

CHOICES, CHALLENGES AND DILEMMAS IN TANZANIA'S ENERGY SYSTEM

Research Paper



SID

Society for International Development



Published by:

Society for International Development (SID)
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This publication has been produced by the Society for International Development with the support of the Heinrich Böll Stiftung, East and Horn of Africa Regional Office. The publication, however, remains the sole responsibility of the **Society for International Development**.

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Design and layout by: **SID Communications Team**

Acknowledgements

Adam Anthony Abraham, the author, would like to thank colleagues at the Society for International Development (SID) and participants of the energy workshop held in December 2023 for useful insights, and comments.

Adam Anthony is currently the Executive Director of [HakiRasilimali](#), an extractive industry research and policy centre. This paper is independent, and the views and opinions expressed reflect the views of the authors alone.



An aerial photograph of a busy port. In the foreground, a large container ship is docked, its deck covered with stacks of colorful shipping containers (yellow, red, blue). Several blue cranes are visible on the ship and on the pier. In the background, a city skyline is visible across a body of water, featuring several tall buildings, including a prominent blue skyscraper. The sky is overcast with grey clouds.

Executive Summary

Energy demand in Tanzania is growing, driven by increasing population and economic activity.

There are plans to increase the energy supply from renewable and non-renewable sources to meet the demand and decrease energy poverty. However, the need to increase supply occurs at the same time as there is a global energy transition away from fossil fuels towards renewable energy which requires a new suite of critical minerals.

With both fossil fuels and these minerals available in Tanzania, what energy choices will be made in the coming decades?

Introduction

Energy demand is growing in Tanzania driven by increasing population and economic activity. This demand could be met by the country's abundant and varied energy resources, including biomass, fossil fuels and the renewable energies of wind, solar and hydropower. Instead, most of the population today live in energy poverty, largely reliant on wood fuel and charcoal for cooking and heating. Biomass today accounts for (80-85%) of all energy demand in Tanzania.

This is the first energy transition facing Tanzania, from biomass to cleaner and more efficient fuels. Development policy has usually proposed using

fossil fuels to make this transition. However, faced with potentially catastrophic climate change, Tanzania, along with all other societies, faces an additional transition: to create a low-carbon energy system that meets its society's needs.

In facing this dual transition, what choices are available in Tanzania and how might they be made?

One policy (**Figure 1**) would accelerate the development of Tanzania's fossil fuels, especially oil and natural gas, for export and domestic use.

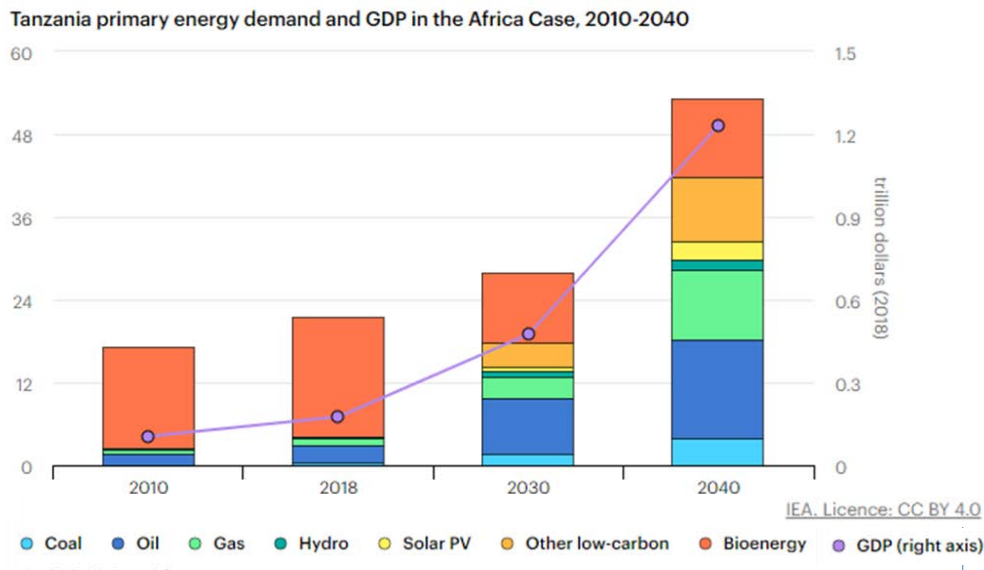


Figure 1: Projection of energy demand to 2040 – example 1

Another policy (Figure 2) would see slower growth in energy demand and the economy, with continued reliance on biomass and less use of fossil fuels. Here, too, there is only a limited uptake of clean renewable energy sources.

This paper outlines a research agenda that can inform current discussions on Tanzania's decisions. It reflects the rich conversations held by the Tanzanian Energy Reference Group in December 2023, backed by information and data from secondary sources.

This paper describes Tanzania's energy mix today and looks at the energy choices facing society. Which energy investments will most reduce energy poverty and improve the well-being of Tanzanian citizens? What might be the consequences of today's energy choices?

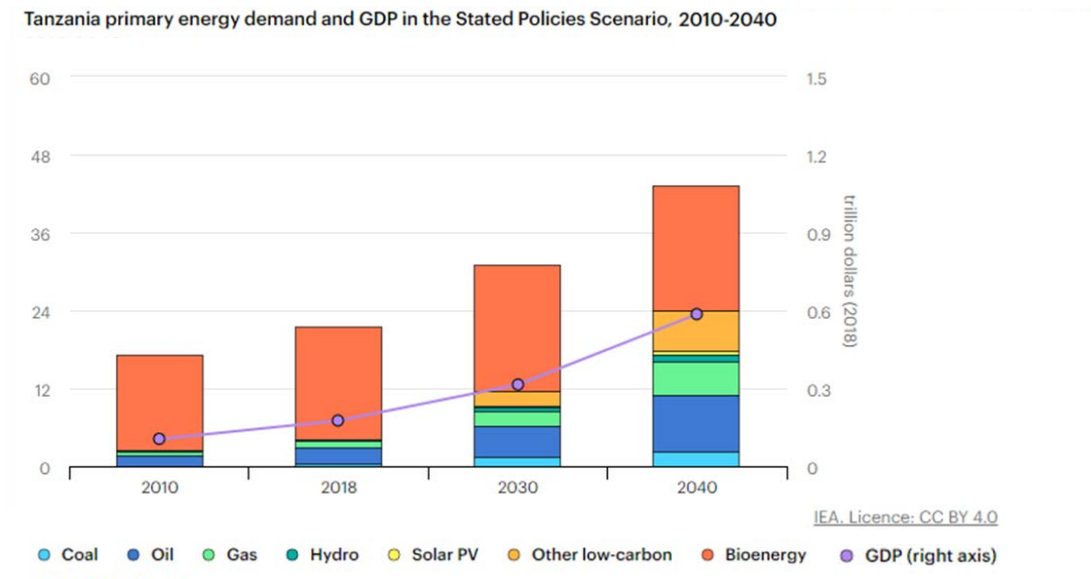


Figure 2: Projection of energy demand to 2040 – example 2

Rural energy development, clean cooking, access, and connectivity

The main energy demand for Tanzania's households is for cooking. Firewood and other solid biomass are the main energy source for households. According to the World Bank less than 60% of Tanzanians have access to electricity especially in the rural areas¹. Accessibility in Tanzania adopts the definition from the International Energy Agency (IEA), which is also used by the Rural Energy Agency (REA) and Tanzania Electric Supply Company (TANESCO). Hence, access to electricity is defined as 'a population having clean, reliable and affordable access to energy services for cooking and heating, lighting, communication and for productive uses'.

According to the Tanzania Cooking Energy Master Plan (2022), 87% of all rural households cook with traditional biomass fuels, followed by 6% of the households using improved cookstoves with firewood and/or charcoal, 4% gas/LPG-based cooking and 3% other fuels including electricity.

Using open stoves that use biomass, kerosene, or coal exposes women and children to toxic smoke known to cause respiratory problems. Overuse of biomass can also have severe environmental consequences for both biodiversity and water systems.

According to the 2021 Energy Progress Report (IEA et al. 2021) Tanzania is amongst the top 20 countries with greatest number of people lacking access to clean fuel and technologies for cooking.

The government is developing a national clean cooking vision to address environmental, health and socio-economic impacts associated with unclean cooking solutions. Tanzania has also developed the national charcoal strategy and action plan (2021-2031) which envision sustainable charcoal value that improves livelihoods. The question remains whether we should continue to encourage charcoal as an energy source in light of the country's energy transition ambitions and climate change commitments. The Tanzanian government has spearheaded initiatives to expand electric power access in rural areas by extending the electricity grid and promoting off-grid solutions. These efforts have been invaluable in reducing energy poverty and supporting economic development (Teske et al. 2023). One of the initiatives that has played a key role in rural energy development is the Tanzania Rural Electrification Expansion Program (TREEP) under the World Bank. This program has helped Tanzania achieve access expansion across the country over the past decade².

¹ <https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=TZ,BH>: accessed on 3 January 2024.

² <https://www.worldbank.org/en/results/2023/11/21/transforming-lives-through-energy-access-afe-1123-in-eastern-and-southern-africa>, accessed on 4 January 2024.



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In total, biomass (charcoal and firewood) used in cooking accounts for nearly 85% of the national energy consumption.

(IEA et al. 2021)

Overview of Tanzania's energy system today

Energy consumption

The total energy consumption in Tanzania has increased 380% (**Figure 3**). This increase was driven by the rapid growth of population and economic development, both production and consumption. Between 1990 – 2017, the average five-year growth rate of energy consumption stood at 12.6%. This trend signals the need to invest in supply capacities, especially as population and the economy continue to expand.

Despite economic changes due to development, **Figure 3** also shows that primary energy consumption in 2021 in Tanzania was still dominated by biomass energy, about 97.67% while the consumption of low-carbon energy such as solar power constitutes 2.33% of total primary energy consumption. For instance, biofuels and waste constitute 88% (five-year average) of total primary energy consumption.

The next highest source is oil, with a five-year average share of 8.8%, followed by electricity, with a five-year average share of 1.94%. Natural gas and coal energy constitute a respective share of 0.38% and 0.54% of total primary energy consumption. This is evidence of a slow penetration of renewable and clean energies in the energy mix. Despite the high share of high-carbon energy in total consumption, Tanzania has recently shown a gradual transition towards low-carbon energy types. Total primary energy consumption in Tanzania continues to increase.

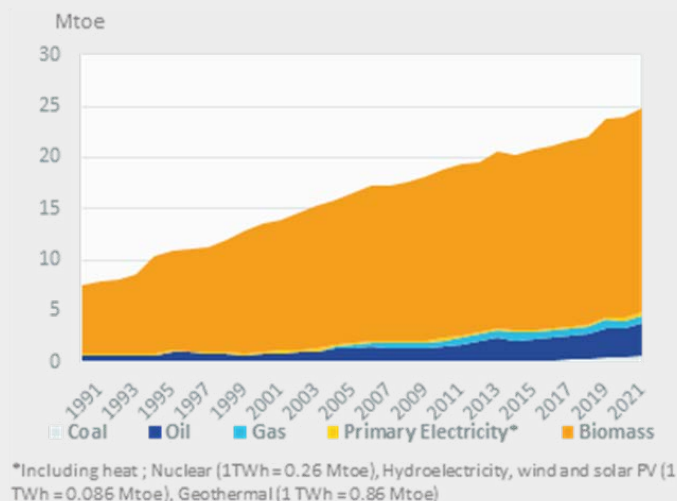


Figure 3: Consumption trends by energy source (Mtoe).
Source: Enerdata <https://www.enerdata.net/estore/energy-market/tanzania>

Energy supply

The total primary energy supply in Tanzania has increased in absolute terms. Between 1990 – 2017 bio-fuels and waste constituted the major energy supply sources constituting about 88% (27 years average) of the total energy supply in Tanzania. Oil, natural gas, and hydro follow in that order, with respective shares of 9%, 1.8%, and 1.2%. The share of renewable energy sources in total energy supply constitutes only approximately 1.2% as against 98% for non-renewable (Philip et al. 2022). Biomass is renewable, but it is being burned faster than it is growing back.

Electric power consumption and supply

While electricity production in Tanzania has increased generally but fallen in some periods, electricity consumption has grown consistently. The major driving factors for electricity consumption are economic growth, population growth, industrialisation, and rural electrification programs. Demand for electric power alone, between 2022 and 2023, increased by 6.86% from 1,276 MW in 2022 to 1,363.94 MW in 2023³. In addition, over the years Tanzania has relied on multiple, though not fully reliable, sources of energy for its power generation such as hydropower.

For instance, in 2023 TANESCO had a total of 1,872 MW total installed capacity against demand that stands at 1,363.94 MW. However, where there should have been surplus, there was load shedding for extensive periods because of the low water level in the power generation facilities. In the total 1,872 MW installed capacity, the leading sources were natural gas 64.04%, hydropower 30.69, Liquefied Fuel 4.7% and biomass 0.6%. There were also off grid mini-solar farms which contributes to 1% of electricity generation in the country. (TANESCO 2023). While currently there is an electricity surplus, the supply will need to match demand growth, while ensuring reliability, accessibility, and transition to cleaner sources of energy.

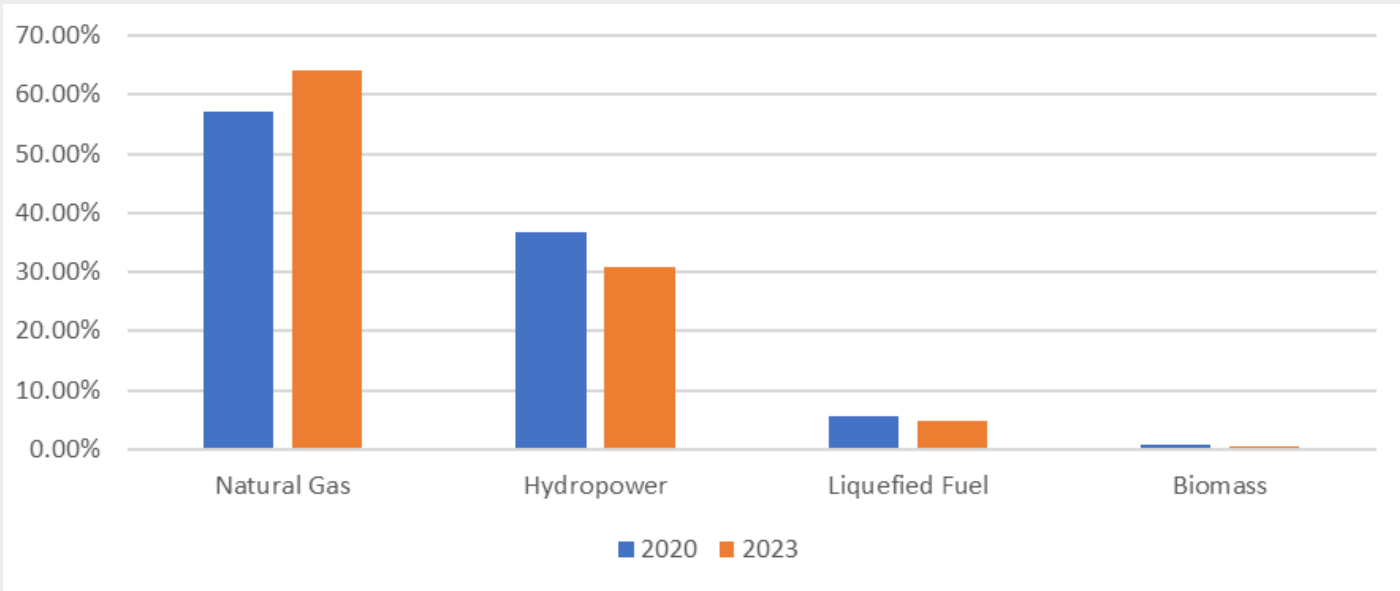


Figure 4: Sources of power generation in Tanzania 2020 & 2023,
Source: TANESCO 2023

³ www.mwananchi.co.tz/mw/habari/kitaifa/live-tanESCO-na-safari-ya-kuliangaza-taifa-4321526, accessed on 5 January 2024.

Both primary energy and electricity consumption show a rising trend, and if this demand is not met with growing and reliable supply, the future seems unclear. Experts such as Philip et al. (2022), proposes that in the short- to medium-term, emphasising demand-side management could prove key in ensuring a sustainable energy system in Tanzania. In addition, a significant boost in supply is required, given the strong drivers increasing energy demand. According to Philip et al. (2022), forecasted peak demand in the medium-term (2020-2025) and long-term (2025-2030) would average annually 1274.74 MW and 1490.33 MW, respectively.

Tanzania power generation relies on various sources, natural gas 64.04%, hydropower 30.69,

Liquefied Fuel 4.7% and biomass 0.6% (TANESCO 2023). But also, according to the 2020 Power System Masterplan (PSMP) update, natural gas generated 892.72 Megawatts (57.02%), hydro-power 573.7 MW (36.64%), Liquid Fuel 88.8 MW (5.67%) and Biomass 10.5 MW (0.67%). Over a period of three years, this shows an increasing role for natural gas, decreasing role for hydro and liquid fuels while biomass remains relatively constant. The electricity supply, being largely hydro-dependent, has suffered periodic short-falls in supply due to water shortages. As such, increasing hydropower potential and diversification to other sources must be a policy priority for Tanzania.

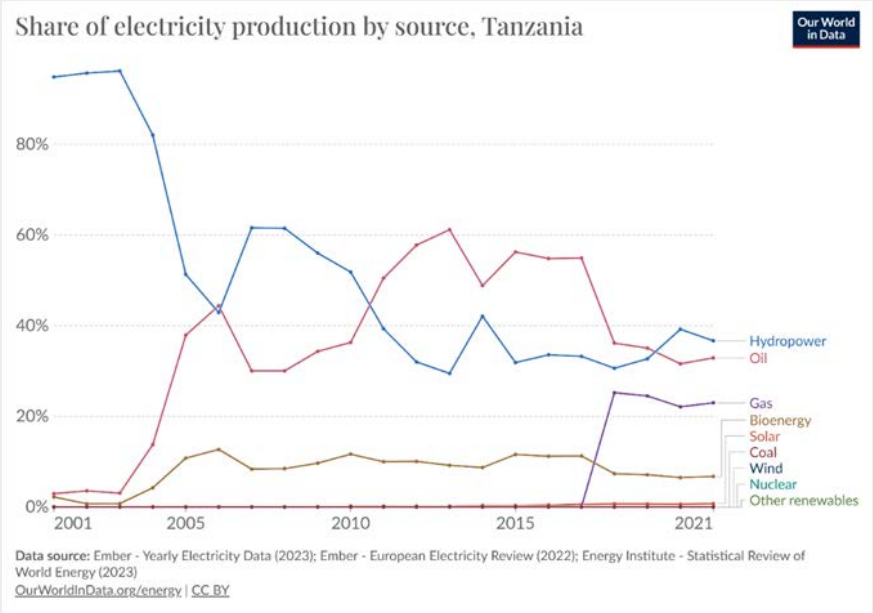
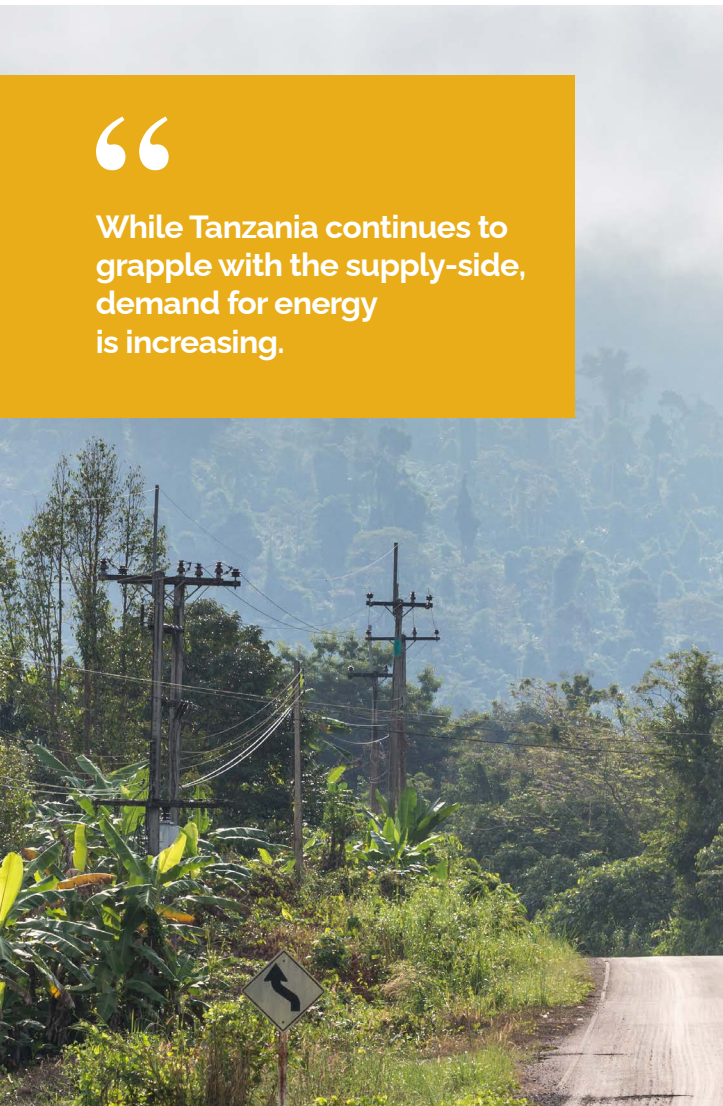


Figure 5: Electricity generation share 2001 – 2021.
Source: Our World in Data, 2023.

Electricity accessibility, connectivity, and costs

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While Tanzania continues to grapple with the supply-side, demand for energy is increasing.



Even with the current supply, accessibility, affordability, and connectivity continue to be critical issues in Tanzania. For instance, current electricity tariffs in Tanzania are ranked among the highest in Africa. The tariff structure does not favour domestic users compared to industrial users, and that can reverse gains in gender equality and energy access (Gray et al. 2022). Women and girls disproportionately bear the burden of energy poverty because of gender norms and traditions, which hinder equal access to modern energy services. As a country, Tanzania might need to look at deliberately creating a gender-responsive energy sector that enables women and men to benefit equally from energy services such as clean cooking.

Tanzania has numerous energy resources from renewable to non-renewable. However, the energy sector in Tanzania continues to be characterized by low electricity access, limited connectivity, and reliance on biomass for household consumption. Recently, Tanzania has embarked upon major power projects such as the Julius Nyerere Hydropower Project (JNHPP) to improve the supply side of energy in Tanzania and there are ambitious targets. Most of these projects however depend on external financing that sometimes delays project implementation. There are also serious environmental costs associated with hydropower. And, despite ambitions to diversify energy supplies through non-hydro renewable energy, Tanzania has mainly developed domestic gas and hydropower on large scale.

Renewables and fossil fuels amidst the quest for transition versus development

Tanzania acknowledges the importance of renewable energy sources in reducing greenhouse gas emissions and ensuring energy security.

This is evidenced by its investment in renewable energy projects, mostly being hydroelectric and growing investments in wind, solar and geothermal (Teske et al. 2023). The idea is to diversify energy mix and reduce dependence on fossil fuels. These initiatives come at a time when the need for a global energy transition is becoming more urgent to avoid damaging climate change.

However, the need to increase the use of renewable energy collides with resource nationalism and the quest to exploit fossil resources without limita-

tions for Tanzania's benefit. Dou et al. (2023) define 'resource nationalism' as the various forms of state involvement in extracting, processing, and marketing natural resources. Despite the world moving towards and promoting renewable sources, a number of countries have shown reluctance to fully develop solar and wind as sources of power on a larger scale. The term resource nationalism is now also frequently mentioned in the sustainable supply of critical minerals needed for renewable energy.

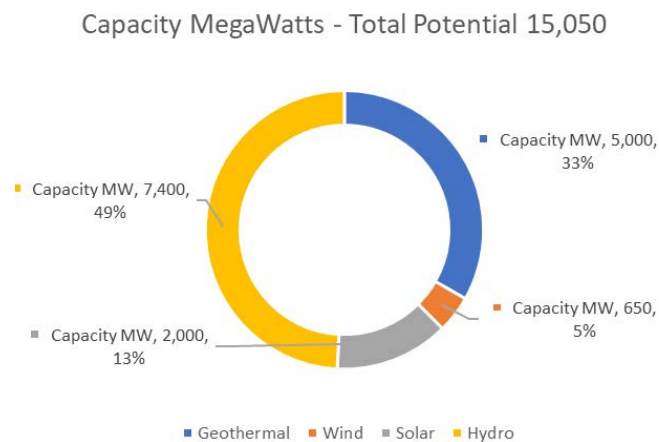


Figure 6: Tanzania's renewable potential.
Source: Own compilation with data from TANESCO (2023)

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Tanzania is estimated to have a renewable energy potential of 5GW from Geothermal, 0.65GW from Wind, 2GW from Solar and 7.4GW from hydropower.

(TANESCO 2023)



Tanzania has a high solar potential that presents a great opportunity for photovoltaic technologies (PV)⁴ power development to meet a growing demand. In addition, Tanzania's windy regions provide a promising renewable energy source and enormous potential to tap into its volcanic activity for geothermal energy.

Despite this potential, renewable sources have rarely featured prominently in government policy or attracted substantial support for investment. Poncian and Pedersen (2023) attribute this fact to the role of conventional resource nationalism. Like other resource-nationalist states, Tanzania has focused on projects where the state has direct investment interests (geothermal, coal, natural gas and hydroelectric) rather than on wind and solar projects where private, and often foreign, investment dominates. Poncian and Pedersen (2023)

believe this explains the slow pace of Tanzania's development of abundant solar and wind resources despite the country's commitments within its policies and plans.

As the global quest for sustainable energy sources continues to grow towards the SDGs target year 2030, the debate on making the transition from fossil fuels to renewables is expected to increase as Tanzania is confronted with a difficult choice to either exploit their fossil fuels or shift to cleaner energy. There are also ongoing debates as to whether renewable energy is cheaper, more expensive, or the same as other sources of energy. According to IRENA Report (2017), one of the barriers to private sector involvement in the renewable energy sector is a restrictive financial environment and high cost of borrowing, but there are also additional hidden costs in red tape and entry barriers.

⁴ These technologies generate power using devices that absorb energy from sunlight and convert it into electrical energy through semiconducting materials.

Critical minerals

A new discussion is developing in Tanzania with regard to the critical minerals and their role in the energy transition.

These minerals are considered essential for the transition to a low-carbon economy based on renewable energy technologies. Initial discussions indicate that Tanzania is endowed with a variety of critical minerals, including lithium, cobalt, nickel, graphite, and rare earth elements (Shao 2023). This presents an opportunity for both the mining and energy sectors. According to the World Bank⁵, the demand for critical minerals is expected to increase by 500% by the year 2050.

While that might mean an increase in exports and revenue, can we ensure that Tanzania benefits not just from the export of critical raw minerals but from their use in renewable technologies such as energy storage or electronic devices that are part of all economic activity these days, including energy systems?

In addition to expanding and strengthening its domestic grid, Tanzania is also executing various cross-border interconnection projects with its neighbours (Kenya, Mozambique, Malawi, Rwanda, Uganda, Burundi, and Zambia) to boost region

al power exchange and promote industrial growth and improve energy security without overloading the existing transmission network. Regional power integration is essential to ease access to the electrical power supply through regional power interconnection (IRENA 2017). With power integration, Tanzania can benefit by exporting surplus power to countries with deficit. Among these projects include Zambia–Tanzania–Kenya (ZTK) Interconnector that will connect Southern African Power Pool (SAPP) countries with Eastern Africa Power Pool (EAPP) countries.

The current surplus and the anticipated 2,114 megawatts from the Julius Nyerere Hydropower Project will be a step towards Tanzania being able to export the surplus power. But before that, Tanzania will need to ensure domestic demand is first met. The domestic energy balance is an important criterion for assessing the security of the energy system. That balance needs to be positive and the export to the neighbours must be reliable to avoid interruptions.

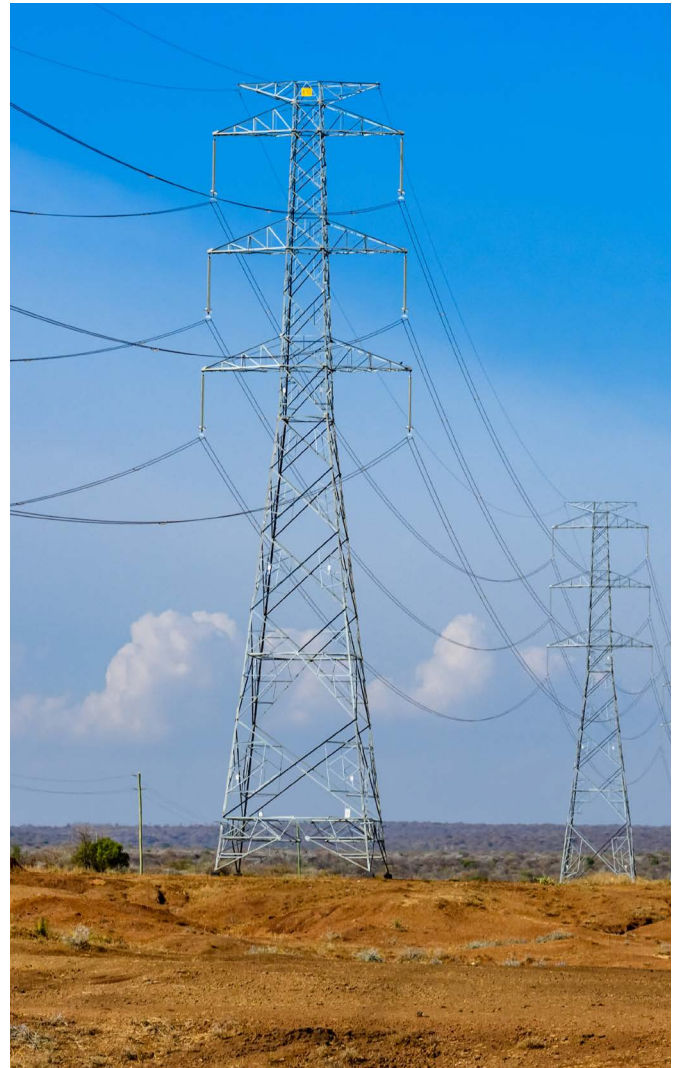
⁵ <https://www.worldbank.org/en/news/press-release/2020/05/11/mineral-production-to-soar-as-demand-for-clean-energy-increases>, accessed on 3 January 2024.

Energy sector layout in Tanzania: policy frameworks and key actors

The entire energy sector is guided by the energy policy of 2015, and other cross cutting policies within other sectors, such as mining. The 2015 energy policy guides development and utilization of energy resources.

Tanzania has various policies in place to support the broader energy sector and specifically for renewable energies. Some of the supporting policies are the National Renewable Energy strategy and Road Map, National Energy Efficiency Action Plan, National Clean cooking vision, and Energy Sector Environment Action Plan. Even though these policies are developed by different ministries and institutions with sectoral goals, there is a level of alignment amongst these policies. However, continuous review and update is recommended especially now as Tanzania is developing its long-term vision 2050.

There are several domestic key stakeholders of the sector led by the Ministry of Energy which is mandated to develop energy and manage the energy sector. These stakeholders are National Environmental Management Council (NEMC), Tanzania Renewable Energy Association (TAREA), Rural Energy Board (REB), Rural Energy Agency (REA), Rural Energy Fund (REF), Tanzania Electric Supply Company Limited (TANESCO), Independent power producers (IPPs), Energy and Water Utilities Regulatory Authority (EWURA), Tanzania Petroleum Development Corporation (TPDC).



Conclusion

Tanzania is faced with two significant challenges.

It is faced with a challenge to shift from biomass to cleaner and efficient energy. At the same time, it also faces a challenge to invest in the vast renewable energy potential and shift to a renewable zero-carbon energy system. Tanzania seems

to slowly be making progress on both aspects but given its energy demands, growing population and commitments to reduce carbon emissions, urgent investment is needed and political will to treat both challenges with greater urgency.

