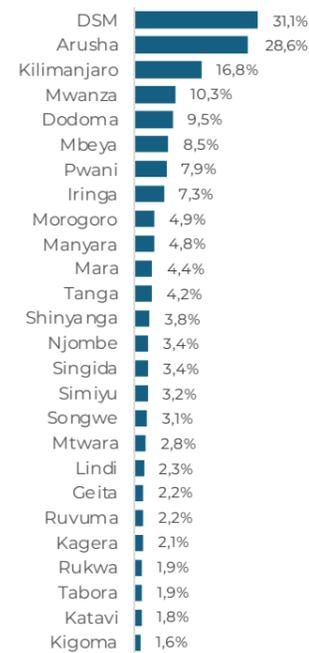
Photo credit: World Wide Fund for Nature - Tanzania

FIGURE 6: VARIATIONS IN REGIONAL USAGE OF CLEAN COOKING ENERGY (PERCENTAGE OF HOUSEHOLDS)

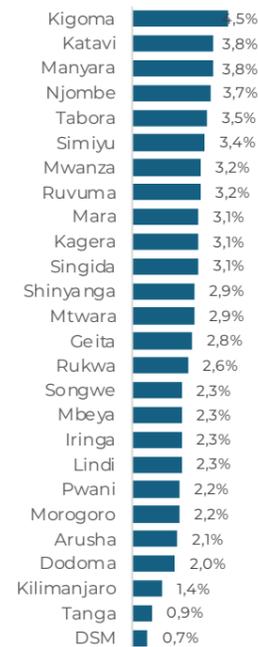
6A: ELECTRICITY



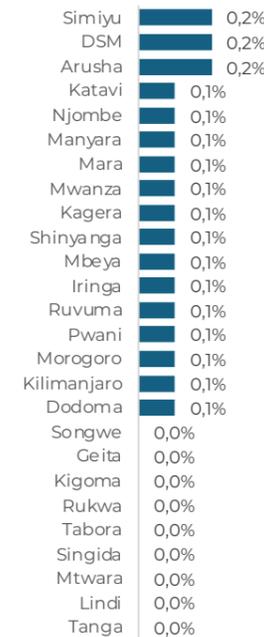
6B: LPG



6C: SOLAR



6D: BIOGAS



Source: United Republic of Tanzania (2022)

7.5.5 Adoption rates for male- versus female-headed households

Data indicate similar adoption patterns (in absolute numbers and percentages) between male- and female-headed households across all clean cooking energy sources (Table 10). The percentage differences range from 0.0 percent to 0.6 percent, indicating minimal gender disparity in clean cooking adoption rates. Both

male- and female-headed households show the same ranking of cooking options: they prefer LPG most, followed by electricity, then solar, with biogas the least preferred of the four.

The 0.6 percentage point difference in LPG adoption suggests female-headed households may struggle with higher recurring costs of LPG compared to electricity (often subsidized or more stable).

TABLE 10: ADOPTION RATES BETWEEN MALE- AND FEMALE-HEADED HOUSEHOLDS

	Male-headed households (%)	Female-headed households (%)	Gender difference
Electricity	4.1	4.3	Female-headed households slightly more likely to use electricity
LPG and natural gas	9.3	8.7	Marginally higher adoption in male-headed households
Solar	2.5	2.4	Minimal gender gap
Biogas	0.1	0.1	No gap

Source: United Republic of Tanzania (2022)

7.5.6 Disparities between urban and rural locations

Significant disparities persist between rural and urban households in the adoption of clean cooking energy sources (Table 11). Urban households are far more likely to access and afford modern energy sources than households in rural areas.

(urban usage is nearly 10 times higher than rural). Rural areas show a slightly higher adoption of solar (3.2 percent) compared to urban areas (1.4 percent) but still lag significantly in overall clean cooking energy adoption. Biogas usage is minimal and equal (0.1 percent) in both rural and urban areas, indicating systemic barriers to uptake, such as high upfront costs and technical complexity.

Electricity and LPG are significantly more used in urban areas. The difference is especially significant for LPG

TABLE 11: RURAL-URBAN DIVIDE IN ACCESS TO CLEAN COOKING ENERGY

Energy Source	Rural (%)	Urban (%)	Difference (%)
Electricity	1.3	8.6	+7.3 (Urban higher)
LPG	2.1	19.9	+17.8 (Urban higher)
Solar	3.2	1.4	-1.8 (Rural higher)
Biogas	0.1	0.1	0

Source: URT (2022) and researchers' calculations.

8 | Efforts by key government institutions to promote clean cooking energy

8.1 Ministry of Energy (MoE)

MoE has introduced the National Natural Gas Utilization Master Plan (NGUMP) and is collaborating with various stakeholders in implementing the National Strategy for Clean Cooking Energy Use (2024–2034) through the following initiatives:

1. Public awareness on the importance of clean cooking energy through media outlets including radio and television, social media, conferences, exhibitions, workshops and public meetings. The National Clean Cooking Communication Strategy has also been finalized.
2. Developing minimum energy performance standards for electric cooking appliances.
3. Amendments to the Rural Energy Act (REA) to establish a dedicated National Fund to support clean cooking energy initiatives.
4. REA financial support for clean cooking infrastructure in public and private institutions that serve more than 100 people per day.
5. Collaborating with the private sector (Oryx, Lake Oil, Manjis and Taifa Gas) in distributing LPG cylinders. This initiative enables citizens to purchase the cylinders at up to a 50 percent discount. By April 2025, a total of 154,224 cylinders had been distributed.
6. Undertaking a baseline survey to assess clean cooking energy needs by location.

8.2 Tanzania Electric Supply Company Limited (TANESCO)

TANESCO is undertaking a range of initiatives to promote clean cooking energy in Tanzania. These include self-financed public awareness campaigns and partnerships with various organizations. Notably, TANESCO and MECS are jointly implementing an eCooking programme across four zones from June 2024 to December 2025. MECS is funding 11,000 e-cookers and TANESCO is facilitating customer access through on-bill financing to reduce upfront costs.

TANESCO is also partnered with Tanzania Traditional Energy Development and Environment Organization–Sustainable Energy Services Organization (TaTEDO–SESO) to promote eCooking and with (UNIDO) to raise awareness in schools. Internally, TANESCO is enhancing its capacity by training staff champions across the four zones and embedding clean cooking champions in key departments. The utility is also investing TZS 500 million to equip 12 secondary schools with electric cooking technologies and is finalizing a clean cooking implementation strategy.

8.3 Tanzania Petroleum Development Corporation (TPDC)

TPDC is currently the sole supplier of pipeline-distributed natural gas to residential households and institutions, including hotels and higher education institutions. To date, TPDC has connected 1,514 households and 15 institutions in Mtwara, Lindi and Dar es Salaam. Ongoing projects are expected to connect an additional 1,000 households in 2025 and another 1,000 in 2026.

Current initiatives include an REA-sponsored project targeting the connection of 470 households in Mnazi Mmoja, Lindi region, and 530 households in Mkuranga, Pwani region during the 2024/25 financial year.

As part of its planning efforts, TPDC develops and submits an annual action plan on clean cooking energy to the MoE. The Corporation is also in negotiations with REA to extend the gas distribution network to Kisemvule (Pwani region), which is expected to add 1,899 new households to the network. A household survey to inform this extension is scheduled for completion during the 2024/25 financial year.

In addition to infrastructure expansion, TPDC is actively investing in public awareness campaigns to promote the use of natural gas for cooking. These efforts include radio programmes and seminars targeting journalists to enhance public knowledge on clean cooking solutions.

8.4 Electricity and Water Utilities Regulatory Authority (EWURA)

EWURA, through its Community and Public Relations unit, educates the public and institutions on the safe and appropriate use of LPG and natural gas. As part of its annual work plans on clean cooking energy, EWURA has been implementing awareness programmes to promote the adoption of natural gas in households, schools and colleges. These campaigns are delivered through various platforms, including radio programmes, trade fairs such as the Dar es Salaam International Trade Fair (Sabasaba) and the International Agricultural Exhibition (Nanenane), and the customer service weeks and other national events associated with the energy sector.

The awareness efforts also target LPG dealers and distributors, focusing on the importance of obtaining EWURA licenses and adhering to safety standards in LPG usage. In addition, EWURA organizes stakeholder meetings to encourage investment in clean cooking energy and to gather feedback on sectoral challenges. It also actively participates in regional forums, such as the Kenya's Energy and Petroleum Regulatory Authority (EPRA) conferences in Nairobi, where it showcases innovations in LPG technology and promotes investment opportunities in Tanzania.

Beyond awareness and promotion, EWURA plays a regulatory role in ensuring the safety and quality of LPG infrastructure. This includes conducting site verifications for proposed LPG facilities and inspecting operational infrastructure. For example, in FY 2024/25, EWURA inspected 49 LPG warehouses serving major distributors and issued multiple construction permits for LPG filling plants. Efforts are now being expanded to include inspections of small-scale LPG retailers.

9 | Efforts by non-state entities to promote clean cooking energy

Biogas technology has been promoted in Tanzania for many years by many entities, including private companies, NGOs, development partners and academic institutions. Rural electrification through the REA, for example, has been extensively supported by development partners, including the World Bank, European Union, France, Sweden, United Kingdom, Norway, African Development Bank, and Japan.

Other programmes, including the Tanzania Domestic Biogas Programme (TDBP), have made significant contributions in scaling up biogas cooking technology. TDBP was part of the Africa Biogas Partnership Programme, a partnership between the Netherlands' Directorate General for International Cooperation (DGIS) that provides financial support, Hivos, responsible for fund management, and Stichting Nederlandse Vrijwilligers (SNV) for technical assistance. The Centre for Agricultural Mechanization and Rural Technology (CAMARTEC), a Tanzanian parastatal institution, was

TDBP's National Implementing Agency (World Access to Modern Energy 2008).

Other institutions contributed to advancing biogas technology as well. They include the Sokoine University of Agriculture (SUA), Mission for Gas and Environmentally Sustainable Development Organization (MIGESADO) and Sustainable Development and the Environmental Restoration of Tanzania (SUDERETA).

MIGESADO, for instance, promoted biogas in the Southern Highlands zone, while SUDERETA has worked mainly in Central and Northern Tanzania. In collaboration with the government's CAMARTEC and other partners, both MIGESADO and SUDERETA formed part of the biogas implementation network that contributed to the creation of technical capacity and local entrepreneurship around biogas systems in Tanzania.



Photo credit: UK DFID | Russel Watkins

10 | Discussion

All five clean cooking energy sources show progress and challenges. For example, almost 80 percent of households had access to the national electricity grid by 2019/20, yet persistent reliability challenges underscore the need for equity-focused investments in regions most affected by interruptions. In addition to supply side challenges, demand-side issues remain significant to enable households to actually connect to and use electricity once they have access to the grid (Meeks & Mahadevan 2025). Currently, few connected households use electricity for cooking, highlighting affordability as a key constraint. Expanding the number of household connections is essential, however, equal emphasis needs to be placed on promoting electricity use for cooking among existing customers. The gap between the usage of clean cooking energy sources and traditional biomass presents a sharp reality; with 82.5 percent of households still relying on traditional biomass energy compared to only 15.9 percent using clean alternatives, highlighting how far Tanzania remains at a far distance from the 80 percent target in the 2024-2034 national strategy. The rural-urban divide is particularly pronounced, reflecting better urban infrastructure and higher income levels that enable access to clean energy. While expanding electricity grid coverage and rising household connection rates present opportunities to increase accessibility to electricity for cooking, this potential can only be realized if accompanied by increases in household income and incentivizing electric cooking technologies.

The government's intent to establish a Clean Cooking Energy Fund through REA will be a significant step toward addressing scalability challenges, particularly in supporting the expansion of the natural gas pipeline network. The current policy of offering free household connections to the natural gas distribution network has helped increase uptake, but poses financial burdens for TPDC, which is compelled, like many other government entities, to operate commercially. Without this subsidy, connection costs would be prohibitive for most low- and middle-income families. This highlights the critical

need for policy frameworks that encourage new entrants in the market, facilitate competition, outline connection requirements and address challenges in unplanned and informal urban settlements. The policy should also be informed by an analysis of the feasibility of recovering connection costs through tariffs, particularly given that the price of gas remains relatively low. Affordability emerges as a cross-cutting constraint limiting scalability, accessibility and equitability, with data showing significant disparities across income quintiles.

Solar is the most affordable option with minimal maintenance and no recurrent energy cost, followed by electricity. Natural gas and LPG are less affordable due to recurring and escalating costs, while biogas is limited by high upfront investment. Low-income households often face a short-term affordability trap, ending up choosing costlier long-term energy due to limited upfront capital. The absence of large-scale national strategies to promote solar cooking, unlike LPG or electricity, represents a missed opportunity that could be addressed through hybrid cooking models combining solar with LPG for flexibility.

Equity considerations reveal the need for targeted interventions in lagging regions, particularly in southern and western Tanzania, addressing both supply factors like infrastructure and reliability, and demand factors like affordability. Solar cooking appears more accessible in grid-limited areas, suggesting potential for targeted incentives in remote regions. The pronounced rural-urban gap in clean cooking energy adoption calls for comprehensive approaches, including incentives for LPG appliances and electric cookers to reduce upfront costs in rural areas. Geospatial and socio-economic data could inform the identification of underserved rural areas for tailored interventions, ensuring that the transition to clean cooking energy addresses not only environmental and health imperatives but also promotes equitable development across Tanzania's diverse regions and communities.

11 | Conclusions

This study has provided a multidimensional analysis of clean cooking energy in Tanzania, revealing a landscape of significant challenge and even greater opportunity. The analysis across the five dimensions demonstrates that no single clean cooking solution is a panacea. Each technology presents a distinct profile:

- LPG is the dominant driver of recent adoption gains, particularly in urban areas, but faces affordability and equity barriers for low-income households and requires major investments in infrastructure to scale up.
- Electricity has high grid reach but low levels of household adoption for cooking, hampered by reliability disparities between regions and the high costs.
- Solar offers low recurring costs but is constrained by high initial investment, technological limitations for local cooking practices, and a lack of large-scale promotion.
- Biogas ranks highest in equitability and affordability of the monthly recurrent costs but remains out of reach for most low-income households due to high upfront costs, resulting in universal under-adoption.

To achieve the national target of 80 percent access to clean cooking by 2034 requires an unprecedented acceleration in progress, that is, four times faster than the current rate. This necessitates a focus on a “systems approach” that moves beyond isolated interventions to simultaneously address both supply-side constraints (infrastructure, distribution networks, regulatory frameworks) and demand-side barriers (e.g., affordability).

In addition, it is important to recognize that income is a fundamental determinant of adoption. Thus, the clean cooking transition must be viewed not solely as an energy sector goal but as an overall outcome of broader national efforts to promote inclusive economic growth and rural development. While working to increase the adoption rates of clean cooking energy, transitional policies also need to address the current biomass economy through sustainable charcoal production, enforcement of forestry regulations, and promotion of alternative livelihoods to those engaged in charcoal trading.

Future studies could broaden the scope to include additional clean-cooking technologies prioritized in the National Clean Cooking Strategy (2024-2034) and assess further dimensions (e.g., environmental, climate and health). In particular, studies could quantify:

- Health benefits from reduced household air pollution.
- Forestry gains from lower demand for traditional biomass.
- Climate benefits expressed as avoided emissions valued using the social cost of carbon (SCC).

This is especially relevant for Tanzania, where charcoal remains dominant, driving deforestation in Miombo woodlands and the foothills of the Eastern Arc Mountains. Monetizing the avoided emissions using SCC would strengthen the economic case for scaling clean cooking energy in line with the targets set in the 2024-2034 national strategy and Tanzania’s climate commitments.

12 | Policy recommendations

12.1 General recommendations

Accelerating the adoption of clean cooking energy requires a systems approach that integrates multiple elements and actors to overcome both supply and demand constraints and foster a supportive environment for market growth. The cross-sectoral strategy, in terms of cooperation between institutions and ministries, should be an integral part of the system approach to clean cooking energy.

Such an approach will need to consider the full clean cooking process and the interaction between cooking technologies (the combination of stove and energy), behaviour (such as what, how and how often households cook), housing conditions (such as the presence of a kitchen) and policy reforms that facilitate an enabling environment for the clean cooking market. Reforms could include targeted incentives, market innovation, regulations that promote market entry and competition, and the development of localized solutions. Importantly, the approach should also not exclude traditional biomass energy, largely because the

transition to widespread adoption of clean cooking energy will take time. During this transition period, the government can:

- Strengthen support to sustainable charcoal production initiatives and efficient charcoal cooking technology. Institutions, such as REA, are currently making advances in this area (see REA 2025).
- Introduce fiscal disincentives for traditional biomass energy.
- Enforce existing forestry regulations to curb illegal and unsustainable wood harvesting used for firewood and charcoal production.
- Scale up village-level entrepreneurship programmes to offer economic alternatives in forest-dependent communities.
- Access global climate change resources for clean cooking programmes, such as improved biomass cookstoves, biogas and pay-as-you-go (PAYG) systems for LPG.



Photo credit: iStock | Poco BW

12.2 Recommendations by dimension

Specific recommendations under each of the study's five dimensions are presented below.

12.2.1 Reliability

To enhance reliability, the study recommends prioritizing investments in electricity grid infrastructure in regions with weaker results for reliability indicators (SAIFI, SAIDI and CAIDI). High-performing areas like Ilala and Dodoma could serve as benchmarks, and national reliability indices can be compared against regional peers. Disaster preparedness also needs to be improved by strengthening contingency plans and backup systems, addressing the vulnerabilities highlighted in recent years.

12.2.2 Accessibility

The government needs to maintain the policy of free connection to the natural gas network, while expanding infrastructure to high-density areas. The upcoming Clean Cooking Fund could support pipeline expansion as well as aiding local governments in planning LPG supply zones. Tax incentives could be extended to components associated with the full package of clean cooking energy solutions, such as cookers and accessories, not only for LPG, but also for biogas and solar technologies, coupled with mechanisms to prevent misuse of exemptions.

Additional recommendations to improve accessibility include:

- Designing future natural gas pipelines to incorporate multiple exit points
- Strengthening utility coordination and the operationalization of the existing Memoranda of Understanding (MoUs) between national utility companies

- Promoting local manufacturing of gas accessories and reducing import costs
- Expediting the revision of the natural gas pricing methodology
- Continuing to invest in public awareness and safety campaigns.

12.2.3 Scalability

To enable scalability of cleaning cooking energy sources will require:

- **Expanding distribution networks**
Increased public investment in expanding last-mile infrastructure (such as transformers and service lines) is needed to improve actual household electricity connections. There is also a need to consider incentives that would support LPG distribution in rural areas, including retail expansion and investment in refilling plants and delivery logistics. The absence of large-scale national strategies to promote solar cooking, unlike LPG or electricity, represents a missed opportunity that could be addressed through hybrid cooking models combining solar with LPG for flexibility.
- **Increasing infrastructure capacity**
Public-private partnerships (PPP) are recommended to increase LPG import and storage capacity, especially by expanding port facilities. Investment in natural gas pipeline infrastructure is also required to connect more households, possibly supported by the planned Clean Cooking Energy Fund. Resource allocation and efficiency in project execution should be prioritized in expanding grid coverage to all hamlets. As of July 2025, a total of 33,657 out of 64,359 hamlets have been connected to the grid, with efforts underway to extend access to the remaining 30,702 hamlets by 2030. As discussed in the preceding sections,

supply-side interventions cannot be addressed in isolation from affordability considerations, since connectivity alone does not necessarily translate into the actual use of electricity for cooking.

- **Achieving regulatory reforms and enhancing quality control and safety**

The Government should review licensing requirements for LPG importers to allow for shared or rented storage infrastructure, lowering entry barriers for new players. Import standards for LPG accessories and installations also need to be enforced to reduce accidents and improve public confidence, and the Government should continue with public awareness campaigns to counter safety misconceptions, particularly around LPG.

12.2.4 Equitability

To enhance equitable access to clean cooking energy, targeted interventions are required in underserved regions, particularly in southern and western Tanzania. These interventions should address both supply-side challenges, such as infrastructure and reliability, and demand-side constraints like affordability. Reviewing and adjusting subsidies could support equitable expansion for electricity-based cooking. In the case of solar energy, further investment is needed in research and pilot projects, especially in areas with low uptake, to better understand cultural, social and technical barriers. Equally important is the need to focus on pilot projects to get the available technologies to users. It may also be advantageous to develop area-specific clean cooking strategies, for example, LPG in urban areas and biogas in livestock-rich zones. For biogas, scaling up of existing technology is key, particularly in agricultural and pastoral areas.

12.2.5 Affordability

As part of the system approach to support uptake of clean cooking energy, there is a need to extend financial relief on upfront costs for biogas, solar, LPG and electricity. Such measures, for instance, in the case of LPG would support the scaling up of recently introduced pay-as-you-go initiatives by the private sector. Based on the data collected, the study found that ensuring connection to electricity is insufficient on its own. To maximize impact on adopting electricity for cooking, it needs to be complemented by measures that address affordability. In addition, large-scale energy switching in rural areas is unlikely until rural economies grow substantially or significant public subsidies support the transition. Therefore, expanding access to clean cooking energy should be seen not only as an energy objective but also as a core component of inclusive economic growth.¹⁵

¹⁵ Refer to discussion in World Bank (2024) and Aamaas et al. (2024).

13 | References

- Aamaas, B., Grimsby, L., Chowdhury, S., Ulsrud, K., Ruhinduka, R., Standal, K., Perros, T., Vindegg, M., Puzzolo, E., & Pope, D. (2024). Required knowledge for clean cooking transition: The case of Tanzania. *Environmental Science and Policy*, 160, 1-7.
- African Development Bank. (2022). Electricity Regulatory Index for Africa. Abidjan, African Development Bank. https://www.afdb.org/sites/default/files/documents/publications/eri_2024_report_afdb_eng.pdf
- Alia, J., & Khan, W. (2022). Factors affecting access to clean cooking fuel among rural households in India during COVID-19 pandemic. *Energy for Sustainable Development*, 67, 102-111.
- Amigun, B., & von Blottnitz, H. (2010). Capacity-cost and location-cost analysis for biogas plants in Africa. *Resources, Conservation and Recycling*, 55(1), 63-73.
- Brandstaetter, E. (2017). LPG in Brazil: At a crossroads GLOTEC – LAM Global Technology Network Latin America. Rio de Janeiro, Brazil Petroleum Gas and Biofuel Institute. https://aiglp.org/src/uploads/2020/11/shv_brazil_final.pdf
- Chaudhari, K., Walke, P., & Shelare, S. (2024). Comparative predictive analysis through machine learning in solar cooking technology. *International Journal of Electrical and Computer Engineering Systems*, 15(6), 543-549.
- Clean Cooking Alliance. (2019). Scaling LPG for cooking in developing markets: Insights from Tanzania. Washington DC, Clean Cooking Alliance. <https://cleancooking.org/wp-content/uploads/2021/07/578-1.pdf>
- Clemence, H. (2018). Africa biogas partnership program: A review of clean cooking implementation through market development in East Africa. *Energy Sustain Development*, 46, 23-31.
- Coldrey, O., Lant, P., & Ashworth, P. (2023). Elucidating finance gaps through the clean cooking value chain. *Sustainability*, 15(4), 3577.
- Dawit G., Baumgartner, J., Jack, D., Carter, E., Shen, G., Orgill-Meyer, J., Rosenthal, J., Dickinson, K., Bailis, R., Masuda, Y., & Zerriffi, H. (2022). A systematic review of household energy transition in low- and middle-income countries. *Energy Research and Social Science*, 86, 102463.
- EBSCO (2024). Solar concentrator. <https://www.ebsco.com/research-starters/environmental-sciences/solar-concentrator>
- Ecohubmap. (2024). Deforestation in Tanzania. <https://www.ecohubmap.com/hot-spot/deforestation-in-tanzania/7s3tklfr5f4tm>.
- Energy and Petroleum Regulatory Authority (EPRA). (2024). Bi-annual energy and petroleum statistics report financial year 2023/202. Nairobi, EPRA. https://www.epra.go.ke/sites/default/files/2024-10/EPRA%20Energy%20and%20Petroleum%20Statistics%20Report%20FY%202023-2024_2.pdf
- Energy Sector Management Assistance Program (ESMAP). (2015). Beyond connections: Energy access redefined. ESMAP Technical Report 008/15. Washington, D.C.: The International Bank for Reconstruction and Development (IBRD), World Bank Group. <https://openknowledge.worldbank.org/server/api/core/bitstreams/248a7205-e926-5946-9025-605b8035ad95/content>
- ESMAP. (2023). Unlocking clean cooking pathways: A practitioner's keys to progress. Washington, DC, World Bank. <https://documents1.worldbank.org/curated/en/099095503072317708/pdf/P1742320fcb6a8051083c008061576a2156.pdf>

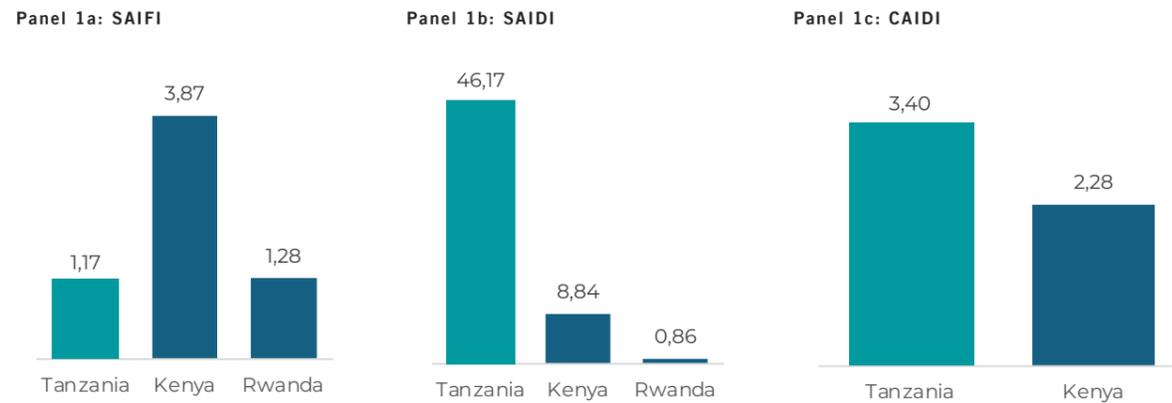
- European Commission. (2025). Interactive Country Fiches. United Republic of Tanzania. Accessed 18 December 2025. <https://dicf.unepgrid.ch/united-republic-tanzania/forest>
- Energy, Water and Utilities Regulatory Authority (EWURA). (2025a). Electricity sub-sector regulatory performance report for the financial year 2023/24. EWURA. Dodoma: EWURA. <https://www.ewura.go.tz/uploads/documents/en-1746685816-Muhtasari%20wa%20Taarifa%20ya%20Utendaji%20Umeme%202023-24.pdf>
- EWURA (2025b). Natural gas sub-sector regulatory performance report for the year ended 30th June 2024. Dodoma: EWURA. <https://www.ewura.go.tz/uploads/documents/en-1744207225-Natural%20Gas%20Sub-Sector%20Performance%20Report%20FY%202023-24%20E2%80%A2pdf.pdf>
- Fankhauser, S., & Tepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. *Energy Policy*, 35, 1038-1049.
- Food and Agriculture Organization (FAO). (2020). Global Forest Resources Assessment 2020 Report: United Republic of Tanzania. Rome: FAO. <https://openknowledge.fao.org/server/api/core/bitstreams/480b30fa-dd26-4427-9d68-8a07640946c9/content>
- Gill-Wiehl, A., Ray, I., & Kammen, D. (2021). Is clean cooking affordable? A review. *Renewable and Sustainable Energy Reviews*, 151, 111537.
- Healy, J. & Clinch, P. (2004). Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland. *Energy Policy*, 32, 207-220.
- Hewitt, J., Holden, M., Robinson, B.L., Jewitt, S. & Clifford, M.J. (2022). Not quite cooking on gas: Understanding biogas plant failure and abandonment in Northern Tanzania, *Renewable and Sustainable Energy Reviews*, 165, 1-9.
- Hosier, R., Kappen, J., Hyseni, B., Tao, N., & Usui, K. (2017). Scalable business models for alternative biomass cooking fuels and their potential in Sub-Saharan Africa. Washington D.C.: World Bank. <https://openknowledge.worldbank.org/entities/publication/b4913857-5778-5d37-abac-9eb16fdc4c49>
- International Energy Agency (IEA). (2016). World energy outlook 2016. Paris: International Energy Agency. <https://iea.blob.core.windows.net/assets/680c05c8-1d6e-42ae-b953-68e0420d46d5/WEO2016.pdf>
- International Monetary Fund (IMF). (2023). Building resilience to climate change in: IMF staff country reports volume 2023. <https://www.elibrary.imf.org/view/journals/002/2023/154/article-A002-en.xml>
- Jiji. (2025). Electric stoves in Tanzania. <https://jiji.co.tz/279-stoves/electric?>
- Leary, J., Batchelor, S., Sago, S., Minja, A., Chepkurui, K., Sawe, K., & Shuma, J. (2019). Policy and national markets review for eCook in Tanzania. Dar es Salaam: TATEDO. <https://mecs.org.uk/wp-content/uploads/2020/12/TANZANIA-Policy-Review-JL-4-10-19-2-COMPRESSED.pdf>
- Lentswe, K., Mawire, A., Owusu, P., & Shobo, A. (2021). A review of parabolic solar cookers with thermal energy storage. *Heliyon*, 7(10), 1-16.
- Malimbwi R.E., & Zahabu E. (undated). The analysis of sustainable charcoal production systems in Tanzania Faculty of Forestry and Nature Conservation. Rome, FAO. <https://www.fao.org/4/i1321e/i1321e10.pdf>
- Meeks, R., & Mahadevan, M. (2025). Electricity infrastructure. *VoxDevLit* 15(1).
- Ministry of Energy (MoE). (2025): Hotuba ya Naibu Waziri Mkuu na Waziri Wa Nishati Mheshimiwa Dkt. Doto Mashaka Biteko (MB), Akiwasiliha bungeni makadirio ya mapato na matumizi ya Wizara ya Nishati kwa Mwaka 2025/26. Dodoma: Ministry of Energy. <https://www.nishati.go.tz/uploads/documents/en-1745835421-HOTUBA%20YA%20BAJETI%20%20MWAKA%202025-26%20-.pdf>

- Mosses, J., Makundi, H., & Hamza, V. (2023). Barriers of solar cooking and policy prescription towards its adoption in Tanzania: The case of Southern Unguja and Kilimanjaro regions. *Energy for Sustainable Development*, 75, 72-81.
- Muhihi, B. G. (2024). Affordability of electricity to rural consumers in Tanzania: An elephant in the room? *Interdisciplinary Journal of Rural and Community Studies*, 6, 1–20. <https://doi.org/10.38140/ijrcs-2024.vol6.02>
- Ruhinduka, R., Bensch, G., Selejio, O., & Lokina, R. (2024). What could explain low uptake of rural electricity programs in Africa? Empirical evidence from rural Tanzania. *Ruhr Economic Papers No. 1084*. Essen: RWI - Leibniz-Institut für Wirtschaftsforschung. <https://hdl.handle.net/10419/299233>
- Rupf, G. V., Bahri, P. A., de Boer, K., & McHenry, M. P. (2015). Barriers and opportunities of biogas dissemination in Sub-Saharan Africa and lessons learned from Rwanda, Tanzania, China, India, and Nepal. *Renewable and Sustainable Energy Reviews*, 52, 468-476. <https://doi.org/10.1016/j.rser.2015.07.107>
- Rural Energy Agency (REA). (2025). Majiko banifu teknolojia ya kisasa inayotumia mkaa kidogo. Dodoma, Rural Energy Agency. <https://rea.go.tz/Articles/majiko-banifu-teknolojia-ya-kisasa-inayotumia-mkaa-kidogo>
- Schunder, T., & Bagchi-Sen, S. (2019). Understanding the household cooking fuel transition. *Geography Compass*, 13(11), e12469.
- Smart Villages Research Group Limited (SVRG). (2020). Low-cost solar thermal storage for time-shifted carbon free cooking. *Modern Energy Cooking Services (MECS)-TRIID Final project report*. Abingdon, Oxfordshire, U.K.: SVRG. <https://mecs.org.uk/wp-content/uploads/2020/12/MECS-TRIID-Smart-Villages-Final-Report.pdf>
- Solar Cookers International. (2025). SCI x TEALEAVES Case Study: Cooking with the Power of the Sun. <https://www.solarcookers.org/about/blog/cooking-with-the-power-of-the-sun?>
- Tanzania Electric Supply Company Limited (TANESCO). (2016). Bei za umeme zilizoizinishwa. Dodoma: EWURA. https://www.tanESCO.co.tz/attachments/customer_services/_unewEou3Ea2ea5kfxYK7GX9H0qhcjnO_2022_11_30_07_10_00.pdf
- TANESCO. (2025). Service line application. <https://www.tanESCO.co.tz/customer-services/service-line-application?>
- Tanzania Petroleum. (2024). The future of clean cooking energy in Tanzania. <https://tanzaniapetroleum.com/2024/09/11/join-the-clean-cooking-revolution-in-tanzania-and-create-sustainable-future/>.
- TanzaniaInvest. (2025). Tanzania launches construction of USD 100 Million Tanga LPG Terminal to serve as regional energy hub. https://www.tanzaniainvest.com/energy/tanga-lpg-terminal-construction-launch?utm_source=chatgpt.com
- Tarimo, D. L., Kimwaga, R., & Alexander, A. (2024). Assessment of adaptation and diffusion of biogas technology in Dar es Salaam. *Tanzania Journal of Engineering and Technology*, 43(4), 119-132.
- The Citizen. (2025, September 25). Taifa Gas pledges to expand clean cooking access for all Tanzanians. *The Citizen*. <https://www.thecitizen.co.tz/tanzania/news/national/taifa-gas-pledges-to-expand-clean-cooking-access-for-all-tanzanians-5193440>
- The Spruce. (2025). How long major appliances should last and when to replace them. https://www.thespruce.com/lifespan-of-household-appliances-4158782?utm_source=chatgpt.com
- Total Energies. (2025). Cooking made easy with TotalEnergies Gas. Refill cost. <https://totalenergies.co.tz/cooking-made-easy-totalenergies-gas?>
- UBUY. (2025). Portable 1800W Solar Cooker Stove Kit with Parabolic Concentrator. <https://www.ubuy.co.tz/en/product/1B3WHJD6G-liuwhweixunda-outdoor-ovens-solar-cooker-stove-kits-1800w-portable-parabolic-solar-cooker-concentrating-solar-cooker-59-inch-foldable-solar-cooker?srsId=AfmBOopJjHcZMncA71nIFqEZIMPY6tyQWVT52w0ZSWyxIX51R-AWzEc7>

- United Republic of Tanzania (URT). (2017). Tanzania's Forest Reference Emission Level Submission to the UNFCCC. November 2017. <https://www.ncmc.go.tz/core/uploads/2024/05/Tanzanias-Forest-Reference-Emission-Level-FREL-1.pdf>
- URT. (2012). The 2012 population and housing census. Dar es Salaam, National Bureau of Statistics
- URT. (2018). Performance audit report on the status of environment with a focus on land degradation, forest degradation and deforestation: Dodoma: Controller and Auditor General (CAG). https://www.nao.go.tz/uploads/reports/Performance_Audit_Report_on_the_Status_of_Environment_with_a_Focus_on_Land_Degradation__Forest_Degradation_and_Deforestation.pdf
- URT. (2022a). National panel survey wave 5 2020/21. Dodoma, National Bureau of Statistics. https://www.nbs.go.tz/nbs/takwimu/nps/wave5/NPS_Wave_5.pdf
- URT. (2024a). National Clean Cooking Strategy (2024–2034). Dodoma, Ministry of Energy. [https://www.nishati.go.tz/uploads/documents/en-1717244388-NATIONAL%20CLEAN%20COOKING%20STRATEGY%20\(2024-2034\).pdf](https://www.nishati.go.tz/uploads/documents/en-1717244388-NATIONAL%20CLEAN%20COOKING%20STRATEGY%20(2024-2034).pdf)
- URT. (2024b). Basic demographic and socio-economic profile: Tanzania Mainland. Dodoma, National Bureau of Statistics. https://sensa.nbs.go.tz/publication/02.%20Mainland_Demographic_and_Socioeconomic_Profile.pdf
- URT. (2025). Press release: National Consumer Price Index (NCPI) for September 2025. Dodoma, National Bureau of Statistics. https://www.nbs.go.tz/uploads/statistics/documents/en-1759922869-CPI%20%20Release_092025_English.pdf
- Verma, A., El-Bayeh, C., Buddhi, D., Amir, M., Ahmad, F., & Singh, H. (2024). Socio-economic impact of solar cooking technologies on community kitchens under different climate conditions: A review. *Engineering Reports*, 6(11), e12998. <https://doi.org/10.1002/eng2.12998>
- Villema, N., Sago, S., Sawe, E., Minja, A., Leary, J., Chepkurui, K., & Leach, M. (2019). The National Stakeholders' Solar Electric Cooking Workshop. TaTEDO, Loughborough University, University of Surrey, & Gamos Ltd. <https://mecs.org.uk/wp-content/uploads/2020/12/THE-NATIONAL-STAKEHOLDERS-WORKSHOP-REPORT-15-3-19.pdf>
- Vögel, Y., Lohri, C., Gallardo, A., Diener, S., and Zurbrügg, C. (2014). Anaerobic digestion of biowaste in developing countries - Practical information and case studies. https://www.researchgate.net/publication/264727438_Anaerobic_Digestion_of_Biowaste_in_Developing_Countries_-_Practical_Information_and_Case_Studies
- William, D., & G. Nyamoga, R. (2024). Supporting business functions influencing the formalization of charcoal business in Tanzania. *Trees, Forests and People*, 16, 1-8.
- World Access to Modern Energy (2008). Tanzanian Domestic Biogas Program (TDBP). <https://www.wame2030.org/project/991/>
- World Bank. (2022). Changing lives and livelihoods in Tanzania, one electricity connection at a time. <https://www.worldbank.org/en/news/feature/2022/06/28/changing-lives-and-livelihoods-in-tanzania-one-electricity-connection-at-a-time?>
- World Bank. (2024). United Republic of Tanzania: Country climate and development report. Washington DC, World Bank. <https://www.worldbank.org/en/country/tanzania/publication/ccdr>
- World Health Organization (WHO). (2025). Household air pollution and related health impacts: Technical brief. Geneva, World Health Organization. <https://iris.who.int/server/api/core/bitstreams/0c1ed565-52df-4f00-b40f-775ec8a8ee7b/content>

Annexes

Annex 1: Benchmarking Tanzania's electricity reliability with neighbouring countries



Source: EWURA (2025), EPRA (2024), Rwanda Energy Group (2024)

Annex 2: Electricity Accessibility and Connectivity

Annex 2a: Progress in electricity accessibility

	2016/17 (%)	2019/20 (%)	Percentage Point Change (%)
Rural	49.3	69.8	+20.5
Urban	99.6	97.3	-2.3
Overall	67.5	78.4	+10.9

Source: EWURA (2025a)

Annex 2b: Progress in electricity connectivity

	2016/17 (%)	2019/20 (%)	Percentage Point Change (%)
Rural	16.9	24.5	+7.6
Urban	65.3	73.2	+7.9
Overall	32.8	37.7	+4.9

Source: EWURA (2025a)

Annex 3: Market potential

	2016/17 (%)	2019/20 (%)	Percentage Point Change (%)
Rural	16.9	24.5	+7.6
Urban	65.3	73.2	+7.9
Overall	32.8	37.7	+4.9
Overall	67.5	78.4	+10.9

Source: EWURA (2025a)

Annex 3: Market potential

Metric	Market implication values
Total households (2022)	13.8 million households
Clean energy users (2022)	2.18 million households
Remaining potential market	11.6 million households
Market saturation (clean cooking energy)	15.9%
Untapped market share	84.1%

Source: National Census Data for 2012 and 2022 and researchers' calculations

Annex 4: Proportions of households using different cooking energy sources

	Percent of Households	Number of Households
Electricity (TANESCO/ZECO)	4.18%	575,982
Solar	2.47%	340,153
Generator/private sources	0.19%	26,621
Gas	9.10%	1,254,229
Biogas	0.09%	12,615
Wind Generated Electricity	0.02%	3,008
Paraffin	0.47%	65,095
Coal	0.11%	15,762
Charcoal	25.83%	3,558,380
Firewood	55.96%	7,709,031
Wood/ residuals	0.08%	11,001
Animal residuals	0.03%	3,658
Charcoal Briquette	0.04%	5,229
None	1.42%	196,211
	100.00%	13,776,975

Source: URT (2022)

Annex 5: Grid power generation capacity and availability status as of April 2025

	Capacity		Availability	
	MW	%	MW	%
Hydropower	2,716.27	67.37	2,580.60	73.46
Natural Gas	1,198.82	29.73	858	24.42
Petroleum	101.12	2.51	60.77	1.73
Solar	5	0.12	3.3	0.09
Tungamotaka	10.5	0.26	10.5	0.3
Total	4,031.71	100.00	3,513.17	100.00

Source: MoE (2025)

Annex 6: Households connected with natural gas pipeline (TPDC) (as of June 2023)

	No. of Households connected
Mtwara	425
Dar es Salaam	880
Lindi	209
Total	1,514

Source: EWURA (2025b), URT (2024b)

Annex 7: Data files for computation of Net Present Values

Annex 7a: Input file

	Upfront Cost (TZS)	Equipment Lifespan (yrs)	Monthly Energy Cost (TZS)	Annual Maintenance (TZS)	Annual Energy Escalation
Electricity	332,000	14	6,750	6,640	3.7%
LPG	155,000	14	30,456	3,100	3.7%
Natural gas	50,000	14	20,000	1,000	3.7%
Solar	393,916	15	0	11,817	3.7%
Biogas	2,000,000	18	9,583	80,000	3.7%

Source: Annex 7h and researchers' calculations

Annex 7b: NPV cost model - Electricity

Planning horizon (years)	10
Discount rate (annual)	0.08
Inputs	
Upfront cost (TZS)	332,000
Lifespan (years)	14
Monthly energy/fuel cost (TZS)	6,750
Annual maintenance (TZS)	6,640
Energy/Fuel escalation % (annual)	0.04

Year	Maintenance (TZS)	Monthly Energy Cost (TZS)	Total Annual Cost (TZS)	Discount Factor	Present Value (TZS)
0	0	0	332,000	1	332,000
1	6,640	81,000	87,640	0.925925926	81,148
2	6,640	83,997	90,637	0.85733882	77,707
3	6,640	87,105	93,745	0.793832241	74,418
4	6,640	90,328	96,968	0.735029853	71,274
5	6,640	93,670	100,310	0.680583197	68,269
6	6,640	97,136	103,776	0.630169627	65,396
7	6,640	100,730	107,370	0.583490395	62,649
8	6,640	104,457	111,097	0.540268885	60,022
9	6,640	108,322	114,962	0.500248967	57,509
10	6,640	112,330	118,970	0.463193488	55,106
NPV of Total Cost (TZS):					1,005,499

Source: Annex 7h and researchers' calculations

Annex 7c: NPV cost model - LPG

Planning horizon (years)	10
Discount rate (annual)	0.08
Inputs	
Upfront cost (TZS)	155,000
Lifespan (years)	14
Monthly energy/fuel cost (TZS)	30,456
Annual maintenance (TZS)	3,100
Energy/Fuel escalation % (annual)	0.04

Year	Maintenance (TZS)	Monthly Energy Cost (TZS)	Total Annual Cost (TZS)	Discount Factor	Present Value (TZS)
0	0	0	155,000	1	155,000
1	3,100	365,472	368,572	0.925925926	341,270
2	3,100	378,994	382,094	0.85733882	327,584
3	3,100	393,017	396,117	0.793832241	314,451
4	3,100	407,559	410,659	0.735029853	301,847
5	3,100	422,639	425,739	0.680583197	289,751
6	3,100	438,276	441,376	0.630169627	278,142
7	3,100	454,492	457,592	0.583490395	267,001
8	3,100	471,309	474,409	0.540268885	256,308
9	3,100	488,747	491,847	0.500248967	246,046
10	3,100	506,831	509,931	0.463193488	236,197

NPV of Total Cost (TZS): 3,013,596

Source: Annex 7h and researchers' calculations

Annex 7d: NPV cost model – Natural gas

Planning horizon (years)	10
Discount rate (annual)	0.08
Inputs	
Upfront cost (TZS)	50,000
Lifespan (years)	14
Monthly energy/fuel cost (TZS)	20,000
Annual maintenance (TZS)	1,000
Energy/Fuel escalation % (annual)	0.04

Year	Maintenance (TZS)	Monthly Energy Cost (TZS)	Total Annual Cost (TZS)	Discount Factor	Present Value (TZS)
0	0	0	50,000	1	50,000
1	1,000	240,000	241,000	0.925925926	223,148
2	1,000	248,880	249,880	0.85733882	214,232
3	1,000	258,089	259,089	0.793832241	205,673
4	1,000	267,638	268,638	0.735029853	197,457
5	1,000	277,540	278,540	0.680583197	189,570
6	1,000	287,809	288,809	0.630169627	181,999
7	1,000	298,458	299,458	0.583490395	174,731
8	1,000	309,501	310,501	0.540268885	167,754
9	1,000	320,953	321,953	0.500248967	161,057
10	1,000	332,828	333,828	0.463193488	154,627

NPV of Total Cost (TZS): 1,920,247

Source: Annex 7h and researchers' calculations

Annex 7e: NPV cost model – Solar

Planning horizon (years)	10
Discount rate (annual)	0.08
Inputs	
Upfront cost (TZS)	393,916
Lifespan (years)	15
Monthly energy/fuel cost (TZS)	0
Annual maintenance (TZS)	11,817
Energy/Fuel escalation % (annual)	0.04

Year	Maintenance (TZS)	Monthly Energy Cost (TZS)	Total Annual Cost (TZS)	Discount Factor	Present Value (TZS)
0	0	0	393,916	1	393,916
1	11,817	0	11,817	0.925925926	10,942
2	11,817	0	11,817	0.85733882	10,132
3	11,817	0	11,817	0.793832241	9,381
4	11,817	0	11,817	0.735029853	8,686
5	11,817	0	11,817	0.680583197	8,043
6	11,817	0	11,817	0.630169627	7,447
7	11,817	0	11,817	0.583490395	6,895
8	11,817	0	11,817	0.540268885	6,385
9	11,817	0	11,817	0.500248967	5,912
10	11,817	0	11,817	0.463193488	5,474
NPV of Total Cost (TZS):					473,212

Source: Annex 7h and researchers' calculations

Annex 7f: NPV cost model – Biogas

Planning horizon (years)	10
Discount rate (annual)	0.08
Inputs	
Upfront cost (TZS)	2,000,000
Lifespan (years)	18
Monthly energy/fuel cost (TZS)	9,583
Annual maintenance (TZS)	80,000
Energy/Fuel escalation % (annual)	0.04

Year	Maintenance (TZS)	Monthly Energy Cost (TZS)	Total Annual Cost (TZS)	Discount Factor	Present Value (TZS)
0	0	0	2,000,000	1	2,000,000
1	80,000	114,996	194,996	0.925925926	180,552
2	80,000	119,251	199,251	0.85733882	170,825
3	80,000	123,663	203,663	0.793832241	161,674
4	80,000	128,239	208,239	0.735029853	153,062
5	80,000	132,984	212,984	0.680583197	144,953
6	80,000	137,904	217,904	0.630169627	137,316
7	80,000	143,006	223,006	0.583490395	130,122
8	80,000	148,298	228,298	0.540268885	123,342
9	80,000	153,785	233,785	0.500248967	116,950
10	80,000	159,475	239,475	0.463193488	110,923
NPV of Total Cost (TZS):					3,429,720

Source: Annex 7h and researchers' calculations

Annex 7g: NPV affordability summary [NPV of total cost (TZS)]

	NPV With Escalation	NPV Base Case (No Escalation)
Electricity	1,005,499	920,072
LPG	3,013,596	2,628,148
Natural gas	1,920,247	1,667,130
Solar	473,212	473,212
Biogas	3,429,720	3,308,439

Source: Annex 7h and researchers' calculations

Annex 7h: Data sources for NPV calculations

	Data Source
Upfront costs	
Electricity	TANESCO (2025); Jiji (2025); Ruhinduka, et al. (2025).
LPG	Total Energies (2025).
Natural Gas	URT (2024a).
Solar	UBUY (2025).
Biogas	URT (2024a).
Equipment lifespan	
Electricity	The Spruce (2025)
LPG	The Spruce (2025)
Natural Gas	The Spruce (2025)
Solar	Solar Cookers International (2025)
Biogas	Vögel, Lohri., Gallardo., Diener and Zurbrügg (2014)
Monthly Energy Cost	
Electricity	Muhihi (2024) and World Bank (2022)
LPG	Total Energies (2025).
Natural Gas	United Republic of Tanzania (2024a)
Biogas	Amigun and von Blottnitz (2010).

Source: Annex 7h and researchers' calculations



Dodoma

Kambarage Tower (PSSSF Building), 8th Floor,
18 Jakaya Kikwete Road
P.O. Box 1081
Phone: +255 (0) 26 296 3882/3

Dar es Salaam

Plot No. 100, 1 Magogoni Street, Kivukoni
P.O. Box 105753
Phone: +255 (0) 22 211 0372/3

Email: info@uongozi.or.tz
www.uongozi.go.tz



UONGOZI



UONGOZI Institute



UONGOZI Institute



uongozi_institute



UongoziInstitute