



May 2022

RE Baseline Report

Renewable Energy Baseline Data Assessment Report

SEED DATA TO GROW CLIMATE ACTION

IN TANZANIA RENEWABLE ENERGY (RE) SECTOR



Photo credit:

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Brot
für die Welt

The report „ Renewable Energy Baseline Data Assessment“ was developed in scope of a project funded by Bread for the World [Aligning II: ALIGNING CLIMATE RESILIENCE, RENEWABLE ENERGY EXPANSION AND SUSTAINABLE DEVELOPMENT IN TANZANIA (PHASE II)]

FLYING BLIND: THE NEED FOR RE BASELINE DATA IN TANZANIA

PLAN FOR 100 % RE: REMOVING THE BLINDFOLD

Tanzania is among the countries with fast growing economies in Africa with a increasing energy demand. To remain a sustainable growth **the energy transition to 100 % renewable energy need to be planned based on reliable and viable data. National Strategies and Polices need to ensure the avability , reliability and viability of Baseline data** for energy sector development in Tanzania. Data-driven planning is key for a efficient and just energy transition.



Low connectivity to national grid

Only 37.7 % of TZ households are connected to the grid



Low productive use of energy

Energy is mainly used for lighting and not for livelihood activities



Lack of RE baseline data

Insufficient data on energy need and RE



Lack of awareness for RE

RE solution are partly unknown

CHALLENGES

SEEING THE BIG PICUTRE: ENHANCING & UTILIZING BASELINE DATA ON RE IN



Short and long-term projections

⇒ Mobilizing resources for short and long -term projections, and plans for advancement in terms of research, technological transfer and exploitation of RE resources in Tanzania.



Mapping and quantify RE potentials

⇒ Continue enhancing cost effective mapping and quantify all RE potentials including geothermal, solar, wind, tidal and alike in the north, south and central regions of Tanzania.



Develop decentralized renewable energy

⇒ Develop decentralized renewable energy (DRE) technologies, so as to increase energy access and connectivity which in turn address climate change crisis.



Develop stand-alone RE policy

⇒ Develop stand-alone RE policy and, or energy efficiency policy that will ensure equal subsidy in RE development between IPPs and TANESCO in electricity generation models.



Awareness raising for RE

⇒ Prioritize awareness raising and dissemination knowledge on the alternative energies in the country.

RECOMMONATIONS

About CAN Tanzania

Registered since 2011, CAN- Tanzania is a non-government and not-for-profit network-organization influencing climate action through environment and natural resource management, green development pathways, and renewable energy advocacy to contribute to building resilient communities in Tanzania. Hence, we work closely with government agencies and like-minded stakeholders to foster the realization of Sustainable Development Goals and Paris Agreement in the country.

Our long-term goal is to empower communities to take appropriate actions in order to adapt to a changing climate through knowledge generation and sharing, raising awareness as well as setting up model projects which demonstrate how climate change challenges can be addressed across levels and scaled to meet the national development goals. Today, the organization works with more than 50 Civil Society Organizations across the country.

Over the recent, CAN Tanzania has increased efforts on advocating for adoption and use of renewable energy and energy efficiency technologies, an approach emerging on realization of energy sector as the major contributor of greenhouse gases (GHGs) contribution worldwide. We believe that green energy systems will abundantly fast-track individual and national economic growth while contributing to sustainable development in Tanzania. Therefore, CAN Tanzania has increased pace in teaming up with like-minded individuals and institutions that focus on accelerating similar commitments such as implementation of Paris Agreement through Nationally determined contributions (NDCs), UNFCCC, International Energy Charter, IPCC and Sendai framework on Disaster and Risk Reduction.

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Acronyms and Abbreviations

RE- Renewable energy

EE – Energy efficiency

TDV- Tanzania Development Vision

NFYDP – National five Years’ Development Plan

NEP – National Energy Policy

LF – Load factor

IPPs – Independent Power Producers

TANESCO – Tanzania Electricity Supply Company

REA – Rural Electrification Agency

NBS – National Bureau of Statistic

TPES - Total primary energy supply

EWURA - Energy and Water Utilities Regulatory Authority

UNDRR - United Nations Office for Disaster Risk Reduction

UNFCCC - United Nations Framework Convention on Climate Change

NDCs – Nationally Determined Contributions

GDP – Gross Domestic Product

SDGs – Sustainable Development Goals (SDGs)

TGDC - Tanzania Geothermal Development Company

Executive Summary

Tanzania is among the countries with fast growing economies in Africa. In July 1st, 2020 Tanzania was declared to be a lower middle-income economy and thus achieving her goal of becoming a middle-income economy country five years earlier than the country projection. Inline to that, Tanzania has embarked on strengthening various infrastructures systems in an entire country with a special focus on transportation and energy systems. Inline to such deliberate initiatives yet baseline energy data particularly renewable energy resources continue to impair proper planning and implementation of various national level programmes that could accelerate energy sector development in the country.

Several initiatives including restructuring national strategies and policies frameworks could contribute to reliable renewable energy data and information. On the other hand, coupling international commitments that Tanzania as the country is abiding with would accelerate a better aligned renewable energy data as well as proper planning and implementation of energy infrastructures in the entire country.

Of more important, the Tanzania government and other key energy stakeholders in the country need to reflect on this renewable energy baseline report for further data availability, reliability and viability for energy sector development in Tanzania. These includes:

- **Mobilize human and financial resources for short and long -term projections**, and plans for advancement in terms of research, technological transfer and exploitation of renewable energy resources in Tanzania.
- **Continue enhancing cost effective mapping and quantify all renewable energy potentials** including uranium, geothermal, solar, wind and alike in the north, south and central regions of Tanzania.
- **Development of decentralized renewable energy (DRE) technologies**, so as to increase energy access and connectivity which in turn addresses this dominant challenge.
- **Develop stand-alone renewable energy policy and or energy efficiency policy** that will ensure equal subsidy in renewable energy development between IPPs and TANESCO in electricity generation models,
- Focus on how to support **raising awareness and knowledge** on the alternative energies in the country.

1. Introduction

1.1. Background

Five years earlier, Tanzania attained her goal of becoming a middle-income economy country in July, 2020 as were projected under Tanzania development vision (TDV) 2025. The upgrade to middle income economy was associated by steady and strong economic performance for an average of over 6% real Gross Domestic Product (GDP) for the past decade (<https://blogs.worldbank.org/>). Tanzania continue to realize TDV 2025 as the guiding roadmap for attaining sustainable development since this vision entails broader perspective of achieving individual and national economic growth.

The vision entails attaining high quality livelihood; peace, unity and stability; well-educated and learned society; good governance and with a base to a competitive economy that promotes continuous competitiveness and sustainable development in the country (TDV, 2000). The Tanzania government phase 3, realizes initiatives to be undertaken for a continued progress and thus has embarked on the industrialization agenda as well as putting forward industrialization guideline deliberately to transform the country to more stable and resilient economic growth (MPOC, 2020).

Catalyse development

Improve energy infrastructure

Tanzania is firmly **working to improve infrastructures** such as **energy and transportation sectors** which will aid industrialization economy and further advancement of enabling environment to achieving in full of TDV 2025. In line to that, the government has prioritized improvement of energy supply and reliability that will create an enabling environment for strategic pathways to achieving goal commitments realized in five years’ development plans II and III and the TDV 2025.

100 % modern energy access by 2030

The vision of reliable and affordable energy

Tanzania is currently relying on major four strategic pathway projects which will aid country industrialization and resilient economy and these includes construction of Standard Gauge Railway (SGR) that demands reliable energy supply; **75% Rural Electrification** and **100% modern energy access** by 2030; commissioning of Mwl Nyerere hydro power dam by the year 2022 and huge magnitude extraction and development of coal for contributing to reliable energy in the country (<https://blogs.worldbank.org/>).

These reflections justify government commitment at ensuring **reliable and affordable energy supply** for resilient economy. Although not considered under this strategic plans, renewable energy sources have potentials to contribute a significant amount of energy that could further built on a Tanzania industrialized resilient economy.

Unchain Renewable Energy

Potential of RE still untapped

Nevertheless, all these initiatives and realization of such power demand to accelerate and achieve these commitments have inadequately considered the potential into available and diversified renewable energy (RE) resources in Tanzania. Tanzania is abundantly blessed with diversified Renewable energy resources such as wind, solar, biogas and geothermal that once efficiently tapped would contribute to resolving energy demand challenges in the country.

Energy access and use in Tanzania

Make the right connections

Tanzania energy access and use situation survey in Tanzania mainland for the year 2019/2020 reports on 85.7% of Total primary energy supply requirement is exploited from biomass resources especially firewood and charcoal mostly used for cooking, heating and drying (NBS/REA, 2020). The remaining energy is generated from **Hydro, Natural gas and geothermal sources** and very few from wind and solar power, that are contributing to electricity power generated and distributed in Tanzania. The large percentage (77%) of electricity generated and distributed in Tanzania mainland is **used for lighting (77 %)** followed by refrigerating (4.7%), cooling (2.9%), security (2.8%) and 5.8% for other uses (NBS/REA, 2020).

Wander in the dark

Unmapped potential of RE

Limited finance, human, physical and modern technological resources continue to impede power supply for domestic and production purposes in Tanzania (Bishoge et al., 2018). Among other attributing challenge is the **lack of data on geo-location and magnitude of renewable energy resources** for its exploitation and usability.

Limited data = Limited planning

Lack of data leads to lack of data- informed strategies

Emerging applications of RE and energy efficiency (EE) technologies continues to promote such resources exploitation, adoption and usability, however, **inadequate data access** on these processes for developing informed national strategies, policies and long-term plans slows the pace contributing to its application and contribution to achieving TDV 2025. This report therefore, reveal the current status on generation, use and application of emerging RE resources. On the other hand, this report examines and explore opportunities for clean energy resources investment and development.

1.2. Objective of the Assessment

The main objective of this assessment report is to gather and analyse renewable energy baseline data while exploring opportunities that will aid scaling up initiatives along adoption and use of Renewable energy and energy efficiency technologies for ecological and socio-economic transformation in Tanzania. Specifically, this report focuses on:

- i. Revealing and **analysing current energy sources** and use in Tanzania
- ii. Explore and undertake **analysis of the potentials and available RE resources** for addressing energy challenges in Tanzania
- iii. Explore on **how RE resources are contributing to current electricity generation** in Tanzania.
- iv. **Analyse policy and legislation framework and opportunities** to foster RE and or EE technologies in Tanzania

2. Approach /Methodology

This section intends to briefly explore key sources of data and mechanisms utilized to gather these data under this assessment report. These includes

2.1 Desk Review

This assessment focused on reviewing important national regulation documents that directly or indirectly dictate overall allocation, distribution and management of energy resources in the country. Deep revision on sectoral policies and its framework on coordinating energy contribution to productivity was a key and thus reflection on important use of RE sources and technology for ecological and socioeconomic transformation in Tanzania.

The assessment activity involved visiting data portals and various key website for current Renewable energy and energy efficiency technology data such as National Bureau of Statistics (NBS), TANESCO, REA and Ministries of energy, agriculture, water and natural resources and tourism websites.

Among the key documents reviewed includes power system master plan update 2019/2020; Tanzania energy access and use situation survey in Tanzania Mainland 2019/2020; Energy policy 2015; National five years development plan 2016/17 – 2020/21 and the next under development 2021/22 - 2025/26 (NFYDP II and III); Nationally determined contributions (NDCs) submitted to UNFCCC in 2015 and the revised NDCs (which was supposed to be submitted to UNFCCC prior ending 2020); National climate change strategy 2021 -2026, and the revised National climate change response strategy 2021 -2026; EWURA Act 2006 and Electricity act 2008. Using this approach saved time and resources as most of the documents were extracted from institutions website and Tanzania National Bureau of statistics (NBS) portal.

2.2 Analysis and Data Interpretation

This method involved data comparison from various sources and with special regard to time of release (availability and data viability). It focused at utilization of data and information for the aim of simplifying the understanding and implications towards use of such simplicity into reliable, clean and affordable energy investments and supportive coordination and regulatory frameworks. The assessment report is therefore expecting to see government decision makers, energy practitioners and other key energy stakeholders such as civil societies, developmental partners, research institutions, academia and other private sector organs relying on this report for green energy systems planning in Tanzania.

2.3 Limitation

Most of the accessed documents from different portals and websites reflects on the deficiency of data while being prepared, and for such a case reduces confidence level of the assessment report. It was therefore important to conduct questionnaires and interviews to responsible authorities and entities for controversial figures on the available data, however, due to limited time and resources only desk reviews and secondary data gathering were utilized for an assessment report.

3. Current energy demand, status and projection requirements.

3.1 Access and connectivity

According to the Tanzania Mainland Energy Access and Use Situation Survey II (2020), for the year 2019/20; 78.4 percent of the Tanzania mainland total population have ¹access to electricity comparing to 67.5 percent in a year 2016/17. The report reveals **11 percent increase in electricity access** from the previous survey conducted in a year 2016/17.

Urban - rural differentials in electricity access

Significant lower electricity access in rural areas

In addition, the survey analysis showed urban - rural differentials in electricity access and that urban access to electricity rose from 97.3 percent to 99.6 percent, while in rural areas electricity access remained significantly lower as compared to urban areas and that rose from 49.3 percent in a year 2016/17 to 68.9 percent in a year 2019/20. Such kind of differentials continue to create a room for sluggish in inclusiveness initiatives for fostering economic and socio ecological stewardship in rural communities.

¹ Electricity Access: Refers to percentage of people in a given area that have relatively simple, stable access to electricity.

Limited access = limited productive use of energy

Energy enables livelihood activities

Limited access and connectivity to electricity in most of the villages in Tanzania tend to undermine human electricity-based productivity initiatives (Productive use of energy). The sustainable development goal seven (SDG 7) emphasize on the focus to ensure an effective inclusiveness of various marginalized groups in the communities for an increased energy access and connectivity.

The big thinking is to reflect **energy as an economic enabler** to these special groups such as women, youth, small holders (farmers, fisher folks and livestock keepers) and poor people. Of more important, more focus need to be directed in clean, reliable and affordable energy investments so there is a swift adoption and take off in productive use of renewable energy resources in rural areas of the country.

Of more important, it remains to be an open opportunity to scale up decentralized renewable energy in these villages where by a **pay as you go** (PAYGO) system has proven success in some pilot projects. These trials with indication to progress will finally improve electricity access and connectivity driven by energy demands for proactive purposes.

Seven regions of Dar es salaam, Kilimanjaro, Mwanza, Mbeya, Mara, Pwani and Geita were recorded with highest electricity access of 100, 93.6, 89.9, 89.0, 87.7, 85.8 and 84.4 percentages respectively, leaving Kigoma (56.3%), Manyara (58.1%), Shinyanga (61.7%), Songwe (61.9%) and Rukwa (64.8%) with least electricity access in the country.

Tanzania government have put more effort in increasing electricity access to many communities as it could be however **household connected to electricity remains low**. Tanzania Mainland Energy Access and Use Situation Survey II (2020) reports that only 37.7% of household in Tanzania mainland were connected to electricity by the year 2020.

There were a 5.1% rise in electricity ²connectivity to household as compared to the year 2016/2017. According to 12th parliament opening speech by the late President Magufuli in November, 2020; the government will ensure an increased electricity access to 2,384 villages by the end of the year 2025, which under that circumstances all 12,280 registered villages in Tanzania will be fully accessing electricity from the national grid.

Electricity connectivity and access in rural and semi urban areas of Tanzania is a prevailing challenge impeding socio-economic development in the country. Power driven from national grid electricity remains to be the

² Electricity Connectivity according to the survey report refers to a pole in the village and an electric bulb in the house. Household connected to electricity are referred to household whose source of electricity was either TANESCO/REA or private entity.

major source of energy for lighting and inadequately utilized for income generating activities and resolving home based domestic activities.

According to ESMAP, Tanzania energy access and connectivity remains to be applied under tier one of energy usability to contribute to economic growth. Its thus of most paramount importance to start reporting on the energy access and connectivity by describing level of tiers. Further observation reveal existing challenge relies on the current used definitions of energy access and connectivity against electricity access and connectivity. Highly used and popularized terms are electricity access and connectivity, which inadequately provide a room for a wide consideration of other sources of energy that could contribute to socio economic development.

3.2 Energy Demand and Generation

Tanzania update to the middle-income economy was a result of a strong and stable economic performance in economic building sectors such as employment in industries and service provision for about a decade. Early signs of slow but steady structural transformation in key sectors included the continued shift of labour from agriculture to services, and even to industry.

Employment in agriculture declined from 71.4% of total employment in 2008 to 66.3% in 2018, while employment in industry increased to 7.1% from 5.7% and employment in services to 26.6% from 22.9% (African Development Bank, 2020). The growing economy posed an increasing energy consumption and demand to support boom in productivity.

In a year 2012, ³Total primary energy supply (TPES) increased from 13.46 million tonnes of oil (mtoe) to 22.16 mtoe, which was almost 100% energy demand increase over the previous decade since a year 2002 (IRENA, 2017). Biomass energy remain to account for 85.5% of TEPS while petroleum, gas, hydroelectricity, coal and peat contribute 6.6%, 1.5%, 0.6% and 0.2% respectively (IRENA, 2017).

³ Total primary energy supply (TPES) is the total amount of primary energy that a country has at their disposal (IEA 2018).

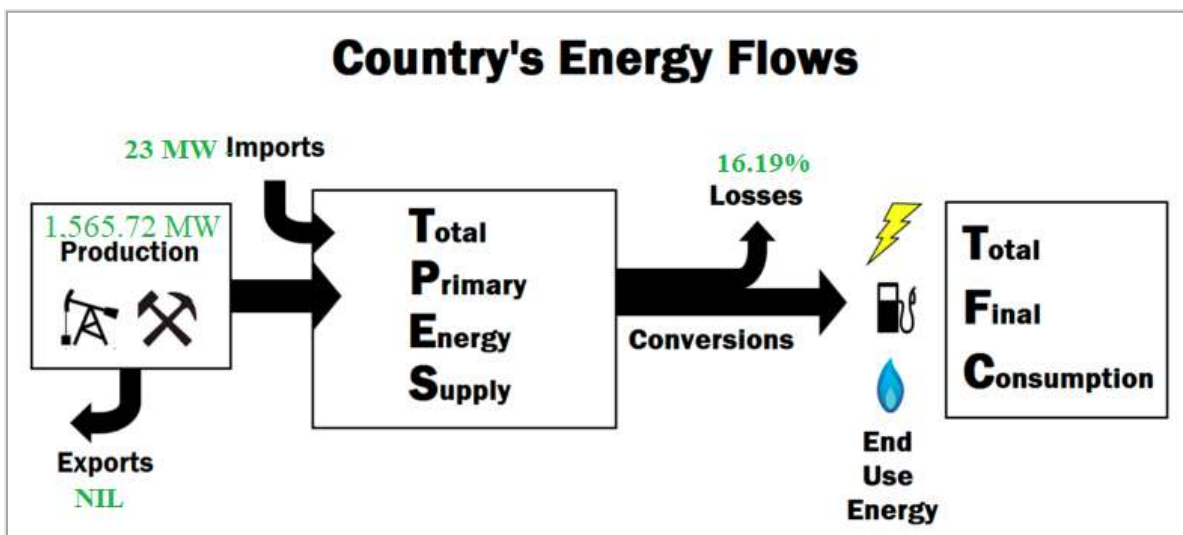


Figure 1: Total primary energy supply in Tanzania (URT, 2020)

According to the power system master plan 2020, Tanzania power system (interconnected grid) have the installed capacity of 1,565.72 MW generated by TANESCO and IPP's (URT, 2020). IPP's generate 189 MW which is equivalent to 12.1% of the total installed capacity. Hydro, thermal, liquid fuel and biomass energy contributes 573.7, 892.72, 88.8 and 10.5 MW, respectively (Figure 2). Remoted and isolated areas are served by thermal generators with a nominal capacity of 36.5 MW. TANESCO remains to be largest power producer and distributor in the country followed by IPPs.

The power system master plan 2020, reports on some of the IPPs that generate and sell electricity to TANESCO for distribution and these includes, Songas 189 MW (natural gas), the other small TPC 9 MW and TANWAT 1.5 MW (biogas), Tulila 5 MW, Mwenga 4MW, Andoya 1 MW, Yovi 0.95 MW, Matembwe 0.59 MW, Darakuta 0.32 MW (hydro). On the other hand, the Tanzania power system imports 17, 5, and 1 MW electricity from Uganda, Zambia and Pemba, respectively.

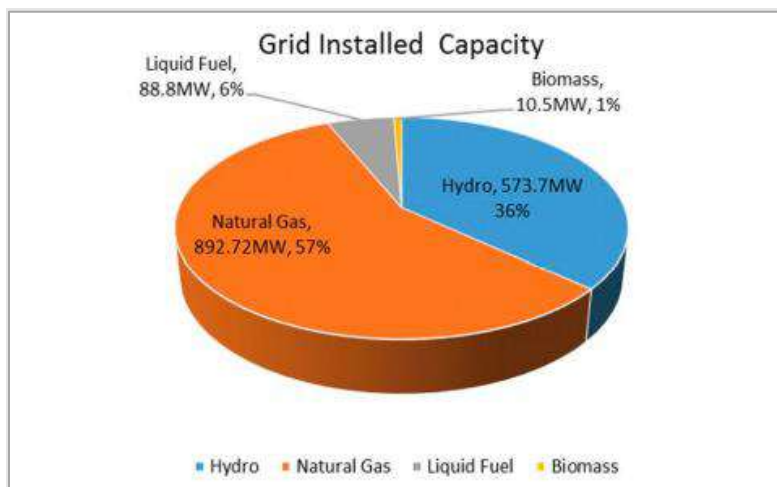


Figure 2: Tanzania power generation mix ((URT, 2020)

There have been several significant changes in the energy system that are reflected in longer-term trends in energy supply and use. For the past decade, there has been a noticeable increase in the total primary energy supply (TPES) and some structural changes in energy sources worldwide. TPES grew 1.4% per year from 2010 to 2018, from 540 EJ to 602 EJ (IPCC, 2018).

Increasing energy demand and end use structures in Tanzania, reflects a continuous level of development **dominated by high energy consumption to the households and limited energy use by industries and manufacturing activities**. Anecdotal statistics reflects an increasing productive use of energy for income generating activities such as solar power water pumping machines in irrigation schemes, refrigeration, heating and drying in different sectors.

3.3 Energy Use

In Tanzania, the **largest energy used is biomass (85.7%)**, and this energy is used in the form of **firewood and charcoal for cooking and heating purposes**. Several studies as reported by Omari *et al.*, (2020) reveals massive forest and land degradation impacts resulted from excessive use of biomass for heating and cooking purposes. Other attributing factors include rapid population growth, land use changes and agriculture practices, and that all these preceding conducts continue to degrade ecosystems and furthermore leading to climate change impacts.

The remaining energy sources contributes to the electricity supplied into households, industries and manufacturing factories by TANESCO and IPPs. According to Energy access and use situation survey II in Tanzania Mainland of 2020, Seventy seven (77%) of electricity is used for lighting in households followed by refrigerating (4.7%), cooling (2.9%), security (2.8%) and 5.8% for other uses (NBS/REA, 2020).

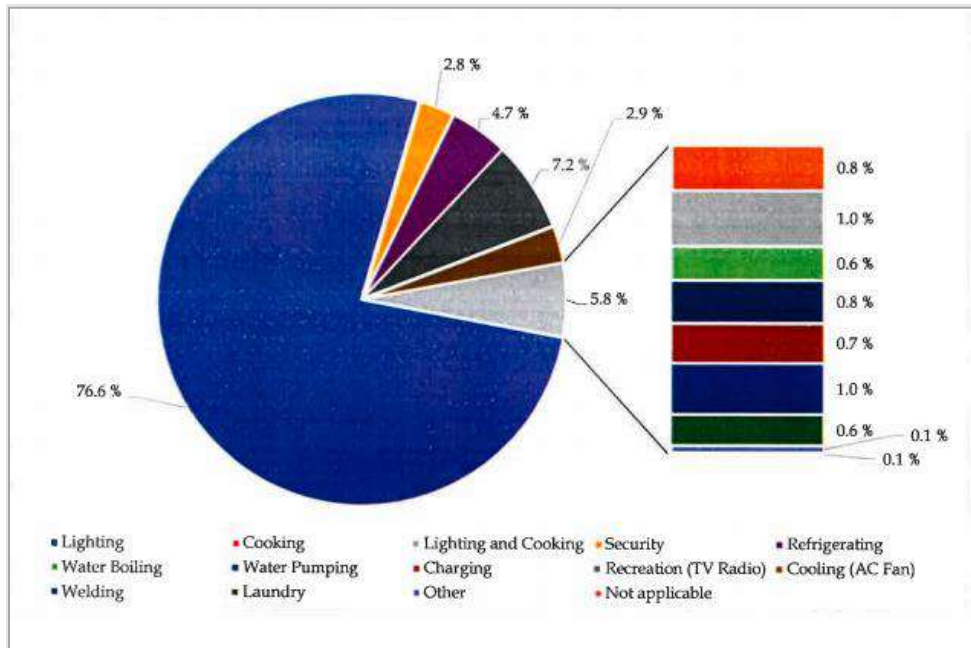


Figure 3: Percentage distribution of Households Reported the main uses of electricity in the Households, Tanzania Mainland 2019/2020 (NBS/REA, 2020).

Tanzania has experienced a steady but slightly increasing power system load factor (LF) from 2009 to 2019. Figure 3 shows a highest load factor to peak in a year 2012 to 76%, however an average load factor of 64.6 from the year 2000 to 2019 have been recorded. The Tanzania power system master plan has been relying on 70% as a benchmark for planning and distribution of electricity in the entire country.

Steady and increasing load factor ensures a stable unit costs of electricity charged to customers and that projects electricity affordability stability while creating an enabling environment for wide use of electricity in the country. Tanzania National five years development plan 2021/20 – 2025/26 (NFYDP III) under development emphasize on promoting renewable green energy technologies including wind, solar and geothermal energy sources in Tanzania. This planning further reflects on green energy systems as the key to natural resources and environmental protection tool and thus contributing to climate change adaptation and mitigation measures in the country.

⁴ Load factor is an expression of how much energy was used in a time period, versus how much energy would have been used, if the power had been left on during a period of peak demand.

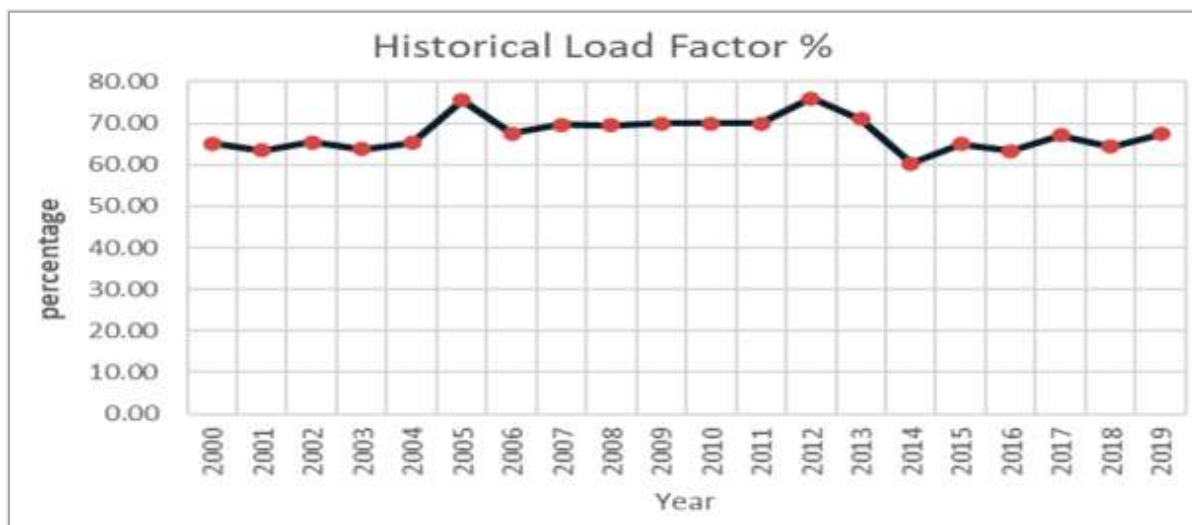


Figure 4: Tanzania power system load factor (%) (URT, 2020)

3.4 Current Energy and, Or Electrification Expansion Initiatives and Projections

Energy system expansion planned mainly based on fossil fuels

In Tanzania power generation systems expansion priorities begin with improvement in the existing systems where feasible prior planning for adding new source of power generating system. To ensure reliable power supply for the load demand, generation is basically based on load forecast results. The highest system maximum demand was recorded to be 1151.66 MW in February, 2020 (URT, 2020). **Planning for power generation** takes into consideration of indigenous resources such as coal, hydro, natural gas, and renewables (geothermal, wind, and solar). In Tanzania, all hydropower system above 10MW are not considered as renewable energy source for managerial purposes.

The risk of climate crisis lock-in

High dependency on fossil fuels and climate-sensitive energy (hydropower)

During the 12th Parliament opening speech on 13th November, 2020 by the late Dr John Joseph Pombe Magufuli (The 5th president for the United republic of Tanzania), the government committed to invest, expand, generate and improve supply of power in the entire country to steer for socio economic development. In his speech, the government commits to finalize construction of Mwl Nyerere Hydropower (2,115 MW), initiate construction of **new hydropower stations** including Ruhudji, Rumakali and Kikonge projected to generate 358 MW, 222 MW and 300 MW respectively (MPOC, 2020).

The focus will also be directed to generation of **more natural gas power** specifically 300 MW from Mtwara region, 330 MW from Somanga Fungu, 600 MW from Kinyerezi III and 300 MW from Kinyerezi IV. Of more

important, the late Hon President Magufuli realized existing potential along renewable energy resources in the country and thus committed to generate more 1100 MW from solar, wind and geothermal energy sources.

Key actors in the energy sector including end users, practitioners, academia, research institutions and developmental partners will need to align to these commitment and plans. Of more important stakeholders need to compliment these initiatives by fostering their investments, planning, implementation, monitoring and evaluation so there is a viable tracking tool to achieve targeted reliable, clean and affordable energy for Tanzanians and thus accelerate, socio economic development.

4. Renewable Energy in The Energy Mix and Contribution to Productivity. Untapped potential

High potential of RE in Tanzania

Tanzania has abundant renewable energy resources that have been inadequately tapped to contribute in the Tanzania power generation mix. According to Tanzania Power system Master plan, (2020); only 105 MW which is equivalent to 6.7% of electricity power generated countrywide is produced from biomass energy, and that large percent of these 105 MW are owned and used by IPPs.

Charcoal and firewood

Unsustainable use of biomass

The anecdotal information reports on less than 2% contribution of renewable energy into the country electricity power generation, however more than 85% of energy utilized in the country comes from unsustainable/unimproved biomass. The most prevailing discussion and concern remains on how this biomass energy are exploited for use.

Several studies including Omari *et al.*, (2020) conducted reports on **unsustainable harvesting and exploitation of biomass resources** which puts human environment at danger through contributing to a number of environmental pollution scenarios. The current government promote tapping and investment in harnessing renewable energy resources in order to increase renewable energy share in the energy mix. These resources include wind, biomass, solar and tidal waves.

4.1 Wind

Wind of change ?

1000 MW wind power potential

According to Power system master plan (2020), several studies that have been conducted reveal a **total potential of 1000 MW wind power** (see PSMP, page 56), with an average speed ranging from 3 to 10m/s. This speed is enough to generate significant amount of clean energy that could increase renewable energy share in the current national power generation mix.

Studies indicate Karatu, Mgagao, Mkumbara, Gomvu, Mafia, Litembe, Makambako and Kititimo as key areas potential to generate wind power in Tanzania Table 1. Highest wind speed is recorded in **the central and northern regions of the country**. Southern regions of the country are recorded to be with low wind speed and this might have been affiliated by wet season starting from October to April or May (Çelik et al., 2015).

Barriers for wind

Several companies including Power pool East Africa, Wind East Africa in Singida and Sion, and Tan Renewable energy Limited in Makambako, Njombe region have shown interest to invest and generate clean energy from wind power (Kitonga & Bonafe, 2015). **Wind power financing, limited availability of human resources and market risks** to sell the generated wind power continue to impair increasing investment in wind energy sources.

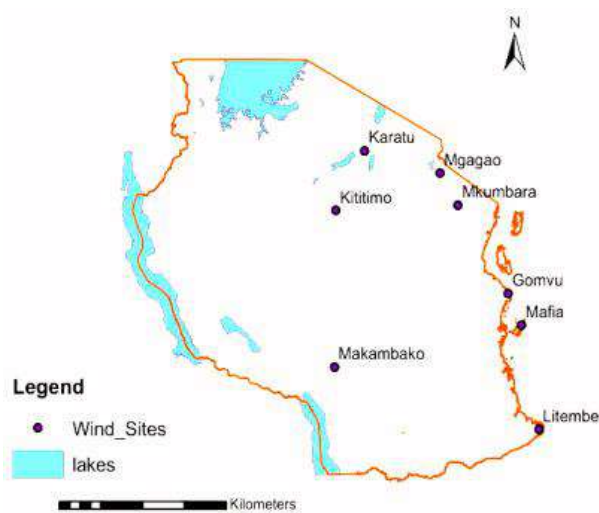


Figure 5: Spatial distribution of wind energy potential areas in Tanzania(URT, 2020)

4.2 Solar

Tanzania has several regions potential for solar power generation with solar insolation capacity ranging from **4.5 to 6.0 kWh per square meter per day**. Some of these regions includes Katavi, Singida, Tabora, Dodoma, Mara and Shinyanga as indicated in Figure 6. For different studies previously conducted in Tanzania, it is estimated that the country has solar power potential of more than 520 MW in total for the named regions.

Table 1: Untapped wind energy potential ((URT, 2020)

S/N	Region	District	Average Wind Speed at 10m (m/s)	Average Wind Speed at 30m (m/s)
1	Singida	Kititimo	8.2	9.4
2	Iringa	Makambako	7.6	8.7
3	Kilimanjaro	Mgagao	3.75	4.85
4	Tanga	Mkumbara	4.14	4.9
5	Arusha	Karatu	4.9	5.5
6	Dar es Salaam	Gomvu	3.56	4.28
7	Mtwara	Litembe	3.21	4.47
8	Coast	Mafia	-	4.01
9	Mwanza	Ukerewe	3.55	4.9

The Tanzania power system master plan update 2020, reports on 6MW total installed solar energy in Tanzania Mainland by the end of the year 2019. All of these solar energies are produced by IPPs for their own use and not directed to the national grid. Most of the IPPs use these solar energies for lighting, powering factories and heating purposes. An extend usefulness of these power sources are found at household level in lower tiers supporting home based domestic purposes, water harvesting, irrigation schemes and training institutions. There is a tremendous increase of use at household levels especially in rural and peri urban areas, and those areas isolated and far from the national main grid, however counterfeit products, limited technical experts, high initial installation costs and unreliability during decreased solar insolation continue to impair an increased pace to adoption and utilization of such power systems in Tanzania.

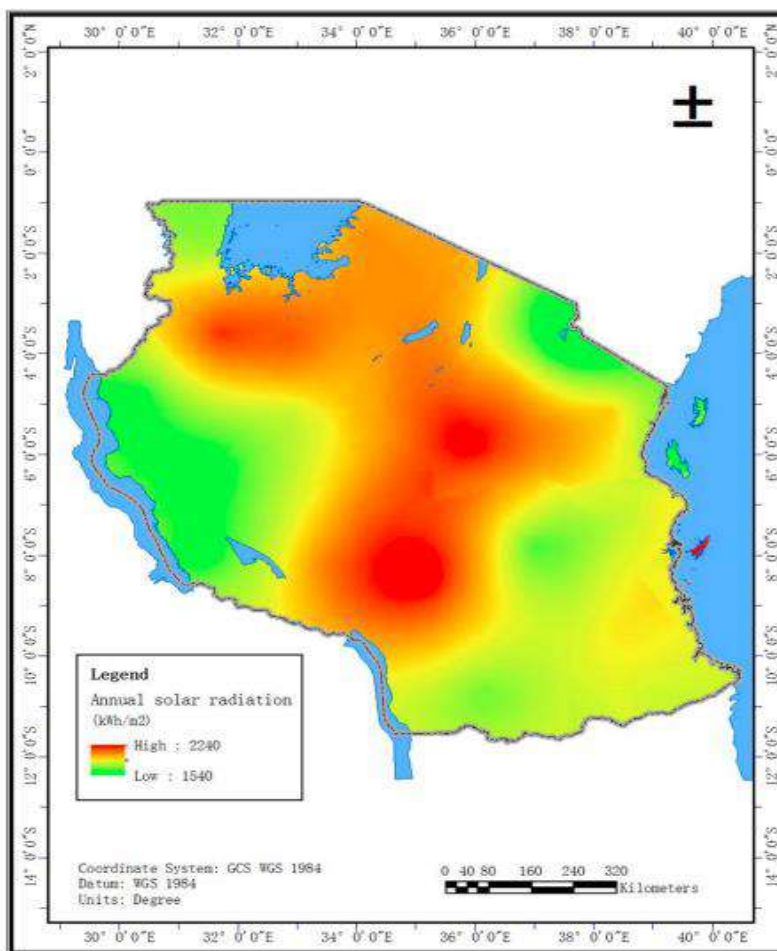


Figure 6: Spatial distribution of annual solar radiation in Tanzania (Çelik et al., 2015)

4.3 Biomass

Biomass energy constitute 85% of the total energy consumed in Tanzania. About 75% of this energy is consumed in the rural areas which heavily contribute to deforestation. Different types of biomass energy include wood fuel (firewood and charcoal), animal waste and agricultural residues. According to Kitonga & Bonafe (2015), the growing woody biomass stock of about 4.39 billion m³ has mean annual increment of 140 million m³.

Previous studies confirm 10 biomass power plants generating 105 MW (Table 2), however large portion of generated energy are used by IPPs for their own use and thus largely not contributing to power supplied through national grid by TANESCO (EWURA, 2018). Abundant use of biomass energy especially firewood has an historical link that domestically lead to rigid communities that willingly could improve the use of such energy sources for sustainable use.

It has to be taken into consideration, that overexploitation and use of biomass degrade the environment and largely contributing to greenhouse gas emissions that are leading to unprecedented impacts of climate change. Unfortunately, the historical usefulness of biomass impose rigidity to switching into other alternative energy sources, believing or unknowingly non-existence of environmental related problems.

Thus, limited knowledge on environmental related problems caused by the use of charcoal and firewood, and limited sense of urgency to act upon switching to better energy options for the knowledgeable communities still lags behind. It is thus of paramount note for the government and energy stakeholders put better policies in place that will enhance sustainable exploitation of biomass resources while continuing building capacities to end users from biomass produces.

The government of Tanzania, through UNFCCC implements the Paris Agreement and, that is intending to implementation of stipulated commitments into a specified Nationally Determined Contributions (NDCs). Tanzania submitted its first NDCs to the UNFCCC in 2015 and become ratified in 2018. Limited inclusivity in preparation and thus poor implementation of commitments led to a necessity of a revised NDCs. Unfortunately, until the end of 2020, the government couldn't succeed to again submit the revised NDC document to UNFCCC.

Currently, the Tanzania government through the Vice president office (VPO) and other key green energy stakeholders including Climate Action Network (CAN) Tanzania and UNDP are in collaborative process to review and fine-tune the revised NDC commitment and immediately submit to the parliament for approval and submission to the UNFCCC. A very critical part of these commitment is to see how they are mainstreamed in the development sectors for planning and implementation and, thus contribute to emission reductions by 20-30% Business as Usual (BAU) from the year 2000.

In addition, Tanzania has prepared National Climate Change Response Strategy (NCCRS) 2021 -2026 which emphasizes on fostering green energy systems as the main contributor and enabler for the national industrialization agenda. The main focus is envisioned industrialised country that relies on reliable, affordable and clean energy (SDG 7) sources, while mainstreaming clean energy and efficiency energy technologies in developmental sectors in the country.

Table 2: Biomass power plant operating in Tanzania (Kitonga, 2015)

Power Plant Name	Fuel	Capacity (MW)	Grid connection
Mufindi (Cogen)	Wood by products	27	Off-grid
Sao Hill (Cogen)	Wood by products	6	Off-grid
Kibena	Wood by products	3	Off-grid
Misenyi (Kagera)	Wood by products	4	Off-grid
Tanzania Plantation Company (TPC)	Sugarcane by products	15	On-grid
Mkonge Energy System (I, II & III)	Sisal by products	2.8	Off-grid
Mkonge Energy System IV (Usambara)	Sisal by products	1.6	Off-grid
TANWAT	Wood by products	3	On-grid
Mgololo	Wood by products	40	Off-grid
Ngombeni (Mafia)	By products from coconut trees.	2.5	Off-grid
Total		105	

4.4: Geothermal

A number of reconnaissance surveys confirms availability and potential geothermal resources in different parts of Tanzania (URT, 2020). Up to the end of the year 2020, already 2170 MW potential from geothermal was confirmed in different localities of the county including Morogoro, Arusha, Shinyanga and Mbeya regions. Tanzania has set plans and goals to exploit and generate 995 MW during the next 25 years from the year 2020 (URT, 2020).

Additionally, in a year 2018 Tanzania Geothermal Development Company (TGDC) initiated plans to generate 5MW, 20 MW and 200MW by the year 2020, 2022 and 2025, respectively (<https://www.thinkgeoenergy.com/tanzania>). TGDC further intends to generate power from geothermal energy sources beyond electricity production but rather aid crop drying, fish farming, green house agriculture and bathing facilities. The power master plan update 2020 assesses important challenges that impair geothermal investments and exploitation in Tanzania and this includes:

- (i) High initial investment costs
- (ii) Long lead time from the conception to power generation
- (iii) High capital and risks in exploration aspects
- (iv) Limited financial resources to undertake baseline studies
- (v) Unfriendly remoteness and infrastructures to access geothermal resources

Below is Table 3 showing revealed geothermal energy potential in the country as of the end 2020.

Table 3: Geothermal energy potential in four regions of Tanzania as of the year 2020

S/N	Site	Capacity (MW)
1	Mbeya	1300
	➤ Ngozi	
	➤ Songwe	
	➤ Keijo-Mbaka	
2	Arusha	500
	➤ Natron	
	➤ Meru	
3	Morogoro	300
	➤ Kisasi	
4	Shinyanga	70
	➤ Ibadakuli	
Total		2170

Source: Tanzania Geothermal Development Company (TGDC)

4.5 Uranium

Uranium is among the nuclear energy sources that generate clean energy and contributes to environmental cleanness at the same time. In Tanzania, 58,500 Mton of uranium resources have been discovered along Mkuju river in Namtumbo District, Southern part of Tanzania. This discovered reserve is equivalent to 927.5 GWyr of energy. An anecdotal information reports on fear to safety for communities surrounding the exploration sites and mining areas. Therefore, an important realization to capacity building and awareness programs could accelerate further interest and demands to its investment, exploitation and use in Tanzania. Some studies indicate prospect reserve of uranium in other regions in the country including Singida, Tabora and Dodoma as indicated in Table 4 below.

Table 4: Uranium reserve in Mkuju-Namtumbo and other areas with prospect deposits in Tanzania.

Name	Region	Size (Mton)
Mkuju	Ruvuma	58,500
Kianju Mbuga	Singida	unknown
Ndala Mbuga	Tabora	unknown
Bahi Swamp	Dodoma	unknown

Source: Geological Survey of Tanzania (GST)

5. Policy and Legislation

Seeding transformation

National policy to regulate the energy sector

Tanzania regulate all energy related matters through the ministry of Energy (MoE). The ministry of energy developed **energy policy 2015** which open up the window and promote private sector involvement in energy generation and supply in the entire country. Under the energy policy, emphasis is being pushed on tapping and generation of energy from clean energy resources to ensure reliable and affordable energy resources.

Primary energy legislation

The Electricity Act of 2008 & Electricity rules of 2019

The primary legislation for generating, transmitting and distributing electricity power in Tanzania is the **Electricity Act of 2008**. The act focuses on the cross country electricity trading and rural electrification (Kihwele et al., 2012). In line with this act, the **Electricity Rules of 2019** (Development of small power projects) and the electricity order of 2019 (Standardized small power projects tariff) stipulates all prerequisites and undertakings to develop and operate power projects in the country.

Enabling environment for decentralized RE

These recent rules and orders have put forward **clear and simplified procedures for the development of mini and off grids** in the country which enhance best enabling environment for the development of decentralized renewable energy in Tanzania. The state-owned company known as Tanzania Electrical supply company Limited (TANESCO) has remained with the monopoly over the power supply in the country since independence.

Energy for everyone

The Rural Energy Agency (REA)

However, the government in recent years through the energy policy 2015 have allowed involvement of private sector in the generation, transmission and distribution in the country. In addition, **Rural Energy Agency (REA)** under the Rural Act of 2005 was established to oversee and implement all **rural electrification projects** in the country through Rural Energy Fund. In recent years, REA has taken initiatives to extend the national main grid in rural areas coupled with small mini grids through energy fund. These initiatives are posing success undertakings in socio economic activities especially in peri – urban and rural areas of the country.

The main challenge remains in the highly scattered settlement villages where by the costs of electricity distribution becomes very high thus leaving these poor population non electrified. However, in most of areas facing this kind of a challenge, an application of decentralized renewable energy solutions with a focus to off grids have proved fruitful progress for the last mile. Furthermore, the highly subsidized TANESCO and REA electricity tend to pose difficulties for the development of new independent mini grids including solar power plants. The tariffs being charged by the independent mini grids are higher and uncompetitiive compared to the subsidized electricity powered TANESCO and REA and thus posing barrier to private investment in renewable energy plants.

The Energy and water utilities regulatory authority (EWURA)

Regulating the energy sector

Regulation of energy sector is undertaken by the **Energy and Water utilities regulatory authority (EWURA)** which was formulated under the guidance of Energy and Water Utilities Authorities Act (Cap 414) (the EWURA Act). EWURA is specifically **dealing with tariff reviews, licencing, reviewing and approving power purchase agreements, and monitoring performance and standards**. Tanzania Energy policy 2015, allows multiple number of energy producers to generate power from various sources such as wind and solar.

Beyond Energy

Key strategies and frameworks guiding the energy sector

This framework aligns with the **National Development Vision 2025 and National Five Years Development plan 2021/26 – 2025/26** that stipulate the need for more strong, secure, and smart power grid. Linked to that is the **National climate change response strategy (NCCRS) 2021-2026** which envision an increased adoption and use of renewable energy resources to cut down greenhouse gas emission by 20-30% BAU as informed by **Nationally Determined Contributions (NDCs)** implementation under the UNFCCC Paris agreement.

The NCCRS 2021/26 emphasize on the realization of green energy systems in the industrialization economy, and ensuring an increased access to social services and productivity in development sectors.

In addition, Tanzania is ratified to the **Sendai Framework** addressing hazard and risk reduction. This framework acknowledges climate change, which is increasing in frequency and intensity, as exacerbating disasters and impeding progress towards sustainable development (Kaimuri et al., 2020). The Ministry of Natural Resources and Tourism and the ministry responsible for public works (the Ministry of Works, Transport and Communication) were found to house the next largest number of principal DRR projects, focused mainly on resource management and road safety respectively.

Taking into regard on the impacts of climate change, Tanzania is committed to enhancing and strengthening climate resilience and mitigation measures through various international frameworks. These includes UNFCCC Paris agreement with a focus to developing and implementing Nationally Determined Contributions (NDCs). Various commitments intending to reduce GHGs for strategic sectors such as agriculture, tourism, transportation, forest, construction, land use and mining were set. Tanzania is currently updating its NDC which was supposed to be submitted in a year 2020. Of the most important action needs to fast rack the approval processes by the parliament and national high-level authorities for submission to the UNFCCC.

In general, most of the small energy producers, investors and village residents are now starting to benefit from renewable energy technologies in Tanzania. However, there is a problem with the **lack of clear energy access roadmap** that harmonize specific investment priorities in renewables to cater for fast, affordable and reliable energy to different levels of economy in the country. In Table 5 below are key government and private institutions responsible to energy or power generation, transmission and distribution in Tanzania.

Table 5: Key energy stakeholders and institutions in Tanzania

S/N	Government/Public Institution Name	Role
1.	Ministry of Energy	It has the overarching role of overseeing policies, strategies and laws within the areas of energy. Its vision is to become an effective institution contributing significantly to the acceleration of socioeconomic development through sustainable development and utilization of energy and mineral resources in Tanzania by 2025.
2.	Tanzania Electric Supply Company Limited (TANESCO)	It is a parastatal institution within the Ministry of Energy in charge of power generation, transmission and distribution. It is the main power utility company in the country and provides about 60% of the effective generating capacity of the national grid.
3.	Energy and Water Utilities Regulatory Authority (EWURA)	This is an autonomous regulatory body set up in 2006 that oversees the technical and economic regulation of the energy and water sectors. Its tasks consist of regulating power retail tariffs, awarding licenses and monitoring and enforcement activities.
4.	Rural Energy Agency (REA)	It was founded in 2005 as part of the Rural Energy Act to support the Government of Tanzania’s endeavours to accelerate access to rural areas. Its major task is to deal with rural access by co-financing rural electrification programmes implemented by relevant actors.
5.	Tanzania Investment Centre (TIC)	This has the mandate of becoming “the primary agency of the government to co-ordinate, encourage, promote, and facilitate investment in Tanzania”. Although not mandatory, the centre is promoted as a one-stop shop for new local and foreign investors because of the incentives offered to projects it approves.
6.	Tanzania Geothermal Development Company	A subsidiary company of TANESCO and became operational in July 2014 with a mandate to be at the forefront of geothermal development in Tanzania. The company is keen to develop the country’s geothermal roadmap and development plan.
7.	Local government authorities (LGA)	They have experience on off-grid production and distribution of energy in their own (mostly urban) areas using decentralized energy systems and mini-grids.
8.	Academic and research institutions	Capacity-building for people working in the energy sector is offered at various universities and research and training institutions in Tanzania.
	Private sector institutions	
9.	Emergency power producers and Independent Power Producers (IPPs)	These are private investors owning power plants of more than 10 MW and currently contributing 40% of the installed electricity capacity.
10.	Small power producers (SPPs)	These are private companies operating small renewables-based power projects (up to 10 MW) under an SPPA to sell power to TANESCO or directly to customers. Many of the small power producers also operate in other business areas such as tea and sugar.
11.	Private solar energy companies	They are organized under the Tanzania Renewable Energy Association but legally permitted to work independently in solar PV installation, importing and selling solar PV products.
12.	Private biomass energy companies	These are companies engaged in the fabrication and supply of improved and clean wood fuel cook stoves.
13.	Civil society Organizations	They include NGOs, faith-based organizations and renewable energy networks. Up until now, many mini-hydropower plants have been owned, operated and managed by faith-based organisations.

Source: (IRENA, 2017)

6. Conclusion and Recommendations

6.1 Conclusion

There is an increasing access to electricity through national grid from 2016 to 2020, however assessment reports reveal a **low connectivity of households** to the national grid, an indication for an **opportunity to scale up DRE resources** that offers accessibility and connectivity to affordable and clean energy for the last mile. For many households connected to the gridy **uses electricity for lighting and not for income generating activities and production purposes**. Most of the electricity end users uses electricity at lower tiers and basically for lighting purposes and **thus need of more push for upgraded higher tiers usability**.

This will contribute to an increased connected and users of electricity power for income generating activities. Additionally, most of the rural areas in central Tanzania are still none electrified. Rural electrical authority is penetrating to some of the village areas with a significant number of residents congregating under one area. Most of the scattered household villages in the rural areas are left behind by the REA programs and initiatives. Decentralized renewable energy (DRE) remain to be the very only solution to the most scattered household villages in Central Tanzania.

There is a number of legislations and coordination framework in place however, policies specifically intending to scale up exploitation, **investment and use of renewable energy and energy efficiency resources are lagging behind** leaving a room for prolonged period of time for such green energy to insignificantly contribute in addressing energy challenges in the country.

Inadequacy of coordination among the existing energy policy of 2015 and other sector plans such as agriculture and forest continue to slow the pace in tapping potentials along renewables in the country. Furthermore, national commitments to international efforts such as Paris Agreement through nationally determined contributions (NDCs) and Sendai frameworks on Disaster Risk Reduction experience limited linkages to national planning and implementations.

In addition, the **lack of awareness**, limited education levels, human and financial resources remain to be the key hindrances towards exploitation and use of renewable energy resources in Tanzania. The increased education and awareness will initiate the anxiety to establish, develop and exploit a wide range of renewable energy technologies for ecological and socio-economic transformation in Tanzania.

6.2 Recommendations

In line with assessed baseline renewable data potentials, power generation and various initiatives in the country pertaining renewables stewardship in Tanzania, this report recommend the following:

○ Short and long-term projections



Deliberate initiatives and strategies by the government and other stakeholders including different developmental partners, CSOs, NGOs, academia and research institutions to put forward and **mobilize human and financial resources for short and long -term projections, and plans** for advancement in terms of research, technological transfer and exploitation of renewable energy resources in Tanzania.

○ Mapping and quantify RE potentials



Continue enhancing cost effective mapping and quantify all renewable energy potentials including uranium, geothermal, solar, wind and alike in the north, south and central regions of Tanzania. This will motivate investment rates as well ensure the reliability to such high demanding capital projects.

○ Develop decentralized renewable energy



The mini and off grid companies, NGOs, Government and other developmental partners have to increase focus on villages with scattered household patterns through **development of decentralized renewable energy (DRE) technologies**, so as to increase energy access and connectivity which in turn addresses this dominant challenge.

○ Develop stand-alone RE policy



The current legal and institutional framework in the country inadequately enhance a wide platform for the renewable energy projects establishment and development. The government needs to put forward the **stand-alone renewable energy policy and or energy efficiency policy** that will ensure equal subsidy in renewable energy development between IPPs and TANESCO in electricity generation models, and therefore pin point the left behind highly taxed clean energy technologies and alike to fast track usability of clean energy technologies in the country. The policy will have to ensure stipulated guidelines on ensuring quality renewable energy products and standards so the users can rely on them.

○ Raising Awareness:



NGOs, International Organizations, the Government and other development partners need to keep a focus on how to support for raising awareness and education on the alternative energies in the country. Most of the communities are still reluctant to the use due to local beliefs, worries on their safety and thoughts on the unreliability. More important, many key energy practitioners and decision makers within the government and the parliament face limited understanding, knowledge and awareness on the role that renewable energy technologies could contribute in addressing community socioeconomic challenges..

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