CENTRAL EUROPEAN REVIEW
OF ECONOMICS AND MANAGEMENT

ISSN 2543-9472; eISSN 2544-0365

Vol. 6, No.1, March 2022, 17-44

www.cerem-review.eu
www.ojs.wsb.wroclaw.pl

Feasibility and potential of renewable and non-renewable energy investments in Tanzania

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Received: 20.11.2021, Revised: 07.02.2022, Accepted: 24.02.2022
doi: http:// 10.29015/cerem.941.

Aim: In the context of renewable and non-renewable energy, this paper aims to explore a range of renewable energy resources in Tanzania that are primarily expected to play a leading role in the supply of energy services in the country. Tanzania, like other countries in the world is striving to invest in renewable energy for sustainable development goals accomplishment.

Research methods: The data used for analysis was collected from 45 businesses/organizations which are operating in the energy sector within the United Republic of Tanzania. The reason was to find out stakeholder's response towards investment in the energy sector. We used purposive sampling to select our sample and asked the stakeholders to fill in the short questionnaire.

Findings: This paper found that there are several opportunities toward investments in renewable energy such as hydropower and geothermal energy; however, an investment in gas as a non-renewable energy source is a good option for Tanzanians.

Value of the paper: This study concludes that Tanzania is facing several challenges on the implementation of energy investments such as institutional, regulatory and legal, lack of human capital as well as economic and financial problems.

Limitations: We have not compared the practices of Tanzania with other countries especially those within sub Saharan African.

Keywords: Renewable Energy, Non-Renewable Energy, Investments, Tanzania.
JEL Codes: D81; P40.

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1. Introduction

The United Republic of Tanzania is the largest country in East African regional block. The country is bordered by the Indian Ocean and eight countries (Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo (DRC), Zambia, Malawi and Mozambique). Tanzania is among the key players in African economy and its important role has been shown on several African social-economic organizations where Tanzania is among the key founders such as the East African Community (EAC) and Southern African Development Community (SADC).

"According to the World Bank (2020), the Tanzanian economy records a strong income growth over the past decade. On 1st July 2020 the World Bank announced that Tanzania's gross national income (GNI) per capital increased from USD 1,020 in 2018 to USD 1,080 in 2019, exceeding the threshold for lower-middle income status." The current economic situation is highly uncertain due to ongoing pandemic (COVID-19) especially in sectors reliant on global demand. The Tanzania's inflation rate has been low and stable. According to the World Bank forecast, Tanzania is among the fastest growing economies in sub-Saharan Africa, Tanzania economy is being above the regions average growth projected at 2.7%.[1]

The World Bank's data shows that the United Republic of Tanzania (URT) has a population of around 58 million, and only 35.6% of the country's population has access to the electricity grid (World Bank 2018). This information implies that the majority of Tanzanian citizens have limited access to energy supply. Ideally, energy is critical for the growth of the economy, social development, and quality of life worldwide (Acikgoz 2011; Abu-Rumman et al. 2020).

In Tanzania, there are several energy sources such as biomass, solar, hydropower, geothermal, biogas, wind, tidal, and waves; however, the major sources of power are only natural gas, petroleum, and hydropower. One previous study reveals that an adequate and efficient energy supply contributes to the country's social-economic and political development (Abu-Rumman et al. 2020).

[1] https://www.thecitizen.co.tz/tanzania/news/world-bank-upbeat-on-tanzania-prospects

The energy supply in the country increases access towards reliable, sustainable, affordable, and modern energy to its citizen. Renewable energy sources are vital to local household users because most people depend on firewood, charcoal, and cow dung as their source of energy. These local energy sources are threatening to human health and contribute to climate problems, mainly global warming effects. To ensure a friendly environment, an efficient and sustainable source of power, the use of renewable energy sources is the best option. For this reason, the investment in renewable energy resources in Tanzania is inevitable.

According to Heshmati et al. (2014), there is a global concern about renewable energy sources. To date, many countries have started to fix facilities that use renewable energy sources for power generation. Sources and to date many countries have started to fix facilities that use renewable energy sources for the power generation. These alternative energy sources are essential in eliminating challenges arising from climate change. Tanzania has great potential to develop these renewable energy sources if the great effort to other renewable sources such as solar, thermal, wind, biomass, and biogas will be utilized similar to the ongoing hydropower projects. Therefore, a well-established, produced, and utilized renewable energy in a modern and sustainable manner will assist a large population of Tanzanians and is expected to eliminate energy problems in the country.

The remainder of this paper is organized as follows. Section 2 presents the energy situation in the country. Section 3 reveals and discusses different renewable energy sources in Tanzania. Section 4 focuses on discussion of electricity situation in the country. In this section we also make use of primary data from 45 companies working in the energy sector and we present policies and regulations of the energy sector in Tanzania. We close this section 5 with paying attention to investments made in the country's energy sector. The final section provides a summary and concluding remarks.

2. Energy situations in Tanzania

Tanzania uses various energy sources; however, electricity and biomass are largely used throughout the country. Tanzania Electric Supply Company Limited (TANESCO) is the main supplier of electric power in the country. This company is a state-owned organization that owns most of the nation's transmission and distribution network and more than 50% of its generating capacity. TANESCO, as a sole national utility organization dominates the power sector in the country. Another main source of energy is biomass, which accounts for 83% of the total energy consumption in Tanzania. In the country's rural areas, biomass is mainly used as fuel for cooking and heating.

The use of firewood as the main source of energy for cooking is still predominant in Tanzania. The data shows about 71.2% of households use firewood as the main source of energy for cooking, followed by charcoal (37%) and kerosene (5%).[2] Further, the report revealed that the use of firewood is more dominant in rural households (92%) compared to urban household (28.4%). Moreover, the use of modern source of energy for cooking (electricity, bio and industrial gas, and solar) by households' accounts for only 1%.[3]

2.1. Energy data

The total primary energy supply in Tanzania is presented in Table 1 below. As indicated in the table, biofuels and waste account for 83.9% of the primary energy supply in the country. This is followed by oil products (11.9%), natural gas (2.8%), hydro (0.7%), and coal (0.6%). The remaining primary sources of energy supply accounts for about 0.1%.

The total final energy consumption in Tanzania is presented in Figure 1 in the KTOE, and Figure 2 in percentage-wise. The data shows that biofuels and waste are the most used energy accounting source for 85% of the country's total energy consumption. The other sources of energy used in Tanzania are oil products, which are about 12%, electricity about 2%, coal about 0.7%, and natural gas, which is about 0.6%.

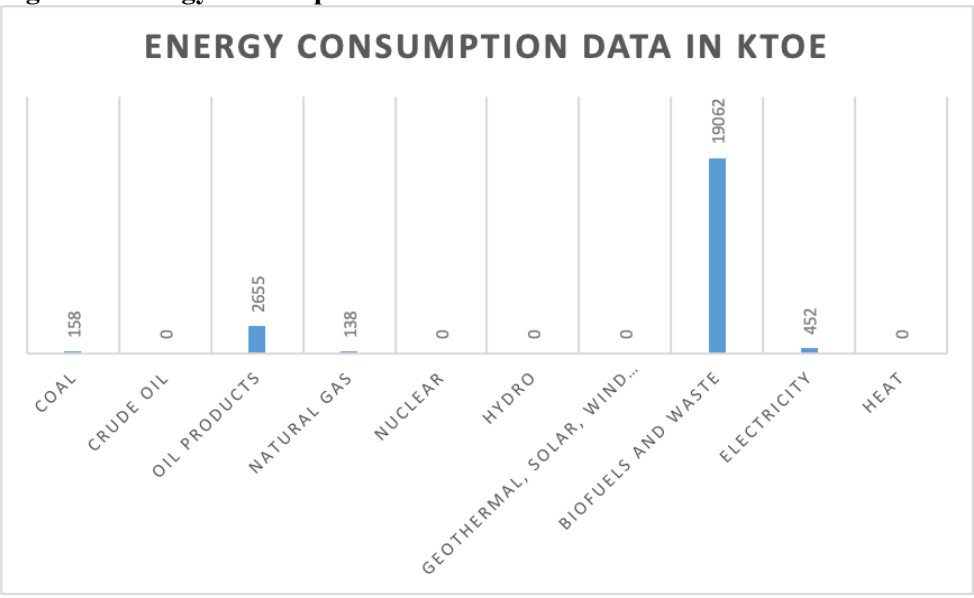
[2] REA and NBS-Energy Access Situation Report,2016 Tanzania Mainland
[3] REA and NBS-Energy Access Situation Report,2016 Tanzania Mainland

Table 1. Energy supply data

Total primary energy supply	KTOE	Percent (%)
Coal	158	0.6
Crude oil	0	0
Oil products	3089	11.9
Natural gas	731	2.8
Nuclear	0	0
Hydro	181	0.7
Geothermal, solar, wind etc.	2	0
Biofuels and waste	21801	83.9
Electricity	6	0
Heat	0	0
Total	**25968**	**100**

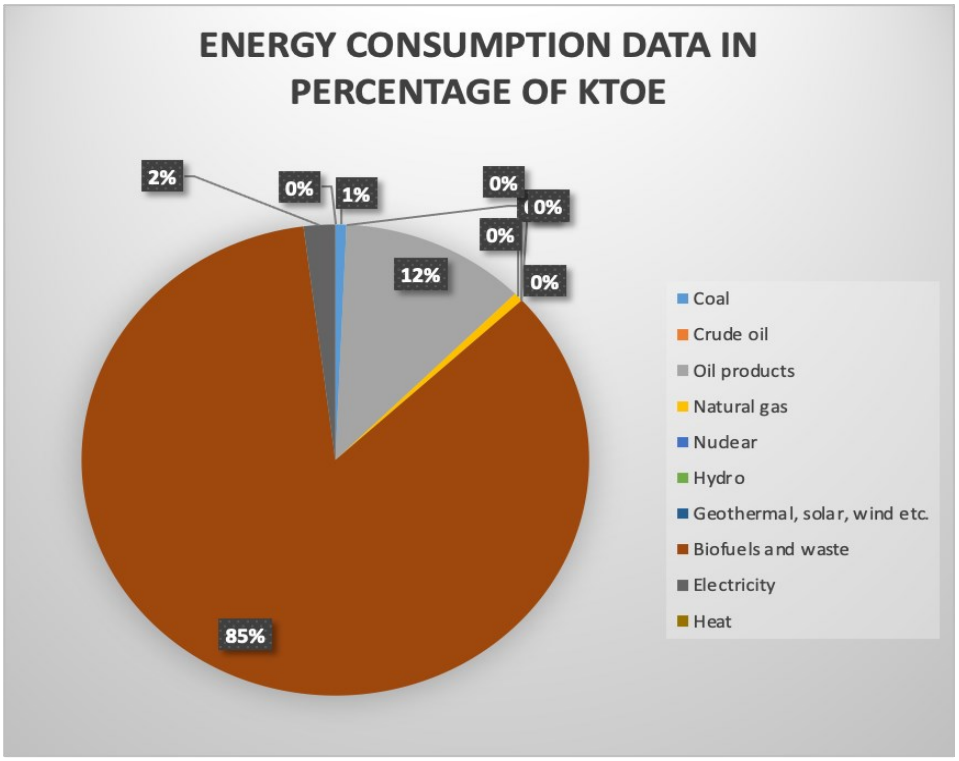
Source: IEA Statistics (2015).

Figure 1. Energy consumption



Source: IEA Statistics (2015).

Figure 2. Energy consumption (percentage of KTOE)



Source: IEA Statistics (2015).

3. Energy sources in Tanzania

3.1. Renewable energy sources

3.1.1. Wind energy

Wind energy has been the fastest–growing renewable energy technology in the world since the 1990s, and it's one of the cheapest resources per unit of generated electricity (Aliyu et al. 2018). The government of Tanzania, through TANESCO, has identified the potential areas for wind parks. There are several areas in the country, predominantly along the coast, with attractive wind speed.[4] Kititimo in Singida Region (9.9 m/s average wind speed at 30m) and Makambako in Njombe

[4] http://www.reegle.info/countries/Tanzania-energy-profile/TZ

Region (8.9 m/s), having been identified as promising wind resources for grid-scale electricity generation. TANESCO in collaboration with the Ministry of Energy (MET) is conducting wind resource assessments on eight further sites throughout the country. The Rural Energy Agency (REA) is supporting the wind measurements on Mafia Island. To date, four private companies have expressed an interest in investing in wind energy, considering construction of farms in the 50-100 MW range.[5]

Recently, the country's first-ever wind farm started generating electricity as part of its start-up testing procedures. This wind farm is located at Mwenga, Mufindi District, in Iringa Region. This wind farm has a full capacity of 2.4 MW; the wind farm will provide much-needed energy security to clients of a rapidly expanding private rural grid network developed and operated by project developer Rift Valley Energy Group.[6] Overall, there are various potential areas for massive investment in wind energy throughout the country.

3.1.2. Solar energy

One previous study revealed that Tanzania has the greatest potential for renewable energy investments, particularly solar energy, due to its high solar irradiance (Aly et al. 2017). The levels of solar energy in the country is promising, ranging between 2,800 and 3,500 hours of sunshine per year and global horizontal radiation of 4-7 kWh per m^2 per day.[7] The central region of Tanzania has high solar radiation compared to other regions or parts of the country. Many solar developers are seeking to set up large solar Photovoltaic (PV) projects in the country.

Recently, about 6 MW of solar off-grid PV has been installed in the country. PV installations are mostly used at villages, schools, hospitals, health centres, police stations, small telecommunication enterprises, and households mainly for premises lighting, street lighting, and basic electricity needs. The government of Tanzania's government has been supporting the expansion of solar PV programs with close collaboration with REA and various donors countrywide. One-grid connected PV plant has been commissioned to date. The 1 MW-plant produces about 1,800 MWh/year. The potential for grid-connected solar PV is estimated to amount 800

[5] http://www.africa-eu-renewables.org/market-information/tanzania
[6] htpp://www.offgridenergyindependence.com
[7] htpp://www.get-invest.eu

MW. A number of private companies have expressed interest in developing 50-100 MW solar plants.

3.1.3. Hydropower

Hydropower is the most important indigenous renewable energy source of commercial energy in Tanzania, with a recognized potential of 4.7 GW of installed capacity and 3.2 GW of firm capacity. At present, only 15% of the potential installed capacity has been developed in the country, and several projects are currently soliciting funding.[8] Generally, the hydropower potentials in the country are located in the Rift Valley escarpments in the West, South west, and Northeast Regions of Tanzania. The planned hydropower generation sources in Tanzania includes the Stigler's Gorge (2,100 MW), Ruhudji (360 MW), and Rumakali (220 MW).[9]

The Stigler Gorge project is the country's largest hydropower project that can produce enough electricity to justify investment in extending the national electricity grid. For many years now, hydropower has been the key source of electricity in the country; however intermittent river flows have threatened its reliability. Moreover, the issue of regional mismatch between hydropower sites and major demand centers is another major challenge facing the country as hydropower is concerned. The Tanzania power system master plan includes 16 hydropower projects with a combined capacity of 3,000 MW to be finalized by 2031. At present, TANESCO owns two small scale hydropower plants, namely Nyumba ya Mungu (8 MW) in Kilimanjaro Region and Uwemba (4 MW) in Njombe Region, while private institutions own two sites such as Mwenga (4 MW) in Iringa Region and Yovi (1 MW) in Morogoro Region. TANESCO has identified a further 131 specific small hydropower sites across the country. Overall, the Tanzania potential in hydropower includes those 16 hydropower projects with a combined capacity of 3,000 MW to be finalized by 2031

[8] http://www.rvo.nl –Final energy report Tanzania
[9] http://www.rvo.nl –Final energy report Tanzania

3.1.4. Bio-energy

The bio-energy account for more than 80% of the total energy consumption in Tanzania. In the rural areas of Tanzania, biomass (mainly wood) is used to produce charcoal, which is sold in the urban areas of the country as the main source of household energy.[10] Throughout the country, charcoal is the single largest source of household energy in urban areas. The proportion of households in Dar es Salaam (the largest commercial/business city in Tanzania) using charcoal has increased from 47% to 71% during 2001 to 2007 (World Bank 2010). In the past, during 2009, it was forecasted that half of the country's annual consumption of charcoal was consumed in Dar es Salaam, amounting to 500,000 tons.

Currently, there is only one grid-connected biogas plant (18MW) in place. However, several private organizations, especially those in agro-industrial, have constructed their captive power systems based on biomass to generate electricity for their daily operations. The potential for modern biomass uses in Tanzania is very high considering that the raw materials available is abundant and includes sisal (0.2 MTPY), rice husk (0.2 MTPY), sugar bagasse (1.5 MTPY), coffee husk (0.1 MTPY), forest residue (1.1 MTPY) and municipal solid waste (4.7 MTPY).[11]

3.1.5. Geothermal energy

Tanzania has potential for geothermal power generation with a temperature of up to 255 degrees centigrade (dry steam). At present, more than 15 thermal areas with hot spring activity could be justifiable development projects. The total potential geothermal power in 50 identified sites is 650 MW. The Songwe site, which is located in the southern part of the country, is the largest with the estimated potential of 100MW of electricity.

The government of Tanzania believes that this renewable energy source will diversify its power sources and bring massive cost benefits to the citizens in terms of appropriate energy sources for the appropriate purposes including reductions in emissions (Kajugus et al. 2018). The major challenges for geothermal power generation in the country are that some of the identified geothermal sites, for

[10] http://www.rvo.nl – Final energy report Tanzania.
[11] http://www.africa-eu-renewables.org/market-information/tanzania

instance, Lake Natron, are in or near reserves such as Lake Manyara National Park and Ngorongoro Conservation Area Authority. The geothermal exploitation involves changing the flows of underground water, which have led to the draining of nearby lakes. Overall, the country potential geothermal power is on those 50 identified sites of 650 MW of electricity.

3.2. Non-renewable energy sources

3.2.1. Natural gas

The exploration of natural gas in Tanzania has been for more 50 years. The first natural gas discovery in the country was made on the Songo Songo Island (located in Lindi Region-Southern Tanzania) in 1974, followed by Mnazi Bay (located in Mtwara Region-Southern Tanzania) in 1982.Tanzania decided to commercialize natural gas in 2004 and 2006 for Songo Songo and Mnazi Bay respectively. Since the year 2010 (about a decade ago), Tanzania has witnessed further natural gas discoveries with the latest estimated natural gas reserve (2016) of 57.25 trillion cubic feet (EWURA 2017).[12]

To date, a total of 67 wells for both exploration and development were drilled between 1952 and 2013 in the country. Tanzania natural gas was discovered for both offshore basins (14 wells) and onshore basins (53 wells). There is a potential for natural gas in the country especially for domestic consumption, natural gas production (annually) has increased from 5.2 billion cubic feet in 2006 to 110 billion cubic feet in 2017, all of which destined for domestic consumption.[13]

3.2.2. Petroleum

The country does not produce crude oil, and Tanzania has not had a recent commercial oil discovery. The county consumes around 35,000 barrels per day of refined oil products, all of which is imported.[14]

The county is a net importer of petroleum products. The imported petroleum products in Tanzania includes Automotive Gas Oil (AGO), Unleaded Motor Spit Premium (MSP), Jet A-1, and Illuminating Kerosene (IK). The county introduced

[12] https://www.tanzaniainvest.com/gas
[13] https://www.tanzaniainvest.com/gas
[14] https://www.eia.gov/intenational/analysis/county/TZA

the Bulk Procurement System (BPS) in January 2012 for petroleum products supply in the country.

In 2018, The East African country imported USD 1.77 billion in Refined Petroleum, becoming the 75th largest importer of Refined Petroleum in the world.[15] During the same period (2018), Refined Petroleum was the 1st imported product in Tanzania. The country import Refined Petroleum from various countries including India, United Arab Emirates (UAE), Saudi Arabia, Switzerland, and Oman.

In April 2021, the construction of a crude oil pipeline would take place from Hoima in Uganda to Tanga in Tanzania. The pipeline will be 1,445 Km long and will cost USD 3.5 billion. This Once completed, the pipeline (The East African Crude Oil Pipeline) is a key potential for the country crude oil and will be the longest heated crude oil pipeline in the world.

3.3. Energy sources feasibility and potentials

This sub section provides an overview of energy sources (both renewable and non-renewable) in Tanzania. The feasibility and potentials of various energy sources in Tanzania has been summarized in Table 2.

Table 2. Energy sources feasibility and potentials in Tanzania

	Feasibility	**Potential**
Renewables:		
Wind energy	TANESCO in collaboration with the Ministry of Energy (MET) is conducting wind resource assessments in the country and Rural Energy Agency (REA) is supporting the wind measurements.	Overall, there are various potential areas for massive investment in wind energy throughout the country.
Solar energy	In Tanzania, the levels of solar energy is promising, ranging between 2,800 and 3,500 hours of sunshine per year and global horizontal radiation of 4-7 kWh per m2 per day.[16]	The potential for grid-connected solar PV is estimated to amount 800 MW. A number of private companies have expressed interest in developing 50-100 MW solar plants.

[15] https:// www.vallis-goup.com-The Petroleum Industry in Tanzania
[16] htpp://www.get-invest.eu

Table 2. Cont.

Hydropower	In Tanzania, only 15% of the potential installed capacity has been developed in the country, and several projects are currently soliciting funding.[17]	The Tanzania potential in hydropower includes 16 hydropower projects with a combined capacity of 3,000 MW to be finalized by 2031.
Bio-energy	The proportion of households in Dar es Salaam (the largest commercial/business city in Tanzania) using charcoal has increased from 47% to 71%, during 2001 to 2007 (World Bank 2010).	The potential for modern biomass uses in Tanzania is very high considering that the raw materials available is abundant and includes sisal (0.2 MTPY), rice husk (0.2 MTPY), sugar bagasse (1.5 MTPY), coffee husk (0.1 MTPY), forest residue (1.1 MTPY) and municipal solid waste (4.7 MTPY).[18]
Geothermal energy	In Tanzania, more than 15 thermal areas with hot spring activity could be justifiable development projects.	The total potential geothermal power in 50 identified sites is 650 MW of electricity.
Non-renewables:		
Natural gas	In Tanzania, a total of 67 wells for both exploration and development were drilled between 1952 and 2013 in the country.	There is a potential for natural gas in the country especially for domestic consumption, natural gas production (annually) has increased from 5.2 billion cubic feet in 2006 to 110 billion cubic feet in 2017, all of which destined for domestic consumption.[19]
Petroleum	The country does not produce crude oil, and Tanzania has not had a recent commercial oil discovery. The county consumes around 35,000 barrels per day of refined oil products, all of which is imported.	The construction of a crude oil pipeline from Hoima in Uganda to Tanga in Tanzania (The East African Crude Oil Pipeline) is a key potential to the country.

Source: Authors' own elaboration.

[1717] http://www.rvo.nl –Final energy report Tanzania
[18] http://www.africa-eu-renewables.org/market-information/tanzania
[19] https://www.tanzaniainvest.com/gas

3.4. Major stakeholders in the Tanzania energy sector

This sub section provides an overview of major stakeholders in Tanzania energy sector (both renewable and non-renewable). In Tanzania, the energy sector is characterized by a plurality of stakeholders; at present extensive reforms are being planned. Currently, the main players are the following.

Tanzania Electric Supply Company Limited (TANESCO) is the energy public utility organization in the country. TANESCO acts as producer, transmitter, and distributor of electricity in the country. It is also a single buyer from Independent Power Producers. Small Power Producers may directly serve clients in areas not covered by TANESCO. In the near future, TANESCO will be divided into two to three companies to create an independent system operator and halt government subsidies.[20]

REA is an autonomous body under the Ministry of Energy of the United Republic of Tanzania. Its main function is to promote and facilitate improved access to modern energy services in rural areas of Mainland Tanzania. REA overseas development in rural areas and it's an independent government agency in the country. REA became operational in October 2007.[21]

EWURA is the energy, and water utilities regulatory authority. EWURA is an autonomous multi-sectoral regulatory authority established by the EWURA Act Cap 414 of the laws of Tanzania. EWURA is responsible for technical and economic regulation of the electricity, petroleum, natural gas, and water sectors in Tanzania pursuant to Cap 414 and sector legislation. EWURA is setting the rules, tariffs, licensing, monitoring and standards.[22]

In Tanzania energy sectors, there are other stakeholders involved, such as donors, Non-government organizations (NGOs), private companies, universities, private and public, and faith-based groups.

[20] African Development Bank Group-Renewable Energy in Africa.
[21] http://www.rea.go.tz/AboutREA
[22] http://www.ewura.go.tz/about-ewura

3.5. Energy policy and regulations

3.5.1. General information

TANESCO has until recently retained a monopoly capacity as the only utility company operating the national grid. Through the Electricity Act, the government of Tanzania has lifted TANESCO's monopoly by allowing private sector involvement in the generation, transmission, and distribution of electricity in urban and rural areas throughout the country. Regulation of the energy sector in the country is undertaken by EWURA. As the regulator, EWURA's activities include licensing, tariff review, monitoring performance and standards, as well as reviewing and approving power purchase agreements. The main energy policies and regulations in Tanzania include; National Energy Policy 2015, Electricity Act 2008, Energy and Water Utilities Regulatory Authority Act CAP 414, Rural Energy Act 2005, and Environmental Management Act 2004.

3.5.2. Renewable energy policy

The government of Tanzania intends to develop these renewable energy sources in order to minimize the production costs, which will make electricity cheap and affordable to the majority citizen in the country. At present, renewable energy policy is incomplete. This policy is focusing on potential renewable energy investments.

3.5.3. Energy efficiency strategy

Energy efficiency initiatives in Tanzania are often hindered by limited capacity in strategic planning at ministerial levels, lack of financial resources for investing inefficient equipment, lack of awareness, shortage of technical capacity to disseminate the skills, and adaptation of the technologies and other issues. Currently, Tanzania has no comprehensive policy, instrument, or strategy targeting Energy Efficiency (EE). The country has recently addressed this issue through the implementation of programmes and projects at an institutional level and in cooperation with several development partners.

In Tanzania, the power system losses were at 16.4%. TANESCO has recently put in place a Loss Reduction Programme, which is currently being implemented. On the formulation of policies, strategies and plans targeting the Energy Efficiency,

the country is working with several development partners to develop an Energy Efficiency Programme This programme will help the government establish an Energy Efficiency Policy with key goals and targets and develop a National Energy Efficiency Action Plan. The programme will also assist to develop a framework targeting energy auditors and managers, energy efficiency standards and labelling, standards, and regulations to address energy efficiency in buildings, industrial energy management and efficient biomass utilisation. Furthermore, the Loss Reduction Programme includes capacity building components in energy efficiency directed at the public and private sectors.

3.6. Electricity

3.6.1. Generation capacity

In Tanzania, electricity is generated by the central grid (main grid), owned by TANESCO, and by isolated mini-grids in remote areas. In addition, TANESCO imports power from Uganda and Zambia. Electricity production has been dominated to date by large hydro. A long-term strategy is to expand electricity production, and transmission capabilities and installed peak capacity is forecasted to increase seven-fold by 2035.[23]

3.6.2. Electricity demand and generation forecast

Tanzania's per capita electricity consumption is shallow. It was 104.79kWh per year in 2014,[24] less than 50% of low-income countries' consumption. Currently, the consumption is increasing rapidly, owing mainly to accelerating productive investments and a growing population. The Power System Master Plan (2010-2035) anticipates that the country's electrification status will increase to at least 75% by 2035. On the same line, the demand from connected clients will increase significantly as Tanzania reaches middle-income status, as stipulated in the National Development Vision 2025.

TANESCO anticipates major demand increases from the water-supply schemes, factories, several mining operations in the country and Liquefied Natural Gas

[23] African Development Bank Group-Renewable Energy in Africa.
[24] Ministry of Energy in Tanzania.

(LNG). Previously, the peak demand capacity was projected to rise rapidly, from about 1,000 MW in 2013 to about 4,700 MW by 2025 and 7,400 MW by 2035. In the same way, it was expected that electricity production would increase ten-fold, from 4,175 Gwh in 2010 to 47,723 Gwh in 2035.

3.6.3. Electricity supply

By 2013, the country electricity generation capacity was 1,564 MW,[25] of which 1,438.24 MW were available from the central grid, with a balance of 125.9 MW accounted for by Small Power Producer mini-grids and imports. About 65% of grid generation capacity was from thermal (33% from natural gas and 32% from oil), whilst large hydropower contributed about 35%. The rest comes from small renewable-energy power and imports.

Table 3. Electricity generation capacity

Source	TANESCO	IPP	EPP	SPP	Total	Percent (%)
Hydropower	553.0	-	-	-	553.0	35
Small hydro (less than 10 MW)	8.8	-	-	4	12.8	0.8
Oil (Jet-A1 and diesel)	88.3	163	205	-	456.3	29
Gas	252.0	249.0	-	-	501.0	32
Biomass	-	-	-	27	27.0	1.7
Imports	14.0	-	-	-	14.0	0.9
Total	916	412	205	31	1,564.1	100
Percent (%)	59	26	13	2	100	

Source: TANESCO (2013).
Note: IPP = Independent Power Producer, EPP = Emergency Power Producer, SPP = Small Power Producer.

[25] TANESCO – March 2013.

3.6.4 Electricity cost

The electricity costs are categorized into different groups depending on the usage level. Specifically, TANESCO distinguishes customers into groups by setting its electricity prices, as indicated in Table 4. Based on the groups indicated in Table 4, the electricity prices are shown in Table 5.

Table 4. TANESCO customers

D1	Domestic Low Usage, for low consumption users (using on average less than 50kWh per year)
T1	General Usage, for general use of electricity including residential, small industries, commercial and public lighting (applies to consumption above 283 kWh per year)
T2	Low Voltage Maximum Demand Usage, for general use at 400 Volts with average consumption greater than 7500 kWh per meter reading period.
T3	Medium Voltage Maximum Demand Usage, for general use where power is metered at 11/33 kV.
T5	High Voltage for general use with power in meters of 132kV and above-including bulk supply of Zanzibar.

Source: TANESCO (2016).

Table 5. Electricity prices

Customer Category	**Price Component**	**Charges from April 1st 2016-Present**
D1-Domestic	Basic Charge	-
	Energy Charge 0-75 kWh/mo	100
	Energy Charge Above 75 kWh	350
T1-General Use	Basic Charge/mo	-
	Energy Charge	92
	Demand (kVA)	-
T2-Low Voltage	Basic Charge/mo	14,233
	Energy Charge	195
	Demand (kVA)	14,004
T3-Medium Voltage	Basic Charge/mo	16,769
	Energy Charge	156
	Demand (kVA)	13,200
T5-High Voltage	Basic Charge/mo	-
	Energy Charge	152
	Demand (kVA)	16,550

Source: TANESCO (2016).

4. Discussion and analysis of empirical research

Our study collected data from 45 businesses/organizations which operates in energy sector within the United Republic of Tanzania, the purpose was to find out the stakeholder's response toward investment in energy sector. In this study, we used purposive sampling to select a sample of 45 businesses/organizations. Our study selects respondents who have been working in Tanzania energy sector for more than ten (10) consecutive years, the short questionnaire was sent to them through email and asked them to fill in the short questionnaire that is added in the appendix 1 of this paper. The surveyed persons were given a maximum period of one week (7 days) to fill in the short questionnaire.

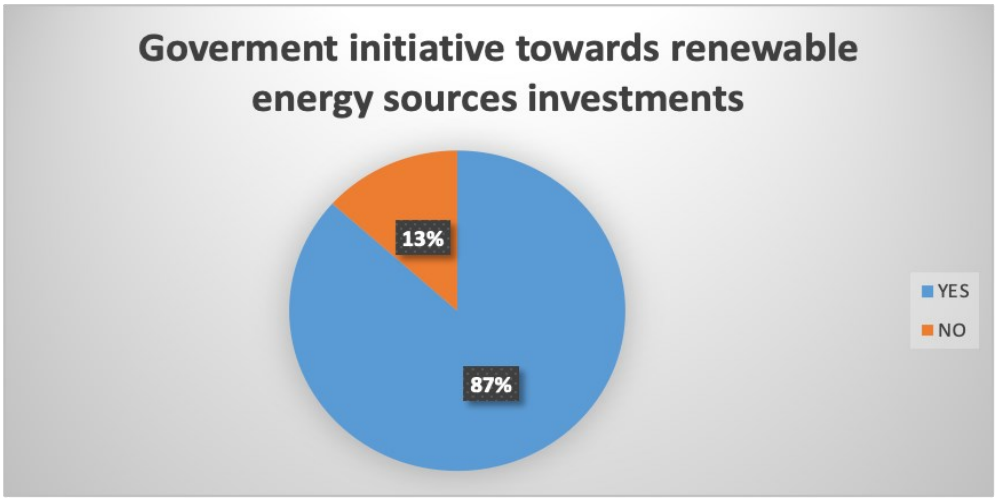
4.1. Investment in renewable energy

4.1.1. Government initiatives

Our study finds that many stakeholders accepted the efforts/ initiative of the United Republic of Tanzania towards renewable energy sources investments. Our survey found that 39 respondents (87%) of business/organizations accepted the government imitative and the rest 06 respondents (13%) rejected. Moreover, many respondents support the public-private partnership initiative. Furthermore, our findings indicate that 41 respondents (91.1%) agree that renewable energy generate affordable power.

The Tanzanian energy policy actively encourages private investments in the energy sector. The private generation of electricity in the country accounts for more than 40% of the available installed base. Private producers are expected to continue contributing to the total energy mix, both with SPPs and larger IPP. Despite this advancement, the policy and regulatory framework for clean energy are yet incomplete. The Tanzania Public-Private Partnership policy foresees that PPP energy projects might arise from international competitive bidding or unsolicited bidding, but mostly are from unsolicited bidding. Currently, EWURA is conducting a study to review the feed-in tariff to an extended client base and for clean energy-specific technologies.

Figure 3. Government initiative towards renewable energy sources investments



Source: Authors' own elaboration.

4.1.2. Opportunities

The targeted stakeholders were asked to recommend on the opportunities towards the development of renewable energy sources investment in Tanzania. The results from our finding indicate that 97.8% of our sample accept the fact that there are opportunities towards the development of hydropower energy investment in the country. 62.2% of our sample agree very strongly on the hydropower investment opportunity as shown in Table 6.

Tanzania is blessed with abundant, high-quality clean energy resources that are largely untapped. The United Republic of Tanzania's total generation capacity from clean energy (excluding large hydro) is around 4.9%; this includes captive generation in sisal, tannin and sugar factories, solar and small hydro plants. The government of Tanzania encourages stakeholders to invest in clean energy and assure them very close support. According to Schwerhoff and Sy (2017), clean energy has an important role in attaining social and economic development goals. At present, clean energy has contributed to poverty alleviation in the country in different ways, including providing employment opportunities to local citizens (Bishoge et al. 2020).

Table 6. Opportunities towards the development of renewable energy sources investment in Tanzania

Opportunities	Response in Percentage (%)							
	Accepted						Rejected	
	01	02	03	04	05	Total %	06	Total %
Wind energy	42.2	13.3	8.9	8.9	20.0	93.3	6.7	6.7
Geothermal energy	53.3	22.2	11.2	2.2	6.7	95.6	4.4	4.4
Hydropower	62.2	15.6	8.9	6.7	4.4	97.8	2.2	2.2
Bio-energy	44.5	17.8	13.3	6.7	13.3	95.6	4.4	4.4
Solar energy	48.8	20.0	8.9	6.7	6.7	91.1	8.9	8.9

Source: Authors' own elaboration.

Notes: 01: agree very strongly; 02: agree strongly; 03: agree; 04: fairly agree; 05: slightly agree; 06: strongly disagree.

4.1.3. Challenges

In order to achieve the overall objectives of economic growth and poverty reduction in Tanzania, there is a need for improvements within renewable energy. The targeted stakeholders were asked to recommend on the major challenges to the development of renewable energy sources investment in Tanzania. The results from our finding indicate that 88.8% of our sample accept the institutional, regulatory and legal as major challenge to the development of renewable energy source investment in Tanzania of which 51.1% agree very strongly on the institutional, regulatory and legal as major challenge as shown on the Table 7.

Table 7. Challenges to the development of renewable energy sources investment in Tanzania

Challenges	Response in Percentage (%)							
	Accepted						Rejected	
	01	02	03	04	05	Total %	06	Total %
Institutional, regulatory and legal	51.1	24.4	6.7	4.4	2.2	88.8	11.2	11.2
Knowledge and capacity	33.3	13.3	17.8	11.2	4.4	80.0	20	20
Ability to learn new concepts Economic and financial	40.0	15.6	4.4	8.9	13.3	82.2	17.8	17.8

Source: Authors' own elaboration.

Notes: 01: agree very strongly; 02: agree strongly; 03: agree; 04: fairly agree; 05: slightly agree; 06: strongly disagree.

4.1.3.1. Institutional, regulatory and legal

The limited role of clean energy in the Power System Master Plan reflects a lack of data availability and inadequate planning tools and methods to integrate clean energy options, mostly distributed generation. The policy and regulatory framework for renewable energy are yet to be implemented. There are no feed-in tariffs or other clear incentives for renewable energy larger than 10 MW to date. Furthermore, there is no legal, and regulatory framework in place for geothermal development.

4.1.3.2. Knowledge and capacity

The country has few or very limited expertise in undertaking feasibility studies, detailed design, and construction of clean energy power plants. Moreover, there is very limited information on the needed quality and duration of resources, especially geothermal, mini-hydroelectricity, and mini-hydroelectricity, and wind. Clients are unaware of the product standards, available technology options and efficient alternative production methods.

4.1.3.3. Economic and financial

Clean energy projects generally need massive capital investment invested. Typical financing instruments available in the country market are not well suited to

developing clean energy projects, which require low cost and long-term debt. The Tanzanian banking sector and investors have limited experience with financing clean energy projects.

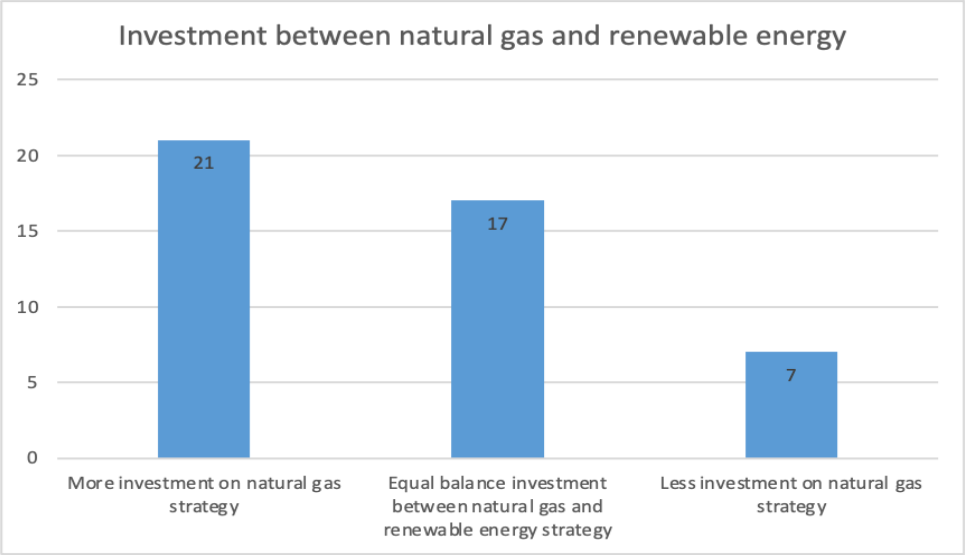
4.2. Investment in non-renewable energy

The targeted population were also asked to recommend on the development of natural gas in Tanzania. The results from our finding indicate that 42 respondents (93.3 %) of our sample accept that natural gas development is very important to the country because the development of natural gas will bring great benefits in Tanzania and its people like low-cost and cheaper electricity, growth and industrial increase, environmental conservation, employment opportunities creation, clean water and provision of industrial energy.

Furthermore, our results indicate that 38 respondents (84.4 %) of our sample suggest an energy strategy of more investment on natural gas or equal balance between natural gas and renewable energy, the respondents believe that more investment on natural gas or equal balance strategy between natural gas and renewable energy will bring a considerable drop in emissions, lower carbon footprint, while serving as critical counterpart to intermittent renewable energy and this will also enabling future hydrogen economy

Moreover, the targeted respondents were also asked to assess on non-renewable energy sources in Tanzania. 35 respondents (77.8%) believe that the ongoing discovery and exploration of natural gas is Tanzania has a promising future although the current supply of natural gas does not meet the increasing demand of natural gas users within the country.

Figure 4. Government initiative towards renewable energy sources investments



Source: Authors' own elaboration.

5. Conclusion and recommendations

Tanzania is one of the countries with the fastest growing economy in sub-Saharan Africa, and therefore, the need for affordable, clean, and sustainable energy to meet her ever-growing demands is pressing (Kichonge 2018). At present, Tanzania has attained a middle-income status, leading to a high demand for electricity in the country to support economic and social activities. According to IEA (2019,) Tanzania's economy could be seven times larger in 2040 than today.

There has been a positive incentive in the implementation of renewable energy in the country. Through the Ministry of Energy, Tanzania's government, in collaboration with developing partners and the private sector, has all potential to invest in renewable energy systems and innovation through Public-Private Partnership (PPP).

Tanzania has a potential renewable energy investment in various energy sources including wind energy, solar energy, hydro power energy, bio-energy and geothermal energy. The country has various potential areas for massive investment in wind energy throughout the country. To date, four private companies have

expressed an interest in investing in wind energy, considering construction of farms in the 50-100 MW range.[26] The potential for grid-connected solar PV is estimated to amount 800 MW. To date a number of private companies have expressed interest in developing 50-100 MW solar plants.

The Tanzania potential in hydropower is also promising as 16 hydropower projects with a combined capacity of 3,000 MW to be finalized by 2031. The potential for modern biomass uses in Tanzania is very high considering that the raw materials available is abundant and includes sisal (0.2 MTPY), rice husk (0.2 MTPY), sugar bagasse (1.5 MTPY), coffee husk (0.1 MTPY), forest residue (1.1 MTPY) and municipal solid waste (4.7 MTPY).[27] Furthermore, the total potential geothermal power in 50 identified sites is 650 MW of electricity.

Our study collected data from 45 businesses/organizations which operates in energy sector within the United Republic of Tanzania, the purpose was to find out the stakeholder's response toward investment in energy sector. We used purposive sampling to select a sample of 45 businesses/organizations and asked them to fill in the short questionnaire. Based on available reports and the answers on the survey, investments in gas as non-renewable source of Energy cannot be forgotten in the Tanzanian context.

Tanzania can become a regional energy and technology hub in the East African Regional Bloc due to its political and economic stability. Our study recommends further studies in renewable energy to compare the practices of Tanzania with other countries especially those within sub Saharan African.

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Appendix 1. Study questionnaire

Dear respondent, The Institute of Finance Management (IFM) is conducting a research on the *Feasibility and Potential of Renewable Energy Investment: The Tanzanian Context*. As a key stakeholder in energy sector, kindly help us to fill in the questionnaire.

Thank you in advance! Follow this link to fill in the questionnaire.

1. Full Name:…… (Optional)
2. Gender (Optional)
   a) Male
   b) Female
3. Designation: …… (Optional)
4. Your email address: …….. (Optional)
5. Name of organization/business: …… (Optional)
6. What is your function in this organization? And if independent, how do you classify your work?
   a. Consultant
   b. Researcher
   c. Other (Please specify)
7. Does renewable energy generate affordable power?
   a. Yes
   b. No
8. Please rate the following renewable energy sources based on a need of huge and massive investment in Tanzania context? (Use the following scale: 01: agree very strongly; 02: agree strongly; 03: agree; 04: fairly agree; 05: slightly agree; 06: strongly disagree)

9.

	01	02	03	04	05	06
Wind energy						
Geothermal energy						
Hydropower						
Bio-energy						
Solar energy						

10. Does Tanzania government put an initiative towards renewable energy source investment?

a. Yes
b. No

11. If the answer on question 9 is YES, please specify……..

12. What are the main barriers to the development of renewable energy sources in Tanzania? (Use the following scale: 01: agree very strongly; 02: agree strongly; 03: agree; 04: fairly agree; 05: slightly agree; 06: strongly disagree)

13.

	01	02	03	04	05	06
Institutional, regulatory and legal						
Knowledge and capacity						

14. Do you have any comment or suggestion to address the challenge mentioned on question 11 above (Please specify) …….

15. What do you think will be the developments of the use of natural gas? (Please specify)…….

16. What is your suggestion on the best investment balance between natural gas and renewable energy?

a. More investment on natural gas strategy
b. Equal balance between natural gas and renewable energy strategy
c. Less investment on natural gas strategy

17. What is your assessment on non-renewable energy sources in Tanzania context? (Please specify)…….

THANK YOU FOR YOUR PARTICIPATION

A copy of your responses will be emailed to the address you provided

ACRONYMS AND ABBREVIATIONS

CSP Concentrated Solar Power
Gwh Gigawatt hour
IEA International Energy Agency
KV Kilovolt
kVA Kilovolt-ampere
kWh Kilowatt hour
KTOE Kilo tons of oil equivalent
MEM Ministry Energy and Minerals
MET Ministry of Energy Tanzania
MT Million tons
Mo Month
MTOE Million tons of oil equivalent
MTPY Millions tons per year
MW Megawatt
MWh Megawatt hour
NBS National Bureau of Statistics
RE Renewable energy
REA Rural Energy Agency
TANESCO Tanzania Electric Supply Company
TZS Tanzania Shilling
UNDP United Nations Development Program