

RENEWABLES
READINESS ASSESSMENT

UNITED REPUBLIC OF
TANZANIA



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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

ISBN 978-92-9260-020-4

Citation: IRENA (2017), *Renewables Readiness Assessment: United Republic of Tanzania*, International Renewable Energy Agency, Abu Dhabi.

About RRA

A Renewables Readiness Assessment (RRA) is a holistic evaluation of a country's conditions and identifies the actions needed to overcome barriers to renewable energy deployment. This is a country-led process, with IRENA primarily providing technical support and expertise to facilitate consultations among different national stakeholders. While the RRA helps to shape appropriate policy and regulatory choices, each country determines which renewable energy sources and technologies are relevant and consistent with national priorities. The RRA is a dynamic process that can be adapted to each country's circumstances and needs. Experience in a growing range of countries and regions, meanwhile, has allowed IRENA to continue refining the basic RRA methodology.

In June 2013, IRENA published a guide for countries seeking to conduct the process in order to accelerate their renewable energy deployment.

For more information: www.irena.org/rra

Acknowledgement

This report has benefited greatly from the input of national and international experts, notably including Yacob Mulugetta (University College London) and Jensen Shuma (Tanzania Traditional Energy Development Organization/TaTEDO), as well as review and comments by Kabaka Kato (Tanzania Geothermal Development Company/TGDC), Maneno Katyega (Tanzania Electric Supply Company Limited/TANESCO), Paul Kiwele (Ministry of Energy and Minerals, Tanzania), Kudakwashe Ndhulukula (SADC Centre for Renewable Energy and Energy Efficiency/SACREEE) and James Ngeleja (independent expert, Tanzania). IRENA colleagues including Rabia Ferroukhi, Arslan Khalid, Joanne Jungmin Lee, Alvaro Lopez-Peña, Asami Miketa, Spyridon Pantelis, Gurbuz Gonul, Henning Wuester and Sakari Oksanen have also provided valuable guidance and input.

Contributing authors: Safiatou Alzouma Nouhou, Tijana Radojicic and Nopenyo Esselasse Dabla (IRENA)

For further information or to provide feedback: publications@irena.org

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RENEWABLES
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FOREWORD

from the Minister of
Energy and Minerals



Tanzania is endowed with diverse forms of renewable energy resources, ranging from hydropower and geothermal to solar, wind and bioenergy. This potential has not been fully exploited. Tapping more of these sustainable resources will facilitate Tanzania's economic transformation, which aims to make it a middle-income country in the next decade.

Energy is a vital input to all sustainable development goals. It needs to be affordable in economic terms, as well as cleaner and sustainable. Some of the country's conventional energy sources, such as coal, are yet to be exploited. However, our enormous renewable energy potential also needs to be promoted. Our energy mix should include all available resources, with the renewable energy contribution gradually increasing.

With these aims in mind, Tanzania approached the International Renewable Energy Agency (IRENA), undertaking to conduct the Renewables Readiness Assessment (RRA) process with IRENA's support. Completion of the process will help to establish an effective framework and stimulate stakeholder efforts to accelerate our energy transition.

As a country, we are very much committed to this, as evidenced by numerous projects and our subscription to Sustainable Energy for All (SE4All) and other international initiatives. I am confident the present assessment will complement our existing efforts and even help us develop our renewable energy resources at a faster pace.

The RRA process was the first of its kind in Tanzania, allowing for progressive dialogue amongst various stakeholders countrywide. It helped to identify specific opportunities and potential, along with barriers and constraints, for the country's renewable energy development. Areas for action over the short to medium term include resource assessments and planning; policy and regulatory frameworks; private sector engagement; and human capacities and skills related to renewables.

I sincerely hope this report will garner wider international support, thereby helping to increase investment in our renewable energy sector. Tanzania is grateful to IRENA for facilitating the RRA process and is committed, as part of efforts to boost renewable energy deployment, to complete the ratification process and become a full member of IRENA.

Hon. Prof. Sospeter M. Muhongo (MP)
Minister for Energy and Minerals
United Republic of Tanzania

FOREWORD

from the IRENA
Director-General



The United Republic of Tanzania, like many African countries, faces a number of pressing challenges, such as a growing population, accelerating economic activity and rising energy demand. Tanzania has recognised renewables as an important means to meet these challenges and achieve a sustainable energy future.

Harnessing Tanzania's vast renewable energy potential energy offers the prospect of expanded energy access and secure domestic energy supplies, sufficient to meet and even exceed the targets set out in the country's development vision for 2025.

This Renewables Readiness Assessment (RRA), undertaken in co-operation with the government of Tanzania, examines the energy sector holistically, identifying barriers and highlighting actions to accelerate renewable energy deployment. It presents clear and practical steps for Tanzania to make maximum use of renewables to power sustainable economic growth

In this regard, the report underlines the need to revise the country's current energy plans, taking into account the latest analysis on renewable resource potential and technology costs. It identifies dedicated incentive and risk-mitigation frameworks as necessary measures to attract private finance and investment. The report highlights the need to expand renewable energy training at higher and vocational education levels, as well as on-the-job training schemes, given that the uptake of new technologies calls for

specialised training and education. The RRA also proposes the establishment of a national renewable energy research institute to collect and make available all relevant statistics and resource information on renewables.

Some 30 countries, spanning the Asia-Pacific region, Latin America, the Caribbean, the Middle East and Sub-Saharan Africa, have undertaken Renewables Readiness Assessments (RRAs) since 2011, exchanging knowledge and encouraging international co-operation to promote clean, indigenous renewable energy technologies. RRA consultations are country-led, with IRENA providing technical support and expertise to facilitate consultations among different national stakeholders.

IRENA wishes to thank Tanzanian authorities, in particular the Ministry of Energy and Minerals, for their commitment to this report. We are grateful for their positive engagement and valuable input.

I sincerely hope these RRA findings will strengthen the pursuit of renewable energy solutions. IRENA stands ready to work closely with Tanzania as the country strives for a sustainable energy future.

Adnan Z. Amin
Director-General
International Renewable Energy Agency

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ABBREVIATIONS

AfDB	African Development Bank
CO ₂	carbon dioxide
COMESA	Common Market for Eastern and Southern Africa
CSP	Concentrated Solar Power
DRC	Democratic Republic of the Congo
EWURA	Energy and Water Utilities Regulatory Authority
GDP	gross domestic product
GW	gigawatt
GWh	gigawatt-hour
IPP	independent power producer
km	kilometre
kV	kilovolt
KW	kilowatt
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory (US)
m ³	cubic metre
MW	megawatt
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
O&M	operation and maintenance
pcm	per calendar month
RRA	Renewables Readiness Assessment
SAPP	Southern African Power Pool
SPPA	small power purchase agreement
TaTEDO	Tanzania Traditional Energy Development Organization
TPES	total primary energy supply
TZS	Tanzanian shilling
USD	US dollar
TOU	Time-of-Use
TPES	Total Primary Energy Supply
USD	United States Dollars
Wp	Watt-peak



Solar photovoltaic installations serve remote communities

Photograph: E.ON Off Grid Solutions — Rafiki Power



EXECUTIVE SUMMARY

The United Republic of Tanzania (referred to throughout this report as “Tanzania”) is situated in eastern Africa. Of its 50.76 million inhabitants, only 18% have access to electricity. At the same time, the country’s economy is diversifying and shifting away from its agricultural base. This has added considerable pressure to energy consumption, making the low access rate and other supply limitations an obstacle to economic growth.

Total primary energy supply (TPES) is dominated by biomass and has almost doubled in the last decade. Electricity is mainly generated from hydropower, oil and more recently natural gas. Costly oil products account for around one-fifth of power generation and are mainly required for off-grid applications and emergency on-grid power supply. The electrical supply varies in times of drought and is highly dependent on hydropower generation, leading to rolling blackouts. What is more, a quarter of power produced is lost due to the state of the grid infrastructure. The unreliability of power supply has had a negative impact on the development of Tanzanian industry. Although Tanzania has excellent wind, solar, geothermal and biomass resources for power production, only 4.85% of non-hydropower renewables are being considered in the Electricity Industry Reform Roadmap to 2025.

The country’s abundant renewable energy potential offers the possibility to overcome some of the challenges faced by the energy and power sector in a cost-effective way. This would lead Tanzania towards economic growth that is sustainable.

A renewable energy zoning study carried out by the International Renewable Energy Agency (IRENA) and the Lawrence Berkeley National Laboratory (LBNL) found that wind power in Tanzania could displace much of the oil-based power at a third of the cost, due to the high correlation of wind resources with system demand (IRENA and LBNL, 2015). An examination of the characteristics of the least-cost energy system for Tanzania found that utility-scale solar PV and wind projects could reach 3.7 gigawatts (GW) and 1.9 GW by 2030, alongside 694 megawatts (MW) of gas-fuelled power plant investment already in the pipeline. This analysis supports the need to reduce the expansion of coal and oil-fired power plants in order to reach the least-cost scenario. IRENA estimates that the overall share of renewables in electricity production, including large hydropower, could reach 78% by 2030. This would require investments of USD 11.4 billion in generation and USD 6.7 billion in transmission and distribution investment between 2013 and 2030. The average generation cost would fall by 17% between 2013 and 2030. This calls for a revision of the existing electricity master plan as well a roadmap to realise the desired least-cost power system investment strategy.

On the policy and regulatory framework side, the draft Electricity Systems Operations Act 2016, under approval, gives priority for dispatch to the electricity generated from renewable energy sources and indigenous sources. However, this act does not specify guidelines for the power forecast period. Despite the existence of feed-in tariffs and small power purchase agreements (SPPAs) for grid-connected projects, renewables-based power generation is unattractive to private investors. This is due to the weak financial position of TANESCO, the sole off-taker, and the government’s inability to guarantee payment if TANESCO defaults.

Another barrier to private sector involvement in the renewable energy industry is the very restrictive financial environment, including the difficulty of obtaining investment loans due to the high cost of borrowing.

The Renewables Readiness Assessment (RRA) discussions also disclosed that the financial sector's limited knowledge of renewables is another obstacle to facilitating financing for renewable energy development in Tanzania. This is because most domestic banks still lack the capacity to plan, structure and appraise projects with suitable financial instruments. There are no established quality control and technical standards or mechanisms for renewable energy equipment. If policy measures are not taken, substandard products will flood the market, affecting the confidence of developers who invest in renewable energy and technology uptake. Other factors restricting renewables investments include the low purchasing power of potential customers, especially in rural areas, and the high upfront investment costs of renewable energy. Equally obstructive are lengthy project development lead times, high land acquisition costs and cumbersome procedures for environmental impact assessment and hydropower water use rights permits.

There are also shortcomings in human capacities and skills in the renewable energy sector in Tanzania. These will need to be resolved adequately so that Tanzania can meet the employment levels required by the Electricity Supply Industry Reform Strategy and Roadmap 2014-2025 and beyond. According to the analysis carried out for this report, the renewable electricity sector could employ 36,000 people throughout the value chain in Tanzania in 2030 under the renewable energy scenario. This is around six times the 2015 figure. However, only the University of Dar es Salaam offers a Master of Science in Renewable Energy at the moment, while other academic institutions in Tanzania only offer undergraduate diplomas for the sector. Given the potential for scaling up renewables in Tanzania, more courses related to renewables are needed. These courses should diversify and expand into all areas of renewable energy project development at the technical, managerial and financial level.

RECOMMENDATIONS

Revise national energy plans

Energy planners in Tanzania need to revise their plans by taking into account the latest studies on resource potential and technology costs. Equally, they need to explore different policy assumptions and scenarios that justify or work out the challenge associated with certain investment decisions. This could be followed by a roadmap for realising the desired investment strategy.

Provide incentives in Electricity System

Operation Rules

The draft Electricity System Operation Rules 2016 need to be revised to include provisions in forecasts for better integrating renewable energy in power systems. These need to take into account the fact that Tanzania is a member of the Southern African Power Pool (SAPP), where the day-ahead market is already in place. This will give renewables the opportunity to make a greater contribution to satisfying the country's growing power demand.

In achieve this aim, Tanzania could consider acquiring the necessary infrastructure including sophisticated information and communication tools for more efficient system-wide decision-making. Furthermore, grid operators will need to acquire the ability to integrate forecast data into their daily operations by learning how to manipulate grids with high share of renewables.

Tanzania should consider adopting transmission and wheeling charges conducive to variable renewables. This should be clearly stated in the revision of the draft Electricity Systems Operations Act 2016. Additionally, private generators could be given the flexibility to sell their surplus power to the grid operator.

Promote long-term equity financing for renewable energy projects through non-banking financial institutions

Tanzania could consider empowering the domestic financial sector to provide equity investments into renewable energy technologies, especially through the Dar es Salaam Stock Exchange. This would be welcomed by the Dar es Salaam Stock Exchange, which has appealed for an environment favouring the increased utilisation of the stock exchange by the private sector,¹ supervised by the Capital Markets and Securities Authority. Through the Dar es Salaam Stock Exchange, the government should also promote the use of mutual funds, which currently only represent 0.1% of asset allocation in the Tanzanian financial systems. These would increase private sector participation by using pooling to reduce renewable energy project risk.

Improve facilitation, collaboration and co-ordination among private sector and financial institutions

In line with the previous recommendation, a framework must be established to enhance facilitation, collaboration and co-ordination among private renewable energy actors and financial institutions. This would increase financial institution knowledge of the renewable energy sector and give the private sector more understanding of the inner workings of the financial system. Close co-operation of this kind between these two types of entities will help mitigate the perceived risk from the renewable energy sector and would foster financing.

Create a risk mitigation mechanism for local investments

In order to increase participation from the local private sector, a risk mitigation mechanism is needed for local investments. It could provide liquidity support as well as guarantees and facilitate access to substantial loans from the banking industry. The facility could be established at a regional level through the Common Market for Eastern and Southern Africa (COMESA) Regional Investment Agency. COMESA could co-operate with international partners, such as IRENA, the Green Climate Fund, German development bank KfW and the African Trade Insurance Agency.

Intensify and expand renewable energy training at the higher and vocational educational levels as well as on-the-job training

The planning scenarios suggested in this RRA show that by 2030 around 20,000 construction and installation jobs will be required in Tanzania for the renewable energy sector. Around 1,100 will be needed in fuel production, 2,900 in manufacturing, 4,000 in decommissioning and 7,900 in operation and maintenance. The Government of Tanzania should make full use of the vocational training facilities across the country to intensify and expand renewables training to meet that labour demand. A renewable energy programme should be promoted within the country's top business schools. It should develop training programmes and courses to broaden the financial and business knowledge base in renewable energy technology projects. New and young engineers entering the local power job market should be given the opportunity to gain experience in the practical aspects of the value chain. Capacity improvement at the vocational education level could be financed through charges applied to foreign investments and through state funding and other sources.

Design and implement local-content requirements for renewable energy projects

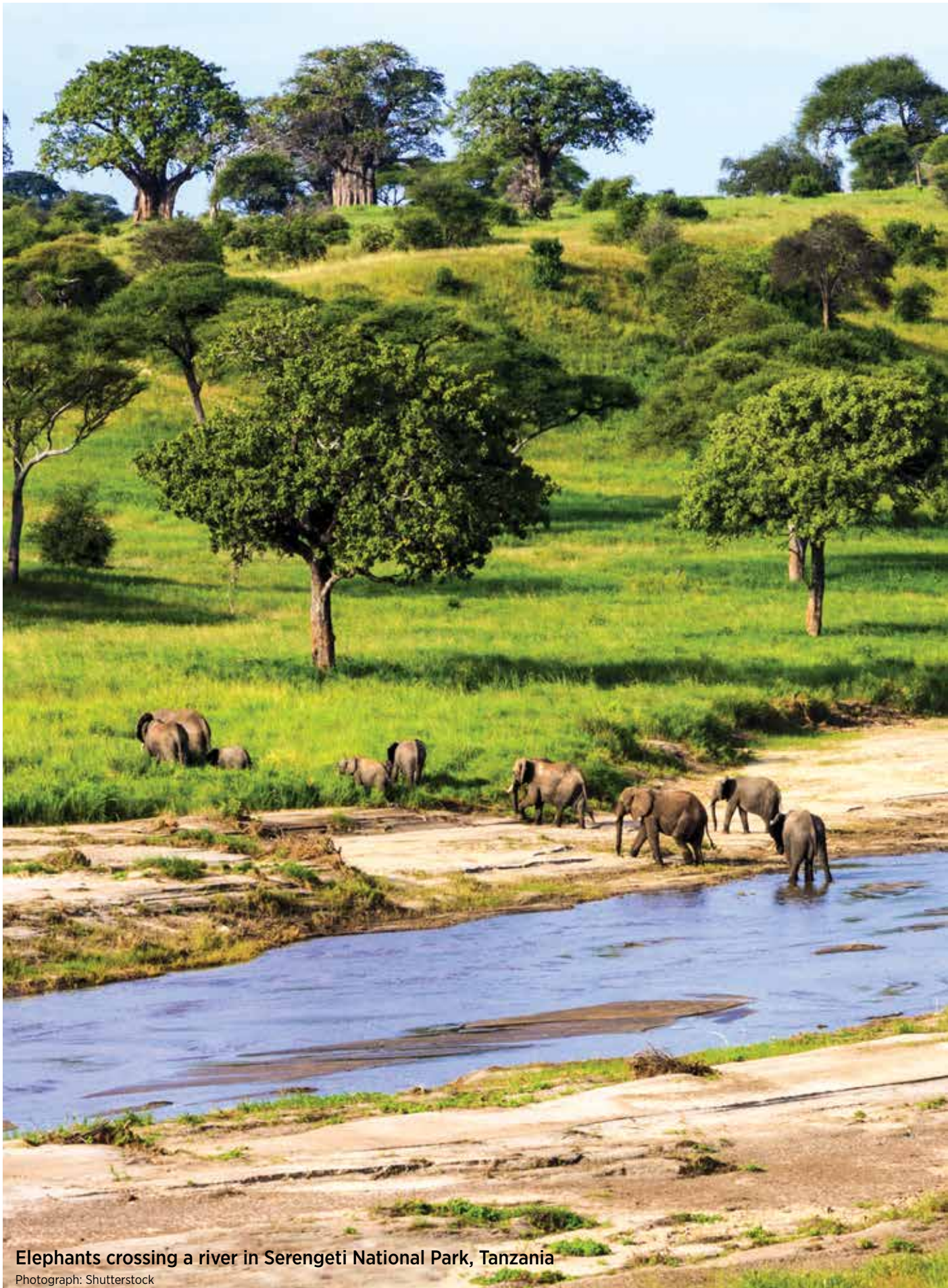
Through a local-content requirement, people could gain better conditions like job security, for which demand will rise if more qualified labour becomes available. The local-content requirement could be applied to labour and manufactured products for renewable energy projects implemented in Tanzania. There are several examples of this in countries in the sub-Saharan African region, such as Ghana, Kenya and South Africa.

Establish a national renewable energy research centre

Given the inconsistency of statistical data and lack of quality control or standard-setting mechanism, the Government of Tanzania should create and provide the capacity for a renewable energy centre whose mandate would be as follows:

- establish a legal and institutional framework for assembling renewable energy statistics
- collect and store all relevant statistics and resource information on renewables
- provide easier access to renewable energy information and resolve inconsistencies in the data
- conduct a data audit to identify relevant data gaps
- develop and implement a methodology for quality control and standards.

¹ Corporate bonds and most of the equity and government bond papers issued and listed on the Dar es Salaam Stock Exchange have been oversubscribed by up to twice the amount available. This shows the extent of liquidity in the hands of the Tanzanian private sector.



Elephants crossing a river in Serengeti National Park, Tanzania

Photograph: Shutterstock



I. INTRODUCTION

1.1 Country Background

Located in eastern Africa, the United Republic of Tanzania (referred to throughout this report as “Tanzania”) is bordered by Kenya and Uganda to the north, Rwanda, Burundi, the Democratic Republic of the Congo (DRC) and Zambia to the west, Malawi and Mozambique to the south and the Indian Ocean to the east. With a surface area of 947,303 square kilometres (km²), it is the largest country in East Africa in terms of land mass.

The country was formed out of the union of Tanganyika and Zanzibar on 26 April 1964. Tanzania is a presidential constitutional republic and since 1996 has had its official capital at Dodoma. In the coastal region, the city of Dar es Salaam is the economic capital and main seaport of mainland Tanzania, serving as a gateway to East and Central Africa. The official currency is the Tanzanian Shilling (TZS) and the official language is Kiswahili/Swahili, while English is widely used for official communication (www.tanzania.go.tz).

Tanzania is mountainous and densely forested in the northeast. The centre of the country consists of a large plateau with plains, savannah woodlands and arable land, and the eastern coast is hot and humid. Three of Africa’s Great Lakes are partly within Tanzania, namely Nyasa, Tanganyika and Victoria.

Given its geographic configuration, Tanzania is vulnerable to climate change and extreme weather events. As a result, Tanzania’s hydroelectric capacity has been dramatically affected (AfDB, 2015). However, Tanzania has among lowest per capita carbon dioxide (CO₂) emissions in the world at just 0.2 metric tonnes.²

The United Nations ranks it as a Least Developed Country with annual per capita gross domestic product (GDP) at USD 879. According to the World Bank, 43.5% of the population lived on less than USD 1.25 a day³ in 2012, making it one of the poorest countries in the world. Its population of 50.76 million (2014) is growing at 2.8% per year, and about 27.6% of the population is urban (World Bank, 2015a). Forecasts by Tanzania’s Ministry of Energy and Minerals suggest that the country’s population will rise to at least 69.5 million by 2025 (MEM, 2014).

The Tanzanian economy has continuously performed well over the last few years, with a growth of 6.9% in 2012 and 7.3% in 2013. Information and communications, as well as construction and manufacturing, are the main contributors to this growth. Inflation has declined to an annual average of 5.6% in 2015 due to a careful monetary policy, favourable agricultural conditions and falling oil prices. Growth is projected to reach 7.2% in 2016 and 7.5% in 2017 (AfDB, OECD and UNDP, 2015). In order to sustain that growth, public investments will become increasingly necessary, especially in infrastructure.

Agriculture is the most important economic sector, employing more than two-thirds of the country’s workforce and supporting the livelihoods of more than three-quarters of Tanzanians (AfDB, OECD and UNDP, 2015). It is followed by services (information and communication), mining and manufacturing.

² Emissions per capita for sub-Saharan Africa amounted to 0.8 metric tonnes of CO₂ per year. The annual average for Low Income Countries was 0.3 metric tonnes of CO₂ in 2011 (World Bank, 2015a).

³ “Population below USD 1.25 a day is the percentage of the population living on less than USD 1.25 a day at 2005 international prices” (World Bank, 2015a).

The Government of Tanzania is going through an economic restructuring process to improve the investment environment and increase the role of the private sector, with the government limiting itself to a facilitating and regulatory function. In addition, the government has been implementing the “Big Results Now” initiative⁴ since 2013, which aims to foster progress in key development sectors, including energy. This strategy is aligned with Tanzania’s Development Vision 2025, which aims to convert Tanzania to a middle-income country by 2025 with a GDP per capita of at least USD 3,000.

The good economic performance of recent years has not necessarily accelerated poverty reduction. Disparities still exist between rural and urban areas, better off and disadvantaged regions (AfDB, OECD and UNDP, 2015). Natural disasters like droughts and El Niño climatic events have affected agricultural productivity, power production and transportation, and this has had negative effects on the economy. However, at this stage, widespread and persistent poverty is the main development obstacle for Tanzania. Through recent policy initiatives, the Government of Tanzania has shown an increased level of commitment to broader poverty reduction, greater social protection and the human development agenda. Public expenditure on infrastructure, energy and increased rural electrification is being promoted. This is viewed as a key development vector for poverty elimination and the economic inclusion of the rural population.

1.2 Role of energy in development in Tanzania

Energy is a critical input affecting all sustainable development efforts. As is the case across the world, energy is vital to all major economic activities in Tanzania.

- **Energy for services**

Services are the main contributor to GDP, taking a 48.8% share in 2014 (Tanzania National Bureau of Statistics, 2015). The information and communications subsector has experienced sustained growth in the usage of mobile phones. This includes the recent expansion in mobile money services, which had around 11.7 million registered users in March 2014 (AfDB, OECD and UNDP, 2015). Energy is also essential for a number of social welfare services, which include health, schools, water and telecommunications in rural areas. Renewable energy could provide the basis for satisfying those

needs. Some social services, such as remote health centres, are already equipped with PV for lighting or storing medical supplies. Some PV units are also used in water pumping. As they grow, social services will need to improve and become more reliable and more sustainable. For energy to play an effective role in poverty alleviation, emphasis should be put on improving energy services in productive uses such as business, agriculture, industry, fishing and tourism.

- **Energy for agriculture**

Agriculture is the most important sector of the Tanzanian economy. The agricultural activities include land preparation, irrigation, weeding, harvesting and processing agricultural products. The sector employs about 80% of the active workforce that supports the livelihoods of more than three-quarters of the population in Tanzania. It contributed to about 23% of GDP in 2014 and meets about 95% of national food requirements (Tanzania National Bureau of Statistics, 2015). The sector has consistently registered a below average annual growth rate over the last decade, amounting to 4%. This is due to factors such as the limited availability of energy and absence of modern agricultural methods, leading to a high reliance on rainfall. About 70% of cultivation in Tanzania is carried out by hand hoe, 20% by ox plough and 10% by tractors (Organisation for Economic Co-operation and Development, 2011). The government has launched a new initiative, the Southern Agricultural Growth Corridor of Tanzania, in order to meet the annual sector growth rate of 6% - 10% in its New Vision for agriculture. Its aim is to steer public and private sector investment initiatives using the model of an agricultural growth corridor to boost agricultural productivity in Tanzania. The Southern Agricultural Growth Corridor of Tanzania investment generation programme has identified power generation as one of the key areas that increases agricultural productivity. This will help to reverse the current high reliance on human energy for these agricultural activities.

- **Energy for industry**

Over time, Tanzania’s industrial sector has changed, mirroring national policy reforms as well as the changing patterns of domestic demand and the global market. It is the third largest contributor to the economy (22.2% of GDP in 2014) after services and agriculture. Recovery in the mining sector continued in 2014, mainly due to increased gold production and higher international prices. Thanks to the sustained stability in power generation as well as sustained demand for manufactured products both abroad and at home, the performance of the manufacturing sector has remained strong.

⁴ Launched in 2013, the “Big Results Now” initiative is based on a Malaysian development model and altered to fit the Tanzanian context.

Rural Tanzania's most commonplace industries have major relevance to rural sustainable development efforts. They include brick burning, crop processing and the production of charcoal, among other activities. These have the potential to raise rural incomes by processing agricultural and forest products to add value. Hence energy is important for both urban and rural development. It is among the most widely used inputs, and the industrial sector is the second large consumer of energy in Tanzania after households. The energy used for industries in urban areas is mostly electricity. Gas is also used by industry in Dar es Salaam. About 70% of electricity is used to run machines (motor and other equipment). The rest of the electricity is used for other energy services (lighting, alarms, offices etc.) in factories. However, old or outdated equipment and underutilised capacity in most factories leads to inefficient energy use.

Improvement of the power sector as highlighted in different government policies, strategies and plans, such as the Power Systems Master Plan of 2012, is considered essential to ensure sustainability of the manufacturing firms. Reliable power supply to manufacturing companies will certainly increase productivity and the industrial base, which is indispensable to the country's overall development agenda.

- **Regional integration**

Regional power integration is essential to optimising the development of energy resources within regional blocks. This will then ease access to the electrical power supply through regional power interconnection. Certain local obstacles to power supply oblige Tanzania to use additional power from neighbouring countries with a surplus. It thus stands to benefit a great deal from regional power integration. Equally, power supply infrastructure connectivity within the region can enable surplus power produced in Tanzania to be easily exported to other countries with a power deficit (MEM, 2015a).

In 2010, Tanzania joined the Eastern Africa Power Pool;⁵ however, work on physical interconnection and effective electricity exchange within the pool is only under way between Uganda and Kenya (Gebrehiwot, 2013), and Ethiopia and Djibouti. In addition, Tanzania is a member of the Southern African Power Pool (SAPP), along with 11 other African nations.⁶ This is an advantage because it implies that Tanzania could act as a "bridge" country interconnecting both electricity pools in the medium term, thus linking northern and southern areas of Africa.

1.3 Renewables Readiness Assessment process

The Renewables Readiness Assessment (RRA) in Tanzania was led by the Ministry of Energy and Minerals in close co-operation with the Tanzania Traditional Energy Development Organization (TaTEDO). TaTEDO has acted as an interface between Tanzanian stakeholders and the RRA support team. Following recommendations from stakeholders, including the Ministry of Energy and Minerals and several donors, the RRA was conducted with a special focus on implementation. Rather than focusing on specific pairings of resources and services, the assessment examined several broad thematic areas, namely resource assessment and planning; policy and regulatory frameworks; private sector involvement; and human capacity and skills.

At the first stage, a background and issues paper on Tanzania was prepared. This was based on desktop research information and a survey conducted through a field mission, which consisted of interviews of representatives of key stakeholder institutions from key governmental, private and civil society bodies. The survey covered topics such as energy sources and access levels; main renewable energy applications and service demands; and the main challenges affecting renewable energy development. Due to time constraints, field respondents were asked to independently complete the remaining questions covering costs, capacity gaps and other subjects. They were requested to return the completed questionnaires within two working weeks of the day of the interview. A final RRA workshop was organised on 9 - 10 March 2016 to peer review and validate the findings from the background paper and issues paper. It defined the practical action that will set these renewable energy subsectors in motion.

This report is structured into five sections. The first presents the introduction, covering country background and the RRA process in Tanzania. The second highlights the regional energy setting and examines Tanzania's national energy sector and specific energy challenges. It offers an overview of the country's renewable energy use at present, as well as its potential. This entails a detailed discussion of the electricity sector. The third section identifies institutions playing a part in Tanzania's energy sector and defines key energy policies and regulatory frameworks, as well as examining finance and investment conditions in Tanzania. The fourth section discusses RRA findings related to emerging concerns and enabling conditions in the four thematic areas identified. It sums up the related opportunities and constraints. Finally, the fifth section covers the recommended action necessary for scaling up renewable energy in Tanzania.

5 This consists of Burundi, the DRC, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan, and Uganda.

6 The DRC is also a member country of both power pools.



Modern bioenergy offers great development potential

Photograph: Shutterstock

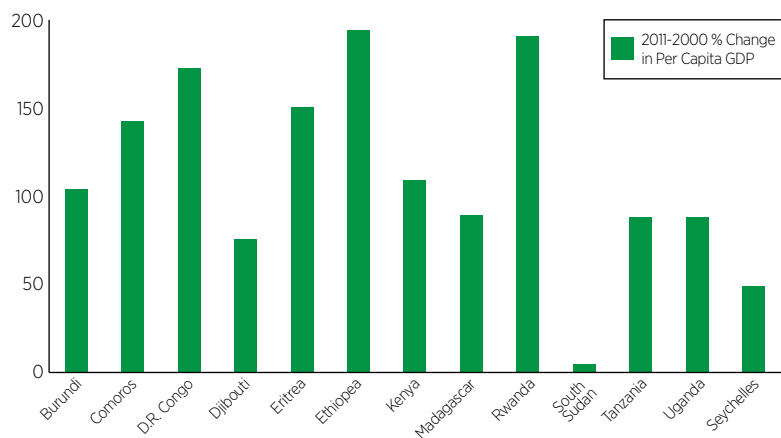


2. ENERGY CONTEXT

2.1 Regional context

Most countries in the eastern Africa sub-region⁷ have exhibited strong economic growth trends, with robust increases in per capita GDP over the last decade (United Nations Economic Commission for Africa, 2014). Between 2000 and 2011, Burundi, the Comoros, the DRC, Eritrea, Ethiopia, Kenya and Rwanda have more than doubled their per capita GDP while the GDP of Ethiopia and Rwanda has grown more than 180% in the same period.

Figure 1: Per capita GDP growth in countries of the eastern African sub-region

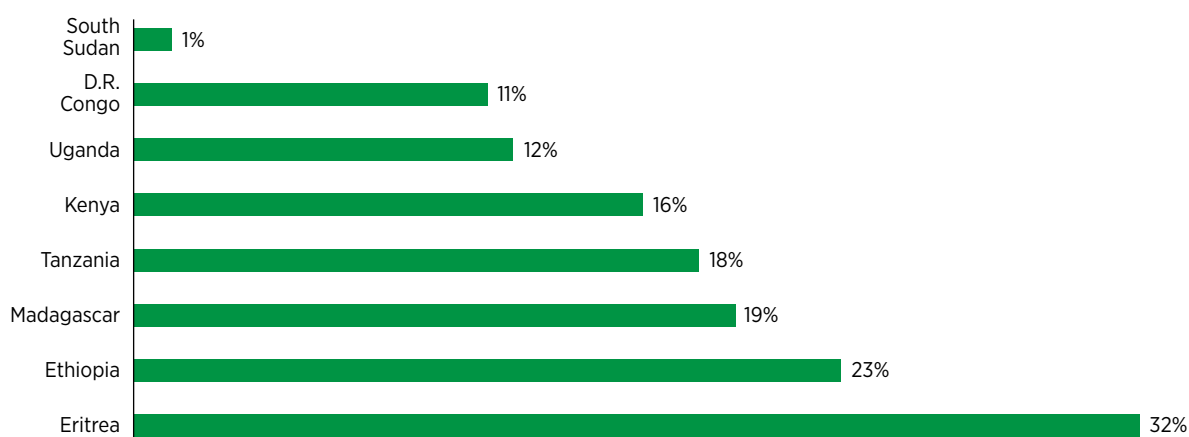


Source: United Nations Economic Commission for Africa, 2014 (based on International Monetary Fund and World Economic Outlook data)

In most of the 14 countries of the eastern Africa sub-region, more than 90% of the population rely on biomass as their main energy source. The utilisation of electricity and other forms of modern energy sources is relatively low. Electricity access rates range from 1% in South Sudan (leaving 9.3 million people without access) to 11% in the DRC (nearly 60 million without access). In Uganda 12% have electricity access, leaving 27 million people without. In Tanzania 18% have access, and 38 million do not. In Kenya 16% have access, and more than 32 million do not, while in Ethiopia 22.5% have access, and nearly 64.5 million do not (see Figure 2). Energy security has also gained in importance due to the increased dependence on imported oil products. Electricity in the eastern Africa sub-region has traditionally been generated from hydroelectricity. However, inadequate energy planning and rapid energy demand growth have compelled the region's policy makers to make particular technology choices to overcome immediate difficulties related to energy. This has resulted in the expansion of thermal generation. The absolute growth in petroleum consumption from 2000 to 2011 amounted to 67% in eastern Africa. This constitutes a significant increase in exposure to global energy markets and associated sources of energy insecurity (United Nations Economic Commission for Africa, 2014).

⁷ The eastern African sub-region referred to in this report consists of Burundi, Comoros, the DRC, Djibouti, Ethiopia, Eritrea, Kenya, Madagascar, Rwanda, Seychelles, Somalia, South Sudan, Tanzania and Uganda.

Figure 2: Electricity access rates in selected countries in eastern Africa



Source: United Nations Economic Commission for Africa, 2014 (adapted from World Energy Outlook data, 2011)

The energy sector in eastern Africa faces numerous challenges but also abundant opportunities. These countries are endowed with significant clean energy resources in transboundary hydropower systems that can be developed to spearhead energy integration across the sub-region. The discovery of oil and gas resources in the sub-region, and growing interest in biofuel development, also offer a route to greater energy security through regional frameworks and infrastructure.

In 2012, total installed electricity capacity in East Africa exceeded 36 gigawatts (GW), including Egypt. This generated about 160 terawatt-hours of electricity largely from gas-fired power plants. Egypt's installed capacity accounts for more than 70% of the region's total, and hydropower is the main source in Ethiopia, Burundi, Uganda and Sudan. After gas and hydropower, remaining capacity is mainly based on oil-fired power plants, with small contributions from wind and solar (IRENA, 2015a). Considering the energy potential of the sub-region, regional integration remains low mainly due to constrained generation capacity and limited regional interconnectivity. Sub-regional electricity trade along with joint investment ventures are a promising way to expand the electricity supply in the sub-region.

Bilateral power exchanges exist among some countries but interconnections are still limited. Existing power interconnections include: the DRC, Burundi and Rwanda; Kenya-Uganda; Ethiopia-Djibouti and Ethiopia-Sudan.

However, a number of power interconnection projects are currently under development in line with the Eastern Africa Power Pool/ East African Community framework. These are expected to bear fruit within the next five to ten years. In addition, the Kenya-Tanzania interconnector project has secured finance to begin engineering work. The line is 260 km long and will have a capacity of 1,520 megawatts (MW) at 400 kilovolt (kV) alternating current. In addition, feasibility studies for the Rusumo-Tanzania

line were completed in 2010. This line is associated with the Rusumo Falls Hydropower Plant (90 MW), which will serve and interconnect the grids of Tanzania, Rwanda and Burundi (United Nations Economic Commission for Africa, 2014). More widely, Tanzania and Zambia are working on an interconnector which once completed will interconnect the southern Africa regional grid with the eastern Africa regional grid. Together with the older interconnections, namely Kenya-Uganda, Egypt-Libya and Burundi-DRC-Rwanda, the projects in the pipeline will boost the interconnection across the eastern Africa region, involving all current member countries (IRENA, 2015b).

Nile Basin Initiative

As a partnership that unites Burundi, the DRC, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda, the Nile Basin Initiative has launched the Nile Equatorial Lakes Subsidiary Action Program (NELSAP). This is one of its investment programmes. It promotes investments in power development and trade, river basin management and development, agricultural trade and productivity, and fisheries and watershed management.

In accordance with its 2012 - 2016 Strategic Plan, NELSAP has listed the following under its "Power Development and Trade" sub-programme:

- Programmatic goal 1: to harness hydropower through co-operation
- Programmatic goal 2: to facilitate better interconnections and increase power trade

NELSAP continuously detects and lays the ground for new projects, aiming to help identify, prepare and implement the supervision and facilitation of resource mobilisation for investment projects in its two sub-programmes (Nile Basin Initiative, 2012).

Within these programmes, several projects are at various stages in the development phase: the Regional Rusumo Falls Hydroelectric and Multipurpose Project,

the Kenya-Tanzania Transmission Line, the Iringa-Mbeya Power Transmission Line, Uganda-DRC (Nkenda-Beni-Butembo-Bunia) Power Transmission Line and the

Tanzania-Zambia Power Transmission Line. In addition, NELSAP has identified the pipeline of projects that could deliver prominent results. These are listed in Table 1.

Table 1: NELSAP's pipeline of power development and trade projects at pre-investment stage

Strategic area	High-level results and key activities	Estimated cost (USD million)	
		Pre-investment	Investment
Hydropower generation and power transmission lines	Semuliki hydropower project (72 MW) (Uganda-DRC)	6	
	Mugomba hydropower project in the DRC (100 MW)	6	
	Akanyaru river hydropower (Rwanda and Burundi) (22 MW)	3	
	Project structuring and financial modelling of hydropower generation projects in South Sudan (Fula, Shukoli, Bedden and Lakki)	8	
	Uganda (Karuma)-South Sudan (Juba) power transmission interconnection, 400 kV of 320 km	3	
	Kenya (Kisumu)-Tanzania (Mwanza) power transmission interconnection, 220 kV of 330 km	3	
	Burundi (Jiji-Mulembwe)-Tanzania (Kigoma) power transmission line, 220 kV of 180 km	2	
	Kenya-Tanzania transmission, 220 kV of 257 km		262
	Uganda-DRC (Nkenda-Beni-Butembo-Bunia) transmission line, 220 kV of 396 km		165
	Uganda-Tanzania (Masaka-Mwanza) interconnection		

Source: Nile Basin Initiative (2012)

Common Market for Eastern and Southern Africa

The COMESA Model Energy Policy Framework, adopted by the Common Market for Eastern and Southern Africa (COMESA) in 2007, seeks to improve the effectiveness and efficiency of modern energy supply industries; the security and reliability of energy supply systems; access to affordable and modern energy services as a contribution to poverty reduction; the availability, potential and demand of various energy resources; economic development; energy sector governance and administration; and the environmental, safety and health impacts of energy production and utilisation. In addition, it seeks to soften the impact of high energy prices on vulnerable consumers (COMESA, 2008).

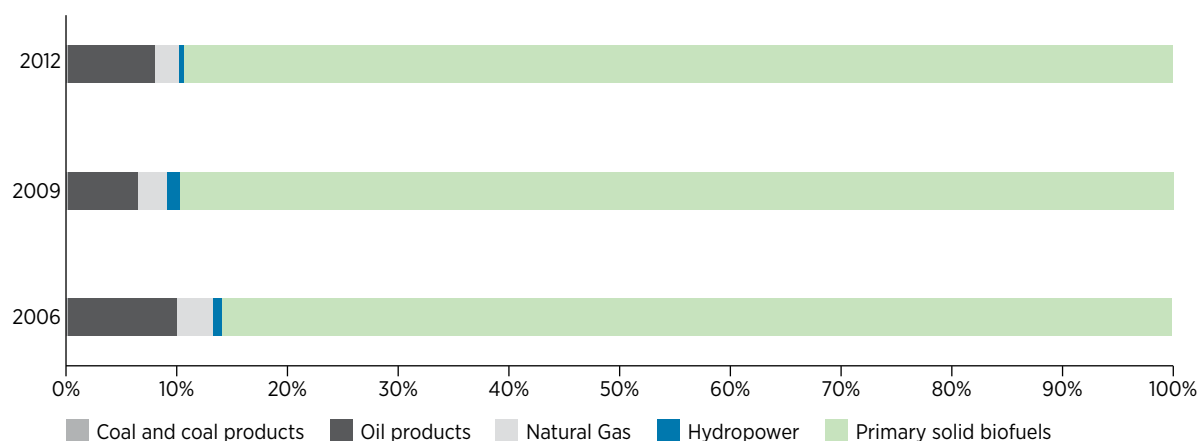
Power transmission networks for interconnection, as well as several power generation projects, are among its regional key infrastructure projects. The Zambia-Tanzania-Kenya Power Interconnector is currently in the construction phase. This distribution network has several aims. Among them, it wishes to promote and stimulate the development of new power generation projects and electricity export potential, and improve the quality of

power to northern Zambia and western Tanzania. It wants to reinforce the Tanzanian national grid and make the country a trading member of the SAPP.

2.2 Energy supply and demand in Tanzania

Tanzania is an economy moving away from its agricultural base. This has placed considerable pressure on energy consumption. Total primary energy supply (TPES) climbed from 13.46 million tonnes of oil equivalent (mtoe) to 22.16 mtoe in 2012 – an increase of almost 100% over the last decade. Figure 3 displays the TPES trend over a six-year period, showing the continued dominance of biomass as primary energy source. According to International Energy Agency statistics for Tanzania in 2012, biomass accounted for 85.5% of TPES, with the remainder distributed between petroleum (6.6%), gas (1.5%), hydroelectricity (0.6%), and coal and peat (0.2%). This energy supply and end-use structure reflects Tanzania's level of development, with limited industrial and manufacturing activity and the dominance of households in energy consumption.

Figure 3: Total primary energy supply in Tanzania, 2012



Source: United Nations Economic Commission for Africa, 2014

Solid biomass in the form of firewood and charcoal is the main energy source for cooking. The quantity of firewood consumed in rural areas is 26 million cubic metres (m³). Of this, 24 million m³ is used for household cooking, 2.03 million m³ for rural small and medium-sized enterprises and 14.4 million m³ in urban areas – mainly as charcoal. According to the United Nations Framework Convention on Climate Change, only 4% of the biomass used is sustainable out of the 90% of solid biomass energy consumed by users. Most biomass demand is for household consumption for cooking and heating, and the remainder (10%) is used by home-based enterprises, commercial, institutional and industrial sectors. Experience shows that biomass energy will remain a dominant source of energy, at least in the medium term. More efforts will thus be needed to ensure sustainability of biomass supply (United Nations Framework Convention on Climate Change, 2012).

Charcoal is the single largest source of household energy in urban areas, representing 20% of total energy use. In Dar es Salaam, more than 70% of households are using charcoal. The city alone consumes approximately half Tanzania's annual charcoal supply, amounting to around 500,000 tonnes in 2009 (Renewable Energy and Energy Efficiency Partnership, 2014).

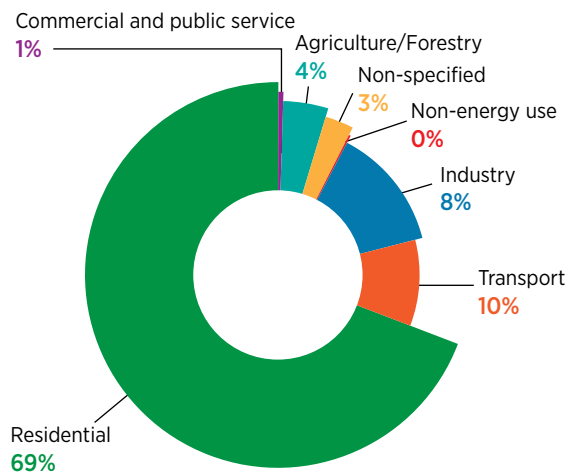
A sector breakdown of energy consumption in Tanzania is shown in Figure 4. The residential sector consumes about 70% of total energy consumed, amounting to 19.25 mtoe. This high proportion of residential sector energy consumption is explained by the use of inefficient stoves for cooking with firewood and charcoal. At the same time, other economic sectors have low total energy consumption. Low energy consumption in the industrial and agricultural sectors is characteristic of an economy based on subsistence farming and little processing and manufacturing activity, which tends to be energy-intensive.

All Tanzania's fossil liquid fuels are imported, and 75% of these are used by the transport sector. Diesel amounts to approximately 75% of transport fuels used in the country. Trains owned by the two railway companies operating in the country, along with a large proportion of freight transport vehicles, are fuelled by diesel. Smaller household electricity generators ("gensets") run on petrol while larger ones of at least 10 kilowatts (KW) run on diesel (Renewable Energy and Energy Efficiency Partnership, 2014). Oil product consumption escalated dramatically by over 100% between 2000 and 2012 (International Energy Agency, 2012), with petroleum products comprising 8.1% of total final consumption, and electricity accounting for just 1.9%.

Tanzanian imports of fossil fuels corresponded to 25% of total gross imports, accounting for USD 2.9 billion (Massachusetts Institute of Technology, 2012) and representing a heavy burden on the country's finances. Diesel for transportation (middle distillates) and fuel oil for electricity generation are driving the abrupt increase in fossil fuel imports. This is a considerable risk to the whole energy sector.

Although currently dependent on imported fossil fuels, Tanzania has a wealth of largely unused indigenous energy resources. These include hydropower, coal, natural gas, uranium, solar, wind and geothermal energy. Its hydropower potential is estimated at 4.7 GW, coal reserves at about 1,200 million tonnes – of which 304 million tonnes are proven – and natural gas at more than 1.6 trillion m³ of proven reserves (Government of Tanzania, 2014). With appropriate planning and utilisation, these resources have the potential to contribute to Tanzania's National Development Vision 2025 to become a middle-income country.

Figure 4: Final energy consumption in Tanzania, 2012



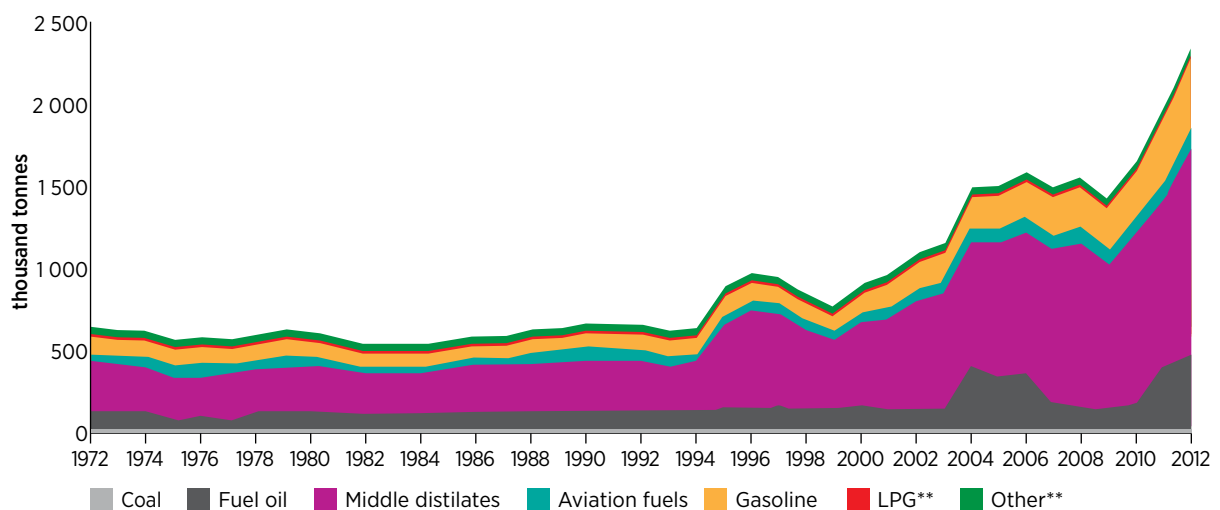
Source: International Energy Agency, 2012

2.3 Electricity sector

The power sector institutional framework and market structure in Tanzania is depicted in Figure 6. The Ministry of Energy and Minerals is in charge of policy formulation while the Energy and Water Utilities Regulatory Authority (EWURA) is in charge of developing regulations in the power sector and monitoring their effective implementation by all relevant stakeholders. The national parastate utility, TANESCO, owns and operates the main grid and has a monopoly over power transmission and distribution of electricity generated from its own facilities as well as from Independent Power Producers (IPPs). In addition, small power producers and stand-alone system providers operate in rural areas with the support of the Rural Energy Agency.



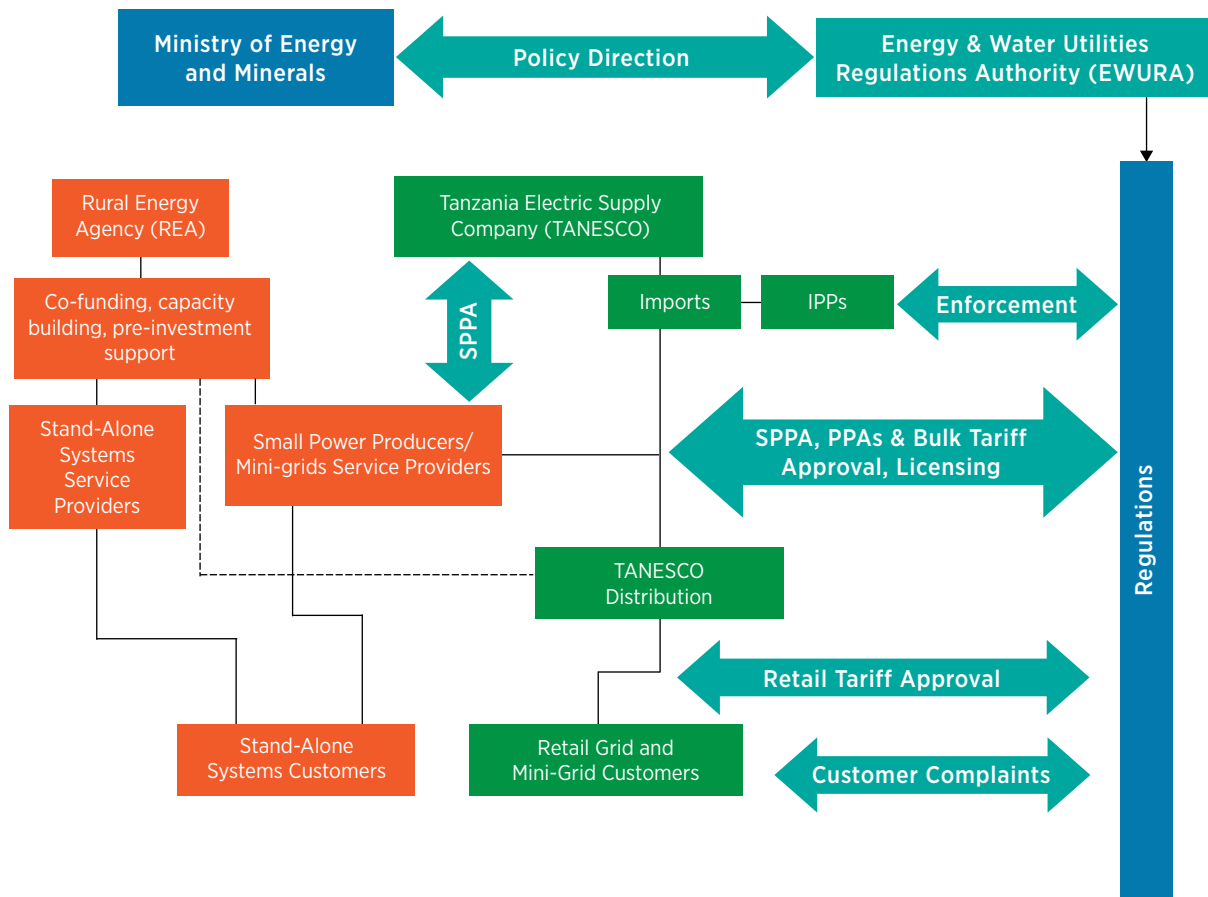
Figure 5: Oil product consumption in Tanzania, 2012



*Consumption includes international bunkers **LPG includes LPG, NGL, ethane and naptha. Others also include direct use of crude oil and other hydrocarbons.

Source: International Energy Agency, 2012

Figure 6: Institutional framework and market structure of the electricity sector



Source: AfDB, 2015; MEM, 2014

In Tanzania, the power sector is steered by the National Electricity Policy 2015, the Energy and Water Utilities Regulatory Authority Act 2001, the Electricity Act 2008 and Electricity (General) Regulations GN 63. Following the enactment of the Electricity Act 2008, EWURA devised a number of rules in 2011 for regulating the electricity supply services, including among others the transmission, generation, distribution and operation of such services. The Electricity (Distribution Services) Rules 2011 give provisions for the governance of regulatory and licensing matters related to the supply of electricity distribution services in Tanzania.

Generation

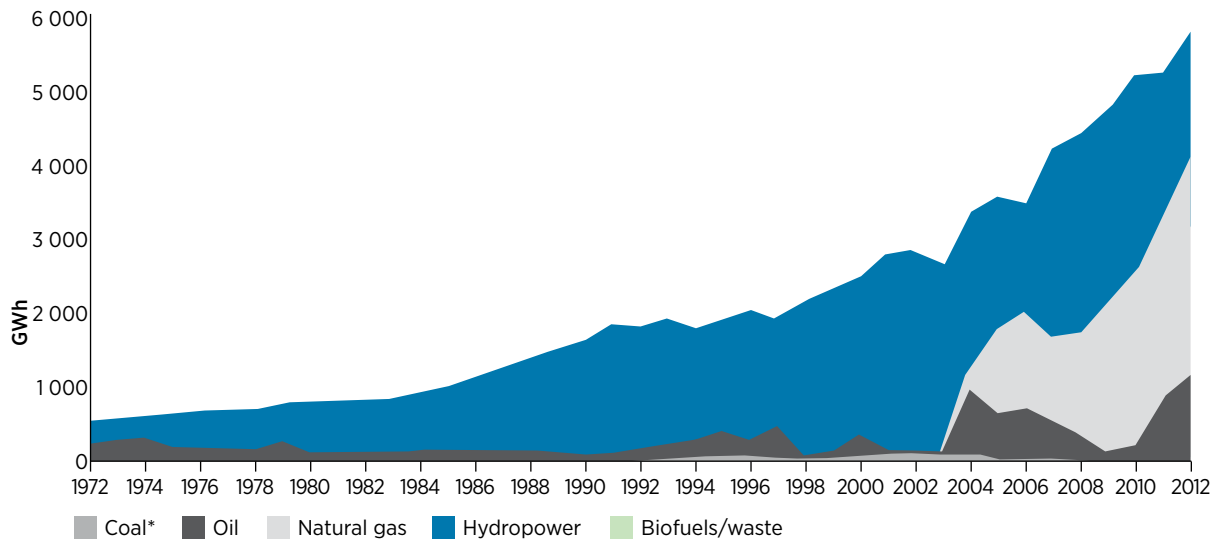
Electricity in Tanzania is mainly generated from hydropower, oil and recently natural gas. The electricity supply varies, especially in times of drought, when hydropower generation is adversely affected. Nearly 25% of electricity generated is lost due to poor grid infrastructure (MEM, 2013a). The unreliability of electricity supply has had a negative impact on the development of the Tanzanian industrial sector. By May 2014, Tanzania's total installed generation capacity was 1,591 MW, of which 1,466 MW was available on the grid. This was composed of 562 MW of large hydropower (35%), 527 MW of natural gas (34%) and 495 MW of oil products (31%). In addition, there was capacity of

27 MW and 13 MW in biomass and small hydropower respectively. Another 300 MW of power generation capacity is thought to exist off the grid, mainly from diesel engines. TANESCO also imports power from Uganda (8 MW), Zambia (5 MW) and Kenya (0.85 MW) to distribute to towns near the borders (MEM, 2014). IPPs and emergency power producers own and operate thermal power plants, the total installed capacity of which amounts to around 417 MW (MEM, 2015a).

From 1980 to 2002, hydropower accounted for nearly all the generation mix. Consequently, the droughts that occurred in 2006 and 2010 led to severe power supply shortages and a reduction in hydropower share to just 35%. TANESCO supplies 59% of total capacity. Meanwhile, IPPs, emergency power producers and small power producers,⁸ which sell wholesale to TANESCO, provide 26%, 13% and 2% respectively. To close the electricity supply gap, TANESCO contracted emergency power producers in 2011. These prove to be a relatively expensive option as they are mainly generating from diesel. Private sector involvement is encouraged. However, the associated generation costs exceed USD 0.30 per kilowatt-hour (kWh).

⁸ Small power producers are IPPs with a capacity of less than 10 MW.

Figure 7: Electricity generation by energy source in Tanzania, 2012



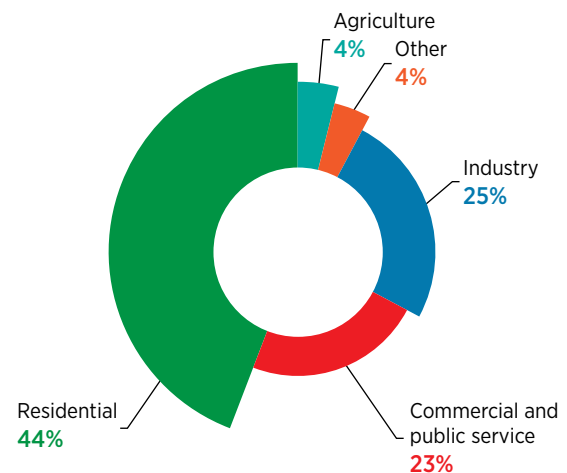
*In this graph, peat and oil shale are aggregated with coal.

Source: International Energy Agency, 2012

As a vertically integrated utility, TANESCO generates power from its own installations but also acts as a single buyer by purchasing from IPPs and small power producers. It is also in charge of selling to its own customers. The “Big Results Now” initiative proposes a drastic restructuring (unbundling) of TANESCO. The Electricity Supply Industry Reform Roadmap 2014 - 2025, prepared by the Ministry of Energy and Minerals, suggests to first split TANESCO into two or three profit business units (generation, transmission and distribution). These would grow into two or three separate entities, which will be further divided into smaller generation and distribution companies. The intention is to increase generation capacity from 1,591 MW to 2,780 MW by 2025 and give access to electricity to five million people in Tanzania. Another aim is to eliminate costly reliance on emergency power plants and meet new demand through low cost solutions. The eventual objective is to make each of the newly created companies profitable. They would apply a cost-reflective tariff, TANESCO’s debts would be reimbursed, and the Government of Tanzania would no longer provide subsidies to the sector (MEM, 2014).

Tanzania’s annual per capita power consumption is very low, at about 105 kWh in 2014 (MEM, 2014), less than half the average in Least Developed Countries. Final total electricity consumption in 2012 was 4,441 gigawatt-hours (GWh). The largest electricity consumer was the residential sector at 44% followed by industry at 25%, and commercial and public services at 23%, Agriculture accounted for only 4% of electricity consumption (International Energy Agency, 2012). Generation is forecast to increase to 47,723 GWh by 2035 (MEM, 2013a). According to the National Energy Policy 2015, installed capacity should be increased to at least 10,000 MW by 2025 to meet such demand.

Figure 8: Electricity consumption by sector in Tanzania, 2012



Source: International Energy Agency, 2012

The electricity demand growth rate is 10% - 15% per year, and peak demand in 2012 was about 1,041 MW (Government of Tanzania, 2014; MEM, 2015). Should business-as-usual conditions prevail, TANESCO foresees significant demand increases due to mining operations, liquefied natural gas plants, factories, water supply and household consumers, thus the peak demand would be close to 8,000 MW by 2025 (MEM, 2015b).

The Rural Energy Agency is responsible for implementing the rural electrification strategy, which mainly concentrates on the extension of the grid and mini-grid distribution network in rural areas. In areas where grid extension is not feasible, the Rural Energy Agency also supports the development of solar PV projects in some villages. Pilot projects on wind-solar PV hybrid systems have also been installed in some

public institutions in rural areas. The Rural Energy Agency receives funds from the Government of Tanzania and development partners, including the Swedish International Development Agency, the World Bank's Tanzania Energy Development and Access Project, and the Norwegian Agency for Development Cooperation. TANESCO operates a number of isolated mini-grids. In March 2015, 18 diesel-fired mini-grids were in operation, with a total installed capacity of 82.2 MW. Two of these are mini-grids with an installed capacity of 29 MW fuelled by natural gas. The remaining mini-grids have a total installed capacity of 53.2 MW and are diesel generators (TANESCO, 2015). Rural electricity access in Tanzania is estimated to be less than 6%.⁹

To supply growing on-grid demand, the Ministry of Energy and Minerals presented a diversified electricity generation mix in its 2014 Electricity Supply Industry Reform report. This included natural gas, coal, hydropower and non-conventional renewables. Despite the high renewable energy resource potential, which could translate into the provision of power at a lower cost, the Electricity Supply Industry Reform Roadmap considers only 4.85% of renewable energy potential. The generation growth envisaged by 2025 is shown in Table 2 below.

⁹ Value according to the definition of the National Electrification Program Prospectus (Innovation Energie Développement, 2014).

Table 2: Present and projected installed capacity by year 2025

Source	Existing capacity (MW) (March 2013)	Additional capacity (MW)	Total capacity by 2025 (MW)
Hydropower	565.8*	1 529	2 095
Oil	456.3	0	456
Natural gas	501	3 968	4 469
Biomass	27	0	27
Coal	0	2,900	2 900
Wind	0	200	200
Solar	0	100	100
Geothermal	0	200	200
Interconnection	14	400	414
Total	1 564.1	9 297	10 861

*Including small hydropower (<10 MW)

Source: Electricity Supply Industry Reform Strategy and Roadmap (MEM, 2014)

Transmission and distribution

The Tanzania transmission network includes the main grid, which covers large urban centres, some mini-grids in suburbs and rural areas located a long way from the central grid, and diesel-powered private generation. In addition, TANESCO imports electricity from its neighbouring countries at distribution level (AfDB, 2015).

TANESCO owns and operates the transmission and distribution systems. However, in some areas, small power producers are responsible for isolated mini-grids. By May 2014, the transmission system consisted of 43 substations with 4,867 km of transmission lines comprising 2,732 km with system voltages at 220 kV, 1,556 km at 132 kV and 580 km at 66 kV. Almost all the transmission lines are

radial single circuit lines. The system is entirely alternating current operating at a frequency of 50 Hertz. The total installed capacity in the main grid system amounts to 1,396 MW (TANESCO, 2014).

For the coming decade, the country's project portfolio for interconnectors consists of five projects:

- a 400 kV interconnector to Kenya in preparatory stage
- a 400 kV interconnector to Zambia with secured funding from AfDB and construction already under way on the Zambian side
- a planned 220 kV interconnector to Mozambique, for which discussions under way with Mozambican counterparts

- a 63 MW hydropower plant project at the Rusumo border with Rwanda and Burundi, which will interconnect the national grids of Tanzania, Rwanda and Burundi through a 220 kV transmission line
- a 220 kV transmission line to Malawi by 2021 and a 340 MW hydropower plant project at the Songwe border.

System losses are high at nearly 18%, largely due to long distance transmission lines, ageing infrastructure and commercial losses. Major investment is required to renovate transmission lines and infrastructure in different parts of Tanzania.

For the Tanzanian electricity sector, scaling up off-grid systems remains a significant challenge (AfDB, 2015). This is due to multiple factors, such as the low density and sparse distribution of the rural population, as well as income poverty. According to the 2012 National Census, the average population density in mainland Tanzania was 49 inhabitants/km². However, the rural regions of Lindi, Katavi and Ruvuma have densities of 13, 15 and 22 inhabitants/km² respectively (National Bureau of Statistics, 2013).

The Rural Electrification Investment Prospectus shows that approximately 46% of rural populations are near the grid; 20% are further away but located in densely populated areas, and 34% are further away in low density areas. Furthermore, USD 3.5 billion of investment is required in the sector to increase the rate of rural access from 6.6% to 36.6%, and the rate in urban areas from 34.2% to 75.7% by 2022 (Innovation Energie Développement, 2014).

Costs and tariffs

Electricity tariff review and approval is in hands of EWURA. With the authorisation of the Ministry of Energy and Minerals, TANESCO submits tariff review requests to EWURA. The tariff level is dependent on a number of factors, including electricity production cost (including operation cost), social cost and other political economic criteria.

In January 2012, EWURA authorised a 40% tariff increase to TANESCO. Nevertheless, TANESCO still incurs losses primarily due to its dependency on emergency power producers, which account for 13% of installed capacity at 205 MW (TANESCO, 2013). As far as integrated generation, transmission and distribution costs are concerned, TANESCO states in its Tariff Review Application Report that the current tariff regime yields an average revenue of about 198 TZS/kWh (USD 0.10/kWh).¹⁰ However, the revenue requirement target for TANESCO in 2013 amounted to 332 TZS/kWh (0.16 USD/kWh). The shortfall of 134 TZS/kWh (62.5%) has severely restricted the ability of the company to provide the services required to meet its obligations to both its lenders and customers (TANESCO, 2013).

The present tariff regime differentiates between the following customer groups and component costs according to basic charge at TZS per calendar month (pcm), energy charge (TZS/kWh) and demand charge (TZS per kilovolt-amp/kVA pcm) (see Table 3). For 2015, TANESCO estimates it had 1.85 million customers, of which 52% correspond to customer category T1 and 47% to category D1 (25% consume more than 50 kWh pcm and 22% less than 50 kWh pcm). The final 1% of customers were in categories T2, T3 and T5.

¹⁰ Exchange rate used: USD 1/TZS 2,075 (July 2015).



Photograph: Shutterstock

Table 3: Electricity tariffs

Customer category	Component	Unit	From 1 February 2013	
			TZS	USD*
D1 Domestic low usage – low consumption users	Basic charge	USD pcm	0	0
	Energy charge	USD/kWh		
	50-0 kWh/pcm	USD/kWh	60	0.03
	> 50 kWh/pcm		273	0.13
T1 General use – for general use of electricity including residential, small commercial and light industrial use, public lighting and billboards	Basic charge	USD pcm	3 841	1.85
	Energy charge	USD/kWh	221	0.11
T2 Low voltage maximum demand usage, for general use at 400 volts with average consumption greater than 7500 kWh per meter reading period	Basic charge	Oil	14 233	6.86
	Energy charge	Oil	132	0.06
	Demand	USD/pcm	16 944	8.17
T3 High voltage maximum demand usage for general use where power is metered at 11/33 kV	Basic charge	Oil	14 233	6.86
	Energy charge	Oil	118	0.06
	Demand	USD/pcm	14 520	7.00
T5 Bulk supply tariff for Zanzibar	Basic charge	Oil	14 233	6.86
	Energy charge	Oil	106	0.05
	Demand	USD/pcm	12 079	5.82

*Exchange rate used: USD 1/TZS 2,075 (July 2015)

Source: TANESCO, 2013

Although a low social tariff exists for customers using less than 50 kWh per month, very few potential customers were able to take advantage of this reduced tariff due to the high connection fees. In December 2012, the household connection fees payable upfront to TANESCO were substantially decreased to approximately USD 68 for a rural customer and USD 120 for an urban customer (TANESCO, 2013).

The power shortage emergency of 2010 and 2011 has resulted in a major expansion of costly thermal generation. The final report of the Joint Energy Sector Review in 2013 states that while electricity provided by the company Songas costs USD 0.066/kWh, the emergency thermal units (Jet A1 and diesel) cost ranges from USD 0.30/kWh to USD 0.43/kWh – a significantly higher cost. Consequently, the cumulative cost of the emergency power producer from August 2011 to December 2012 was estimated at USD 597 million and financed through loans guaranteed by government from local commercial banks (Larsson *et al.*, 2013).

For the country's economy, cheaper electricity generation sources must be explored and energy access efforts intensified in the medium to long term. The existing tariff levels will not be able to withstand the rise in average costs without driving TANESCO into insolvency.

2.4 Renewable energy resources

Tanzania has considerable renewable energy resources, including hydropower, solar, wind and biomass resources in the form of forests, agricultural residues, animal and urban waste. There are also potential geothermal resources. Renewable energy resources and potentials in Tanzania are provided in the sections below.

With the exception of biomass and hydropower, renewable energy sources have only been exploited to a limited extent. The spread of renewable energy technologies has been limited mainly to promoting

improved stoves, improved charcoal production techniques, biogas, windmills for water pumping and to a lesser extent PV. This has been installed on rooftops, providing power solutions to areas not connected to the grid and as a backup to intermittent grid power supply. PV is also used for telecommunications towers and street lighting in some urban areas.

Other renewable energy sources have mainly been promoted through private initiatives at various locations in Tanzania. Hotels, hospitals and dispensaries have attempted to install solar water heaters. Unfortunately, many of these units are out of order, mainly due to lack of after sales services. Micro-hydropower generation has mostly been undertaken by missionaries.

Large hydropower

While Tanzania's potential hydropower capacity is estimated at 4,700 MW, only 561 MW has been built (Government of Tanzania, 2014). The largest hydropower plants are at the Mtera (80 MW), which has a storage capability of more than one year, and Kidatu (200 MW) dams on the Great Ruaha River.

One of the challenges for hydropower development in Tanzania is the geographical distance between hydropower sites and major demand centres. While the former are located mainly in the southwest, the bigger and more commercial cities are the major demand centres, and these are in the north, northwest and east. Tanzania has abundant hydropower resources which could play a significant role in its future energy development. It could provide an excellent backup

to other renewables and store large quantities of intermittently generated electricity from solar and wind. For energy security, it could provide peaking power and also generate large amounts of power at least during the rainy season.

The Electricity Supply Industry Reform Roadmap targets an additional capacity of 1,529 MW to be installed by 2025 to bring the total to 2,091 MW. Taking into account planned capacity additions, large hydropower will still represent approximately 20% of the installed capacity after 2025, with risks of supply disruptions due to recurring droughts.

Small hydropower

Although assessments show an overall potential of 480 MW for small hydropower, only 15 MW of small hydropower installations are connected to the grid. Most of the remaining small hydropower installed in the country is owned by private entities. Five sites in the 300 - 8,000 kW range are owned by TANESCO. More than 16 are owned by faith-based groups, 29 with a 15 - 800 kW capacity range amounting to a total of 2 MW (AfDB, 2015).

By 2013, 11 projects had signed small power purchase agreement (SPPAs). Of these, four are mini-hydropower projects totalling 20.5 MW, biomass projects totalling (21.6 MW) and solar projects (2 MW) (MEM, 2013b). TANESCO has also signed Letters of Intent for six small hydropower projects with a total capacity of 29.9 MW while small hydropower projects are also being developed as isolated mini-grids (see Table 4 below).

Table 4: Overview of small hydropower projects in Tanzania

Developer	Ministry of Energy and Minerals	Rural Energy Agency, Global Village Energy Project and World Bank	EU	UNIDO*
Sites	Morogoro, Iringa, Njombe, Mbeya, Ruvuma, Rukwa, Katavi, Kagera	6 hydropower mini-grids	Yovi	Six mini-grids based on mini/micro-hydropower
Capacity		7.5 MW	1 - 2.3 MW	

*United Nations Industrial Development Organization
Source: MEM, 2015

Geothermal energy

Tanzania lies within the East African Rift System. Several reconnaissance surveys, hot spring and geothermal site assessments have been carried out in the country since 1949. These studies of geothermal sites included measurements of surface temperature, water and gas flow as well as analysis of water and gas in the hot springs (Mayalla *et al.*, 2011).

The country established the Tanzania Geothermal Development Company as a public entity for

spearheading domestic geothermal development since 2013. Since then, a number of exploration studies on geothermal energy are in progress at different levels in different geothermal sites. The most researched site is Ngozi prospect. This is now at the detailed exploration stage, refining the geothermal conceptual modal and locating the drilling targets for exploration wells expected to be drilled by 2017. Most of the other geothermal prospects in the country are at the reconnaissance stage.

The early geothermal studies of surface manifestations across the country indicated the potential for more than 5,000 MW in geothermal projects. More than 50 sites have been identified so far and are proposed for more detailed investigation, mainly from three regions. These sites are:

- the Northern Zone (Kilimanjaro, Arusha and Mara region)
- the Southern Zone (Rukwa and Mbeya region)

- the eastern coastal belt, which is associated with rifting and magmatic intrusion (the Rufiji Basin) and the Luhoi Spring site, with potential for 50 - 100 MW.

Tanzania does not have any geothermal power generation facilities, and there is no commercial usage of geothermal water. However, there is potential to harvest the resource for domestic to industrial heating once it is brought to the surface (Mnjokava, 2014).

Figure 9a: Location of geothermal prospects in Tanzania

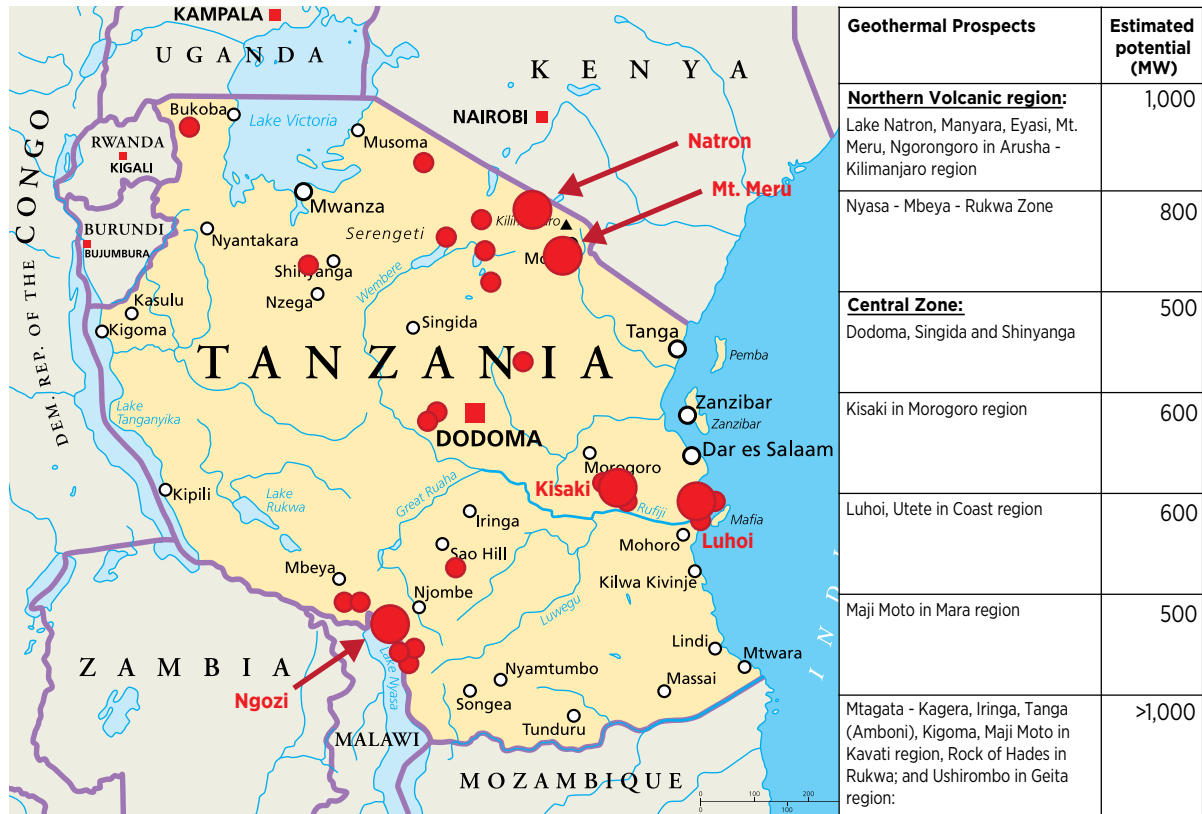


Source: Tanzania Geothermal Development Company (2015)

The Japan International Cooperation Agency will evaluate the resource further by supporting satellite imaging and the identification of resources at sites with high potential. It will then select from between three and five fields for further in-depth investigation. Pre-feasibility studies based on conceptual models of the field will be carried out, along with suitability

assessments based on project economics and environmental and social factors. An exploratory well-drilling programme will be prepared for promising sites, and test well drilling will take place with the support of the Scaling Up Renewable Energy Program of the World Bank. Resource confirmation will be followed by feasibility studies (AfDB, 2015).

Figure 9b: Tanzania's geothermal resources



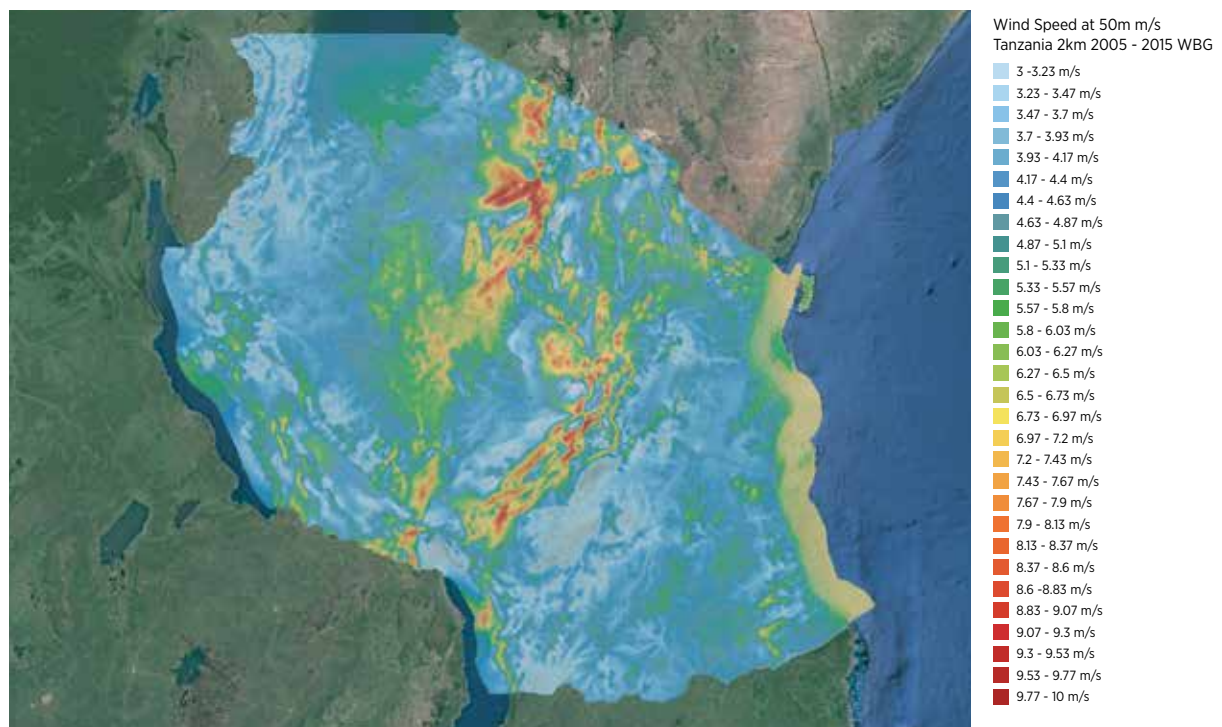
Source: Tanzania Geothermal Development Company (2015)

Wind

Tanzania is blessed with strong wind resources, which attain speeds of between six and eight metres per

second (m/s), particularly in escarpment areas around the Rift Valley and along the coastal areas (see Figure 10 and Figure 11).

Figure 10: Wind map of Tanzania



Source: transmission lines produced by the World Bank's Infrastructure Country Diagnostic project; wind map produced by Danish National Laboratory for Sustainable Energy (RisØ DTU); country borders taken from Global Administrative (GADM) Database

Several studies have been in progress for a number of years, including an investigation programme sponsored by the Ministry of Energy and Minerals, TANESCO and TaTEDO with technical and financial support from the Denmark National Laboratory (RISØ), and the Danish International Development Agency (DANIDA). These

organisations have made major efforts to assess wind resources and undertake investment feasibility for harnessing wind energy. This investigation ended in 2003 (DANIDA/IS, 2003) and presented specific locations for which it produced detailed information. This is described in the table below.

Table 5: Wind resources in Tanzania

Site	Study	10 m wind speed (m/s)	30 m wind speed (m/s)
Makambako	Original Wind East Africa	7.6	8.7
Singida	Wind East Africa	8.2	9.4
Karatu (Arusha)	DANIDA/Risø/ TANESCO	4.9	5.5
Mkumbara (Tanga)	DANIDA/Risø/ TANESCO	4.14	4.9
Gomvu (Kigamboni)	DANIDA/Risø/ TANESCO	3.56	4.28
Litembe (Mtwara)	DANIDA/Risø/ TANESCO	3.21	4.47

Source: German Technical Cooperation Agency (Deutsche Gesellschaft für Technische Zusammenarbeit), 2009b

TANESCO and the Ministry of Energy and Minerals are leading wind resource assessments in Mkumbara, Karatu, Gomvu, Litembe, Makambako, Mgagao and Kititimo, while the Rural Energy Agency is supporting wind measurements on Mafia Island. Wind measurements at 30 m are available from TANESCO for the three sites of Makambako, Mwanga and Singida. Singida is where the country's first ever large-scale wind power plant is being built, with a capacity of 100 MW. When the study report was issued in 2005, measurements had been taken for the high wind season. The results showed average wind speeds of 10-11 m/s, thus confirming the previous results from the DANIDA project.

The latest resource assessment initiatives include the preliminary findings from the World Bank Energy Sector Management Assistance Program (ESMAP) renewable energy resource mapping project. The initial results were based on global datasets and satellite analysis and show high wind power potential over more than 10% of the

country. This is an area comparable to the size of Malawi (World Bank, 2015b).

Moreover, the International Renewable Energy Agency (IRENA) and the Lawrence Berkeley National Laboratory (LBNL) have developed a methodology for renewable power development within the Africa Clean Energy Corridor, an initiative in which Tanzania is a participant. The approach combines geospatial, statistical, energy engineering and economic methods to comprehensively identify and value high quality wind zones for grid integration based on technoeconomic criteria, generation profiles, and socioenvironmental impacts.

Geo-referenced PDF maps are one of the key outputs of that study, embedding both the visual content as well as the attribute values of each zone. A snapshot of the interactive map is presented in Figure 11 below for wind zones and shows the highest potential and most cost-effective zones for Tanzania.

Figure 11: Wind energy zones in Tanzania



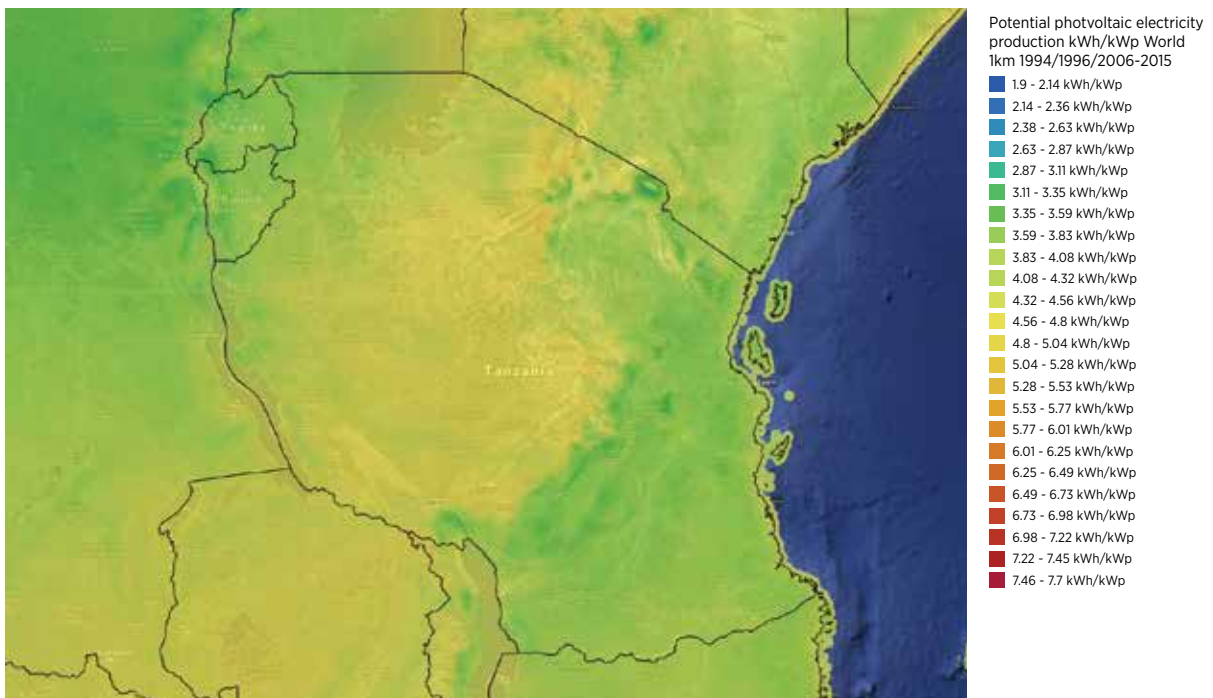
Source: IRENA-LBNL (2015); for more on IRENA-LBNL zoning study: mapre.lbl.gov

Solar

Tanzania's annual solar resources exceed 5 kWh/m² per day throughout the country. Insolation is generally higher and more consistent in the Lake Victoria basin and along the coast. However, in the elevated areas

around Moshi and Arusha, and in Iringa and further south, insolation is considerably reduced (*i.e.* less than 4 kWh/m² per day) during the cloudy season. This is between May and August (see Figure 12).

Figure 12: Global solar irradiation in Tanzania



Source: Transmission lines provided by the World Bank's Africa Infrastructure Country Diagnostics project; solar global irradiation map developed by Vaisala; country borders taken from the Global Administrative (GADM) Database

The preliminary results from the renewable mapping project carried out by the World Bank Energy Sector Management Assistance Program, as well as the IRENA-

LBNL study, both show that Tanzania has a good store of solar resources (Figures 13 and 14).

Figure 13: Concentrated solar power zones in Tanzania



Source: IRENA-LBNL (2015); for more on IRENA-LBNL zoning study: mapre.lbl.gov

Figure 14: Solar PV zones in Tanzania



Source: IRENA-LBNL (2015); for more on IRENA-LBNL zoning study: mapre.lbl.gov

Tanzania's PV consumer market started evolving in the early 2000s due to the capacity developed by NGOs and the formation of the Tanzania Solar Energy Association, which is now called TAREA. The private market has evolved from an installed capacity of 300 kilowatt-peak in the late 1990s to just over 5 MW in small-scale installations in 2012 (Hansen, Pedersen and Nygaard, 2014). During this development, annual sales grew from 70 kilowatt-peak in 2002 to 2 MW in 2011. They are thought to have been higher in 2012 and 2013 due to favourable policy developments, support schemes and the rapid reduction of costs for solar PV in off-grid locations.¹¹ The increased sales in off-grid markets are also a result of increased consumer awareness and buying power. Equally, sales have been influenced by the government's recognition of the potential role of solar PV in the electrification of large economically active parts of the country. The grid would otherwise take a much longer time to reach these areas.

Solar home systems and small-scale commercial systems amount to around 75% of installed PV capacity in Tanzania and therefore contribute the most to the country's solar market (Ondraczek, 2013). By the end of 2008, 40,000 solar home systems had been installed, and their annual sales amounted to 4,000 - 8,000 (Hansen, Pedersen and Nygaard, 2014). The remaining 25% of installed PV capacity mainly consists of PV systems in schools, health centres, missions and government offices, and to a minor extent in the telecommunications and tourism sectors (Hansen, Pedersen and Nygaard, 2014). There is some application of solar PV electricity for productive use. Examples include pineapple processing by Matunda Mema (T) (in Karagwe District), gold processing by New Luika Mines (in Mbeya District) and Geita Gold Mine (in Geita District), and timber machining by Sao Saw Mill.

There are currently no grid-connected PV generation plants in Tanzania. However, grid-connected solar PV is increasingly viewed as a promising replacement for thermal power generation in remote mini-grids. Nevertheless, no large investments have taken place yet. There is growing interest in small and large projects involving connection to the main grid but

these discussions are still only at a preliminary stage (Deutsche Auslandshandelskammer, 2013).

Biomass

Biomass energy is major renewable energy resource used in a traditional way by almost all households, institutions and small and medium-sized enterprises in Tanzania. Biomass energy is mostly used for heat production and as fuel for cooking in Tanzania. Figures on dependence on woodfuel for cooking range from more than 73% to 90% (World Health Organization, Global Environment Facility and United Nations Development Programme, 2009). More than 90% of biomass demand is for household consumption (firewood, charcoal, crop residues). The rest of biomass demand is for commercial, institutional and industrial sectors (10%). Annual consumption of charcoal in Tanzania stands at one million tonnes per year and is growing fast, contributing to more than nine million tonnes of CO₂ and depletion of more than 300 hectares of natural forest per day. Change of land use and deforestation also accounts for 58% of the country's total greenhouse gas emissions. Growing demand is driven by rapid urbanisation and high relative prices or scarcity of energy substitutes, particularly kerosene, electricity, biogas, biomass briquettes and liquefied petroleum gas. The Biomass Energy Strategy report baseline projections show that without supply-side and demand-side interventions, demand for charcoal will double by 2030 from approximately 2.3 million tonnes in 2012 (CAMCO Clean Energy, 2014).

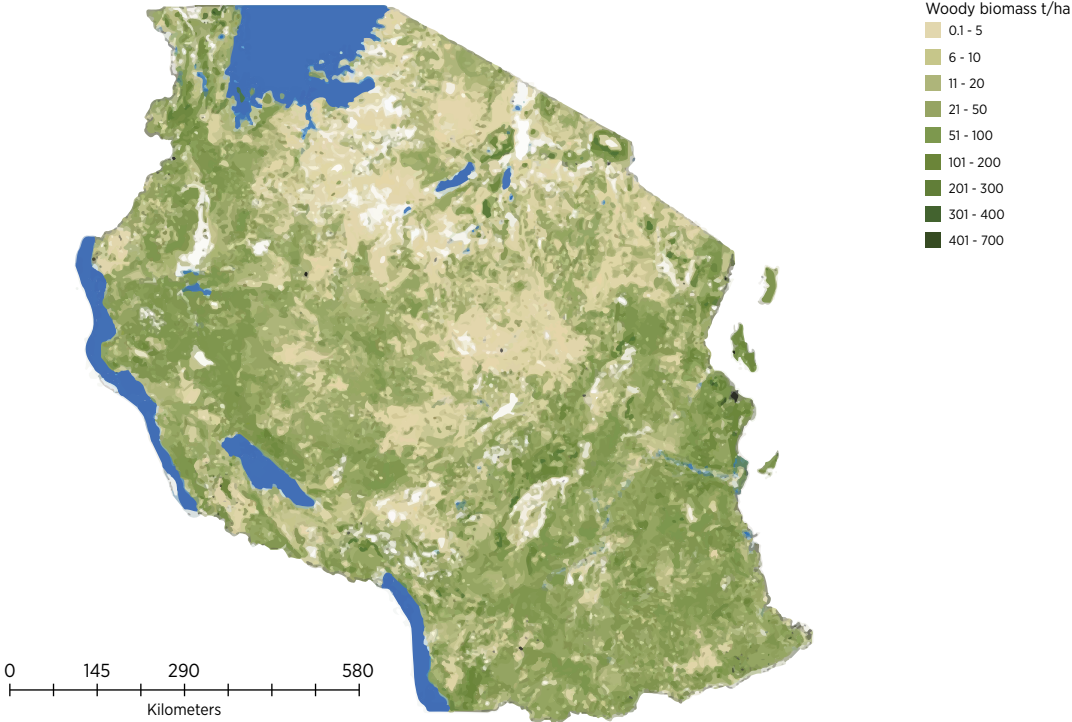
The initiatives supporting increased access to clean cookstoves or fuels have been scattered. They were launched in the 1980s by the Ministry of Energy and Minerals and carried out by TaTEDO, which has been playing a leadership role and supporting the co-ordination and sustainability of efforts. Since much higher total energy consumption is expected in future, reducing total firewood and charcoal use by improving cookstoves would have a positive impact on deforestation.

¹¹ The mini-grid market segment in Tanzania is also limited, and little is known about it. No agency currently keeps track of the deployment of specific PV systems.



Photograph: Shutterstock

Figure 15: Woodfuel resource density in Tanzania in tonnes per hectare



Source: Food and Agriculture Organization of the United Nations (2010)

Commercial biomass energy¹² is a major energy and income revenue source for rural and urban livelihoods. Charcoal and commercial woodfuel (firewood) amounted to approximately USD 1 billion in revenues for a large portion of the rural and urban producers, transporters and wood energy sellers in 2012. Commercial biomass energy is the largest source of revenue in rural areas (CAMCO Clean Energy, 2014).

Biogas was introduced by the Small Industries Development Organization in 1975, with a number of other NGOs promoting use of the technology. However, the Centre for Agricultural Mechanization and Rural Technology, later in co-operation with the German Cooperation, accelerated awareness and technology dissemination, especially in northern Tanzania. The Tanzania Domestic Biogas Programme started in 2009, and its first phase finished in 2013 with the installation of 8,799 biogas plants. The second phase started in 2014 and will end in 2017. The two phases are aiming to erect 20,700 plants altogether. The programme is hosted in the Centre for Agricultural Mechanization and Rural Technology and receives technical assistance from SNV Netherlands Development Organisation. It is part of the Africa Biogas Partnership Programme managed by Hivos with funding from the Netherlands Directorate for Development Cooperation (Directoraat-generaal Internationale Samenwerking).

With more than 17,000 hectares of sugarcane plantations along with forest and agricultural residues, there is estimated co-generation potential of more than 315 GWh/year. This amounts to almost 10% of the

country’s power generation. Energy generation potential from excess bagasse in sugar mills is about 99 GWh per year – 3% of national electricity generation (MEM, 2013b). Two private companies currently supply TANESCO with biomass generation: Tanganyika Planting Company (a major sugar producer) supplies 3 MW while Tanzania Wattle Company (a tannin producer) has an SPPA for 1.5 MW.

Driven by high oil prices, energy security concerns and global climate change, demand for biofuels has been increasing and has found its way onto the agricultural development, energy policy and natural resource management agendas. The Government of Tanzania made its interest in biofuel developments explicit in 2005 at the time of a GIZ study on liquid biofuel for transportation in Tanzania. This reviewed the potential of the biofuel subsector in the country and the importance of developing biofuels, with an emphasis on biodiesel and bioethanol. The study proposed a biofuel development institutional structure. It suggested that the Ministry of Energy and Minerals could facilitate the formation of the National Biofuel Task Force, National Biofuel User Association and the Biofuel Policy. Different stakeholders were engaged in liquid biofuel development, including the sector-oriented ministries, civil society organisations, the private sector, multinational companies and individuals. Some of the initiatives established were biofuel rural electrification and biofuel outgrower schemes.

¹² The term commercial biomass energy refers to biomass energy produced and sold on a commercial basis.

Renewables, including off-grid solutions, can help meet rising urban energy needs



Photograph: Shutterstock



Solar PV off the main grid

Photograph: E.ON Off Grid Solutions - Rafiki Power



3. ENABLING ENVIRONMENT FOR RENEWABLE ENERGY

3.1 Key energy stakeholders and institutional set-up

The energy sector in Tanzania comprises governmental institutions, private sector operators, NGOs and a parastatal and vertically integrated power utility, TANESCO.

Government/public sector institutions

- **Ministry of Energy and Minerals:** this has the overarching role of overseeing policies, strategies and laws within the areas of energy and mineral resource management. The ministry's stated vision is to be "an effective institution contributing significantly to the acceleration of socioeconomic development through sustainable development and utilisation of energy and mineral resources in Tanzania by 2025". Its tasks also include planning, capacity development and financial resource mobilisation.
- **Tanzania Electric Supply Company Limited (TANESCO):** this is a parastatal institution within the Ministry of Energy and Minerals and is 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. It supplies power directly to mainland Tanzania and to Zanzibar Electricity Corporation. Its mission is to generate, transmit and supply electricity in the most effective, competitive and sustainable manner possible.
- **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 licences and monitoring and enforcement activities.
- **Rural Energy Agency:** this 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. It is an autonomous body under the Ministry of Energy and Minerals and its task is to deal with rural access by co-financing rural electrification programmes implemented by relevant actors.
- **Tanzania Investment Centre:** this had 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.
- **Tanzania Geothermal Development Company:** this is a subsidiary company of TANESCO and became operational in July 2014 with a mandate to be at the forefront of geothermal development in Tanzania. Tanzania Geothermal Development Company is a key stakeholder

concerned with enabling and supportive policies and regulations that would accelerate geothermal development in the country. The company is keen to develop the country's geothermal roadmap and development plan.

Private sector institutions

- **Emergency power producers and IPPs:** these are private investors owning power plants of more than 10 MW and contributing 40% of the installed electricity capacity. Current players include Songas, Independent Power Tanzania Limited (IPTL), Symbion Arusha, Aggreko and Symbion Dodoma. All these companies have thermal stations that operate with diesel, gas or heavy fuel oil.
- **Small power producers:** 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. The small power producers include Mwenga Hydropower, Mufindi Paper Mills, TANWATT, Texpol Company, Ngombezi (Mafia) etc.
- **Private solar energy companies:** most of these companies are organised under the Tanzania Renewable Energy Association but work independently in solar PV installation, importing and selling solar PV products. These companies include ENSOL, Sustainable Energy Services Company (SESCOM), Ashton Energy, Zara Solar, Alternative Energy, Step Solar, Solar Sisters, Resco, Davis and Shirliff, Rex Energy, Baraka Solar, Anchor Power, Photons Energy etc.
- **Private biomass energy companies:** these are companies engaged in the fabrication and supply of improved and clean woodfuel cookstoves. Among these companies are the Sustainable Energy and Enterprise Company, ARTI Energy, Husk Power Systems, INVOTECH, Green Resources, Sugar Companies (Illovo-Kilombero, Tanzania Plantation Company, Mtibwa and Kagera), Centre for Agricultural Mechanisation and Rural Technology, Tanganyika Wattle Company (TANWAT), Sao Hill Sawmill Industries/Green Resources, East African Briquette Company, Tanga, Kilimanjaro Industrial Development Corporation, Mena Wood Briquetting, SIMGAS, Katani, Biomass Energy Tanzania etc.

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. These institutions include Arusha Technical College, Dar es Salaam Institute of Technology, Mbeya Institute of Science and Technology, the University of Dar es

Salaam, University of Dodoma and organisations within the Vocational Education Training Authority (Mafinga Lutheran Vocational Training Centre, Legeruki Lutheran Vocational Centre, Hai Vocational Training Centre, Mobisol Academy and M-Power Academy).

- Research and development efforts to stimulate energy innovation are important pillars of development in the energy sector. Although the energy policy stipulates a requirement for research, the country does not have specific institution for energy research. Research studies are conducted by consultancies commissioned by different stakeholders, such as the Economic and Social Research Foundation, Costech, Geological Survey of Tanzania, Nishanti Associates, Research on Poverty Alleviation, TaTEDO, Institute of Resource Assessment, Sokoine University of Agriculture etc.

Most of the research studies cover policy development and also the production and use of renewable energy such as bioethanol as a fuel for domestic and industrial uses. Equally, they deal with the renewable energy fuel value chain, liquid biofuel feedstock production etc.

Civil society organisations

Civil society organisations in the renewable energy sector include NGOs, faith-based organisations and renewable energy networks. Various NGOs and faith-based organisations promote access to sustainable and renewable energy. The faith-based organisations include missionaries who installed mini-grids as far back as 1928. Up until now, many mini-hydropower plants have been owned, operated and managed by faith-based organisations. The two main networks in Tanzania are the Tanzania Renewable Energy Association and the National Gender and Sustainable Energy Networks. TaTEDO is a national NGO that has been advocating sustainable energy access for over two decades. Other NGOs include AMKA Trust, CARE-Tanzania, Clean Cookstoves and Fuel Alliance of Tanzania, Tanzania Forest Conservation Group, SNV Netherlands Development Organisation (Tanzania), Voluntary Service Overseas (Tanzania), NORGES VEL, Tanzania Renewable Energy Incubator, Energy Lab, Same/Mwanga Environmental Conservation Advisory Organization and WWF (Tanzania).

Local government authorities

Local government authorities in Tanzania have experience of off-grid production and distribution of energy in their own (mostly urban) areas using decentralised energy systems and mini-grids. For instance, the local government authority in Mbarari, Mbeya used small hydropower to supply electricity to Mbarali Township. Few district councils generate electricity using thermal generators. Most largely rely on imported heavy fuel oil and Jet A fuel to distribute

power in their urban areas. By the end of November 2014, only 12 district headquarters had not yet been electrified, namely Bukombe, Kasulu, Kilinda, Kilolo, Ludewa, Namanyere, Namtumbo Ngara, Ngorongoro, Serengeti, Ukerewe, and Utete. Around 30 MW of thermal generation is in isolated off-grid areas. There is a need for intensive strategies to expand energy generation to different sources by local government authorities.

3.2 Energy policies and regulatory framework

Tanzania formulated the first version of the National Energy Policy in 1992, which was subsequently revised in 2003. This spearheaded development in the energy sector by aiming to align itself with cross-

cutting macroeconomic objectives and by promoting the involvement of the private sector in energy. The implementation of the National Energy Policy yielded the enactment of the Rural Energy Act 2005 leading to the foundation of the Rural Energy Agency and the Rural Energy Fund in 2007. This had been preceded by the establishment of EWURA in 2006 as well as the Electricity Act 2008, the Petroleum Act 2008 and the adoption of the Standardised Power Purchase Agreement and Tariffs, also in 2008. The National Energy Policy document was again revised in 2015 and included more aggressive approaches to easing the entry of the private sector and alternative energy technologies (MEM, 2015). The renewable energy sector in Tanzania is guided by a number of policies and legislation shown in Table 6. These are divided into general guidelines; electricity sector; renewable energy sector; tariffs and strategies.

Table 6: Policies and legislation which affect the renewable energy sector

General	Status	Description of policy/strategy
National Energy Policy 2015	In place Published in 2015	By ensuring an efficient and sustainable energy value chain which includes production, procurement, transportation, distribution and end-use systems, the National Energy Policy aims to ensure the provision of reliable and affordable energy in Tanzania.
Electricity Supply Industry Reform Strategy and Roadmap 2014 - 2025	Published on 30 June 2014	The Electricity Supply Industry Reform Strategy and Roadmap aims for more efficiency as well as an improvement of the quality of services and goods delivered to customers, a sound business environment and the growth of the power sector to allow the country to meet its development targets.
National Public Private Partnership Implementation Strategy	To be covered in Electricity Supply Industry Reform Strategy and Roadmap	This strategy provides an important instrument for attracting investments and effectively resolving managerial, financial and maintenance issues related to public goods and services. The implementation of the strategy will enable the Government of Tanzania to efficiently deliver socioeconomic goods and services.
Ministry of Energy and Minerals Three-Year Strategic Plan	In place (2011/12–2015/16) Published November 2012	This plan provides strategic direction, guiding the implementation of the ministry's plan and budget.
National Investment Promotion Policy	1996	Encourages investment in all feasible sources, with a focus on domestic resources.
Electricity sector		
Electricity Act 2016	Draft	This act, which is being drafted, includes more options for renewables.
Electricity Act 2008	In effect	This act provides for the facilitation and regulation of generation, transmission, transformation, distribution, supply and use of electric energy as well as cross-border trade in electricity and rural electrification planning and regulation.

Table 6: Policies and legislation which affect the renewable energy sector - CONTINUED

Electricity sector		
Rural Energy Act 2005	In effect	This act facilitates the establishment of the Rural Energy Board, the Rural Energy Fund and Rural Energy Agency.
Power System Master Plan	In effect; the 2012 update was issued in May 2013	The overall objective of the plan is to reassess short-term (2013 - 2017), mid-term (2018 - 2023) and long-term (2024 - 2035), generation, transmission plan requirements as well as the need to connect currently off-grid regions, options for power exchanges with Ethiopia (through Kenya), Zambia, Uganda, Rwanda, Burundi and Mozambique, and increased supply of reliable power.
Rural Energy Strategy	Draft Rural Energy Prospectus ready	The strategy intends to provide direction for bridging the energy access gap in rural parts of Tanzania.
Rural Electrification Master Plan	Due to follow the Rural Energy Strategy	The Rural Energy Master Plan aims to promote decentralised power generation from renewable sources in rural electrification efforts.
Renewable energy sector		
Environmental Management Act 2004	In effect	This comprehensive piece of legislation represents the main legal and institutional framework governing sustainable environmental management in Tanzania. It includes incentives as well as mechanisms to ensure adequate environment management at all levels of governance in a way that includes villages and districts in the national environmental management framework.
Biofuels Policy	Draft policy under approval	This document provide direction for developing liquid biofuels in Tanzania by giving proper guidelines to stakeholders interested in investing in liquid biofuels in the country.
Biomass Energy Strategy	Draft strategy under approval	With the objective of ensuring the implementation of an enabling institutional framework, this strategy aims to uncover sustainable supply pathways for biomass energy while at the same time addressing energy access and energy efficiency in the biomass energy subsector.
Tariffs		
Energy and Water Utilities Regulatory Authority Act 2001	In effect	This act aims to set up a central regulatory authority for water and energy utilities, which was concretised by the establishment of EWURA in 2006.
Feed-in tariff policy	Consultancy final report on Renewable Energy Feed-in Tariff (REFIT) submitted to EWURA and waiting for endorsement before policy preparation	The policy expects to promote a multi-player renewables-based power generation market by establishing a fixed tariff for a certain period. The policy was launched to provide security and confidence to investors in renewables-based power generation.
Small Power Producers Framework	2nd Generation framework in application since April 2015	This framework aims to stimulate the increased involvement of private actors in the development of small renewable energy installations (less than 10 MW) in Tanzania. To reach that objective, the framework clarifies tariffs and outlines incentives and tools to mitigate the risks often encountered during small-scale projects.

3.3 Financing and investment

Foreign direct investment is critical to energy infrastructure, especially in developing countries such as Tanzania. In 2013, Tanzania received the highest total foreign direct investment in the East African Community, amounting to USD 1.87 billion. This was primarily due to the gas and mineral sectors. The total injected into the East African Community region amounted to USD 6.2 billion (United Nations Conference on Trade and Development, 2014).

Between 1997 and 2014, Tanzania accommodated 12 projects funded by foreign direct investment in the energy sector – 11 in electricity and one in natural gas. The total sum invested amounted to USD 960 million, of which USD 644 million was directed at electricity (World Bank, 2016). This was exclusively aimed at IPPs and emergency power producers using thermal generation (principally through natural gas). New foreign direct investment directed at the renewable energy sector is accounted for in the Scaling Up Renewable Energy Program and in the Electricity Supply Industry Reform Roadmap.

Within the same framework for attracting more private involvement in the power sector, a feed-in tariff scheme was put in place in 2008 for small power producers (100 kW to 10 MW) in Tanzania. SPPAs for small power projects were approved in 2009 for mini-hydropower, biomass, solar PV and wind. Flaws have been observed in the implementation of the SPPAs, namely the unattractive tariffs based on avoided costs; the payment of small power producer tariffs in local currency; and the relatively short term of the SPPA (15 years). This made it rather difficult for the local private sector to make use of SPPAs and did not significantly increase the penetration of renewable energy technologies. Under the first generation SPPA, EWURA only approved 40.1 MW of SPPAs with biomass (15.6 MW), solar (2 MW) and hydropower plants (22.5 MW). A second generation SPPA was therefore approved in 2015. It provides for a fixed tariff in US dollars for the duration of the SPPA (up to 25 years) by size for hydropower and biomass regardless of the location, instead of annual tariffs in local currency. For solar and wind, the tariffs will be defined through competitive bidding to allow the users to benefit from technology cost reduction.

In addition, the Rural Energy Agency provides grants for qualified project developers through the Rural

Energy Fund, Resourced through governmental annual budgetary allocation, contribution from international partners, levies on the sale of electricity by the national utility, and also through Special Purpose Funds for rural energy by development partners, the Rural Energy Fund provides money in the following forms:

- grants towards the capital costs of projects
- capacity-building activities in relation to planning and project preparation
- financial assistance e.g. for co-financing investment in innovative projects related to the objects of Special Purpose Funds created by development partners.

Meanwhile, the Tanzania Investment Centre offers certificates for incentives and investment guarantees, and registers technology agreements for investments worth more than USD 300,000 (foreign investors) and USD 100,000 (local investors). It also assists in the removal of bottlenecks to establishing and running businesses by bringing together relevant government agencies in a one-stop shop. Energy is among the priority investment areas for which, among other incentives, the following are offered to encourage investment:

- import duty exemption on various goods, including wind generators, solar PV and thermal equipment
- zero duty on imported raw materials for the local production of deep cycle batteries and solar PV equipment
- zero rated value-added tax on exports.

Moreover, the Tanzania Investment Act 1997 provides the following incentives to all holders of certificates of incentives:

- 0% duty and value-added tax relief on all capital goods
- 30% corporate tax (25% for listing company on the stock exchange)
- 10% withholding tax on dividends
- 10% withholding tax on interest.

Moreover, with the support of international partners, Tanzania's financial system actors are increasingly considering opportunities to provide financing for renewable energy and energy efficiency projects. Rural and urban entrepreneurs with a courageous spirit can approach these macro- and microfinancial institutions, and obtain finance for launching and developing renewable energy projects.

Solar PV off the main grid



4. EMERGING ISSUES AFFECTING RENEWABLE ENERGY DEPLOYMENT

Challenges and opportunities for the renewables sector in Tanzania are explored in this section. The development of the renewable energy market is largely subject to the country's natural resource assets and corresponding technologies which convert energy sources into services. This section is thus divided into subsections covering different resources, policy and regulatory frameworks, private sector involvement, and human capacities and skills for developing the existing renewable energy resources. In each subsection, the status of each particular subsector is reviewed followed by matters that need to be resolved.

4.1 Resource assessment and planning

Although Tanzania's potential renewable energy resource is considerable, the Electricity Industry Reform Roadmap takes into account less than 5% of the non-hydropower renewables that could be connected to the grid. This rather low target could be attributed to a number of factors. One important factor is a general lack of information on the technical and economic potential of different renewable energy resources in the country. This has led to inadequate target-setting and planning, and decisions biased towards more conventional generation sources, such as coal, gas and large hydropower, in which the country has solid experience.

As indicated in Section 2.4, a number of country assessments of the renewable energy resource have been carried out. However, in many cases this data lacked further analysis to determine the technoeconomic potential of power generation from these sources. For example, available resource information for geothermal power generation is limited to preliminary studies of surface temperature, water and gas sampling and analysis of hot springs which date back to the 1950s. For power generation from biomass, there is no estimation of the potential attributed to different crops. Until recently, wind speed data were only available for a small number of stations at heights of under 10 m. Yet data for heights of 50 - 100 m are required for large-scale wind energy applications. For solar, no estimates have been taken on the potential for PV or concentrated solar power (CSP) power generation, nor how much is technically or economically feasible.

To enable policy makers, project developers and other interest groups to make balanced decisions on large-scale renewable energy development, further analysis of these resource assessments is required. This needs to evaluate the quality of renewable resources from a technical and economical point of view. In addition, other criteria should also be considered. These include, for example, grid operability (temporal correlation between electricity generation and system demand at a particular site), transmission and road infrastructure cost, proximity or overlap with environmentally sensitive areas, and population density.

According to the zoning methodology in the IRENA-LBNL study (IRENA and LBNL, 2015), the estimated installed capacity potential for PV, CSP and wind technologies in Tanzania is considerable. This is shown in Table 7. The minimal ambition reflected in the country's energy targets is not justified given the level of potential shown in estimates of installed wind and solar capacity. The Electricity Industry Reform Roadmap plans for 200 MW of wind and 100 MW of solar PV. The zoning study found that the capacity values of the wind zones identified are very high, which indicates

that the wind generation profiles could contribute significantly to meeting the country's peak demand. It could thereby contribute to system reliability due to its higher correlation with system demand. Approximately 20% of the total installed capacity is emergency oil-based generation at around USD 0.30/kWh. Due to its high capacity value, wind generation has the potential to displace much of this oil-based emergency power and to do so at a third of the cost as the levelised cost of energy (LCOE) for wind lies in the range of USD 0.065-10/kWh (see Table 8).

Table 7: Estimated installed capacity potential (MW) for wind, solar PV and solar CSP at various thresholds of resource quality

	Wind					Solar PV					Solar CSP				
Resource quality (w/m ²)	200	250	300	350	400	230	240	250	260	270	260	270	280	290	300
Installed capacity potential (MW)	46 900	20 800	9 390	4 570	1 900	59 000	59 000	58 400	50 700	47 200	26 100	21 600	10 500	4 140	5 000
Planned capacity	200					100					0				

Analysis from IRENA-LBNL zoning study (2015)

Table 8: LCOE ranges of renewable energy zones

Technology	LCOE range (USD/kWh)
Wind	0.065 – 10.0
CSP	0.214 – 0.22
Solar PV	0.118 – 0.14

Analysis from IRENA-LBNL zoning study (2015)

Furthermore, agricultural land was found to comprise about half the wind resource area in Tanzania, implying that land leasing policies could be of importance to high potential and cost-effective wind development. Given that the direct land footprint of a wind turbine is relatively low compared to the entire area of a wind farm (Denholm *et al.*, 2009), dual use of the land for farming and wind generation is preferable from a land use efficiency point of view¹³

Stakeholders are not always aware of all the resource assessment studies being undertaken or how best to use these. Furthermore, the absence of a central repository unit which stores, analyses and advocates the validation of resource assessments means there

is a lack of awareness, difficult access and ultimately low use of available information. During the RRA consultation process, stakeholders expressed the need to establish a designated unit in Tanzania which will contain all relevant statistics and resource information on renewables.

13 In an actual sense, land can be leased, but only to local users. Whenever land is leased to a foreign entity, the local or central government has to be involved through the Ministry of Lands. If the area required by an investor is below 50 hectares, it can be leased by the village government. Land of more than 50 hectares needs a permit from the local or central government land office (through the Ministry of Lands). The land ownership in this case should be changed from village to general land and then leased to the investor.

4.2 Planning

IRENA has devised a power sector investment planning tool for southern African countries. Known as the System Planning Test (SPLAT-S) model, it covers the investment period to 2050. This is a least-cost optimisation model, which enables analysts to assess investment paths to achieve different policy goals.

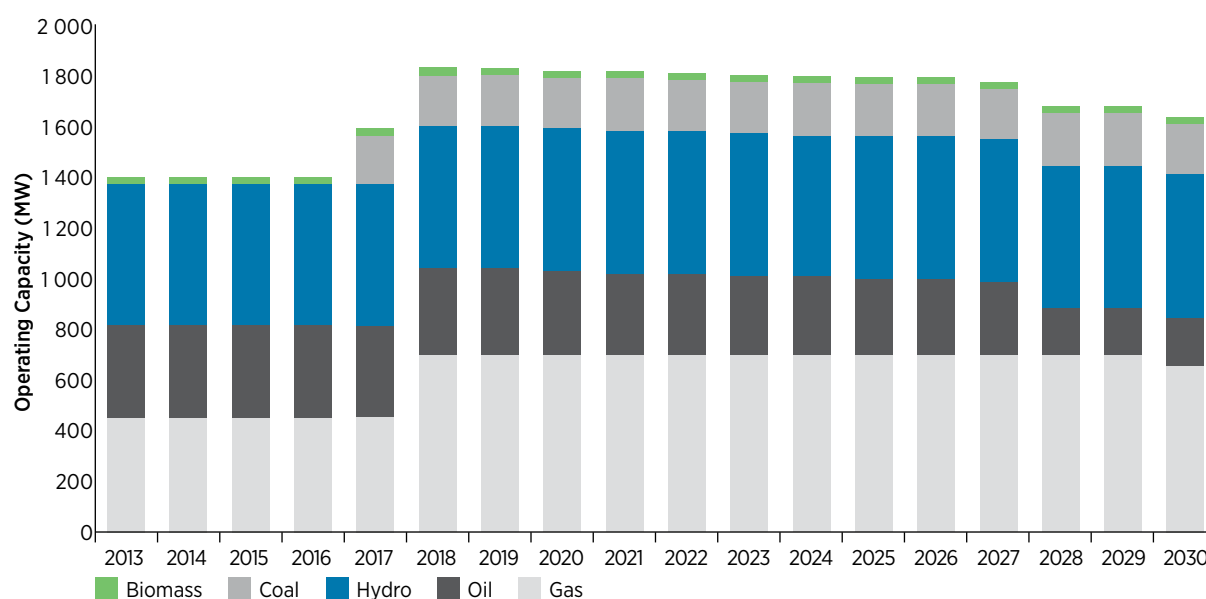
For the purpose of the Tanzania RRA, the scenario was updated to reflect the latest renewable energy cost trends. Moreover, the renewable energy zones identified through the zoning methodology in the IRENA-LBNL Study (IRENA and LBNL, 2015) have been explicitly incorporated in the SPLAT-S model for Tanzania.

The assessment presented here is based on certain assumptions, including fuel costs, infrastructure development and policy developments, which were taken from the assumptions primarily in the SAPP

Master Plan with some updates from IRENA's range of evaluations. These may well be different from the perspective of the energy planners in Tanzania. Since our assessment is strongly influenced by these assumptions, IRENA encourages the energy planners in Tanzania to explore different policy assumptions and scenarios needed to justify or to elaborate challenges associated with certain investment decisions.

The starting point of this analysis is an assessment of current power plants and identification of new scheduled capacity additions already under construction (Figure 16), including the retirement schedule for older power plants. According to the latest statistics (2013), the total installed capacity in the Tanzanian power system is 1,393 MW which includes 832 MW of thermal capacity, from which 454 MW is run on natural gas, 351 MW run on oil and 27 MW on biomass plus 561 MW of hydropower. Only small capacities (42 MW gas and 171 MW oil) are expected to be decommissioned within the planning time horizon.

Figure 16: Retirement schedule of existing plants and plants under construction



According to the Power Sector Master Plan,¹⁴ electricity demand in Tanzania is projected to rise from five terawatt-hours today to 24 - 33 terawatt-hours by 2030. Even using the most conservative estimate, the existing capacity and the capacity addition in the pipeline would clearly not be sufficient to meet demand by 2030.

IRENA's costing analysis anticipates that Tanzania could benefit from the global trend of rapid cost reductions in wind and solar power alongside local policies to promote the renewable energy. Given these patterns, it suggests that the levelised cost of electricity generation for grid-connected renewable technologies could be reduced by 17% for biomass, 50% for wind and 36% for solar PV compared to 2013.

In this scenario, three resource zones for wind, solar PV, and CSP (nine renewable energy zones in total) are included in the analysis. For each type of technology, the three "best" zones are identified on the basis of economic criteria alone. This is worked out from the total LCOE of a representative project from each zone, taking into account resource quality, transmission investment needs and road construction needs. The wind zones selected are located in the Iringa province in the centre of the country, as well as the Arusha province in the

¹⁴ The Power System Master Plan was used for the analysis because it provides more detailed information on additional capacities and their timelines, unlike the Electricity Supply Industry Reform Roadmap.

northeast. The selected PV and CSP zones are in the upper central part of the country in Sigida.¹⁵ The sum of the maximum output from the three zones is beyond the projected demand for 2030 for each technology.¹⁶

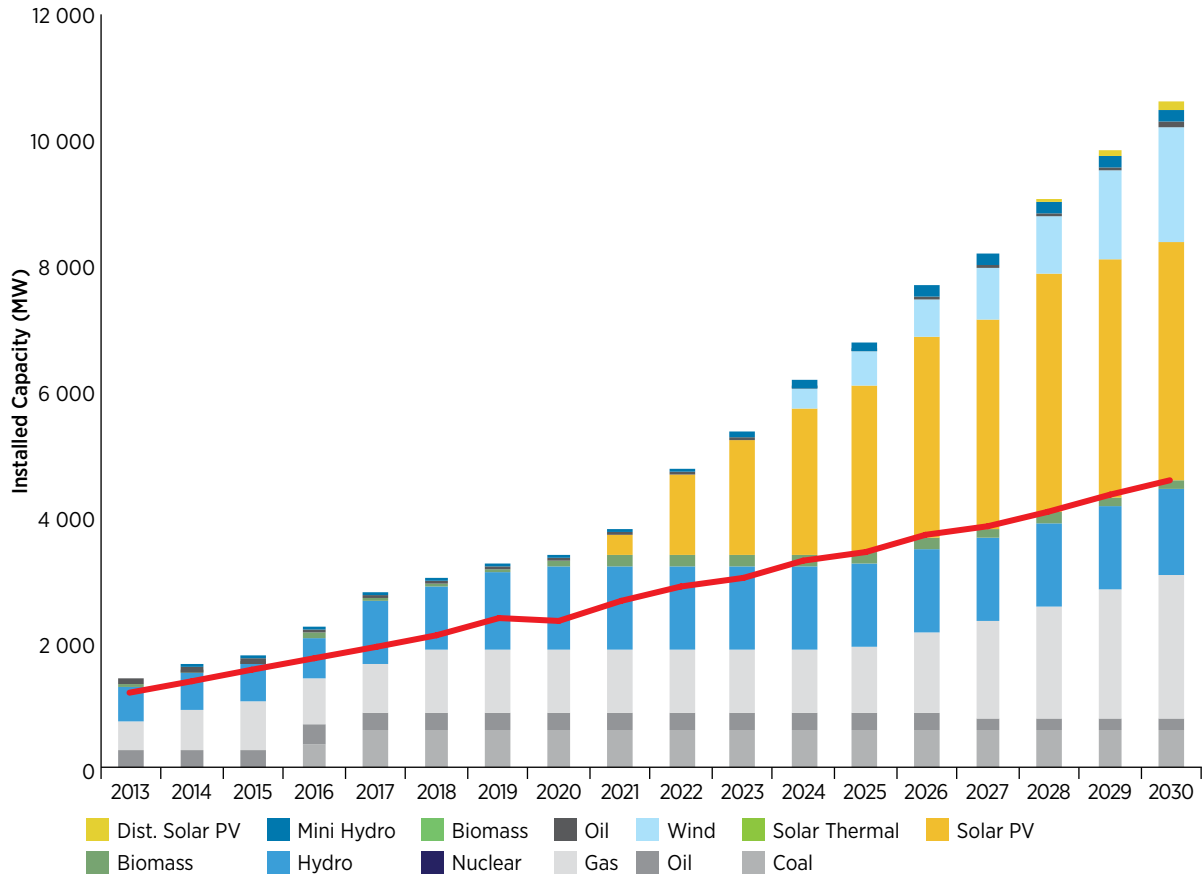
As shown in Figure 17, the installed capacity of utility-scale solar PV and wind projects in this scenario would reach 3.7 GW and 1.9 GW by 2030 respectively. Solar PV starts to be an important part of capacity mix in the early 2020s, while wind is introduced in the second half of the decade. Since 694 MW of gas-fuelled power plant investment is already in the pipeline (i.e. under construction), gas is the most important fuel for power generation over the next decade. However, there is considerable gain from exporting the gas resources instead of using them for domestic power production. The country's coal reserves may be exploited to some extent, providing affordable baseload power. However, the further expansion of coal-fired plants is not part of a least-cost energy system by 2030. Until then, no additional capacity is projected for oil-powered plants, whose share of the capacity mix will be as low as 2%. Assessments show that by 2030 peak demand

reaches 4.5 GW, and the sum of installed capacity for dispatchable power plants (i.e. hydropower, gas, oil and coal) also amounts to about 4.5 GW. To ensure there is balance in a system with such a high share of installed variable renewables capacity, strong interconnections are needed with neighbouring countries, as well as enough reserve power.

IRENA's analysis also finds that 378 MW may be sourced from decentralised generation, which will account for almost 4% of total electricity supply. Decentralised generation will consist mainly of mini-hydropower options and oil generators, where solar PV may be introduced by the end of the decade.

15 The zones included in the analysis are as follows: AB, AH, K for wind (as in Figure 11), Z, AG and R for solar PV (as in Figure 14), M, N, and O for CSP (as in Figure 13).
 16 Maximum deployment of these technologies is set at 500 MW per zone. In assessing the penetration of renewable energy, consideration is given to the "must run" minimum generation limit which cannot be replaced by variable renewable energy and is experienced by some fossil based technologies. This limit is set at 50% for coal-fired plants and 25% for future gas power plants.

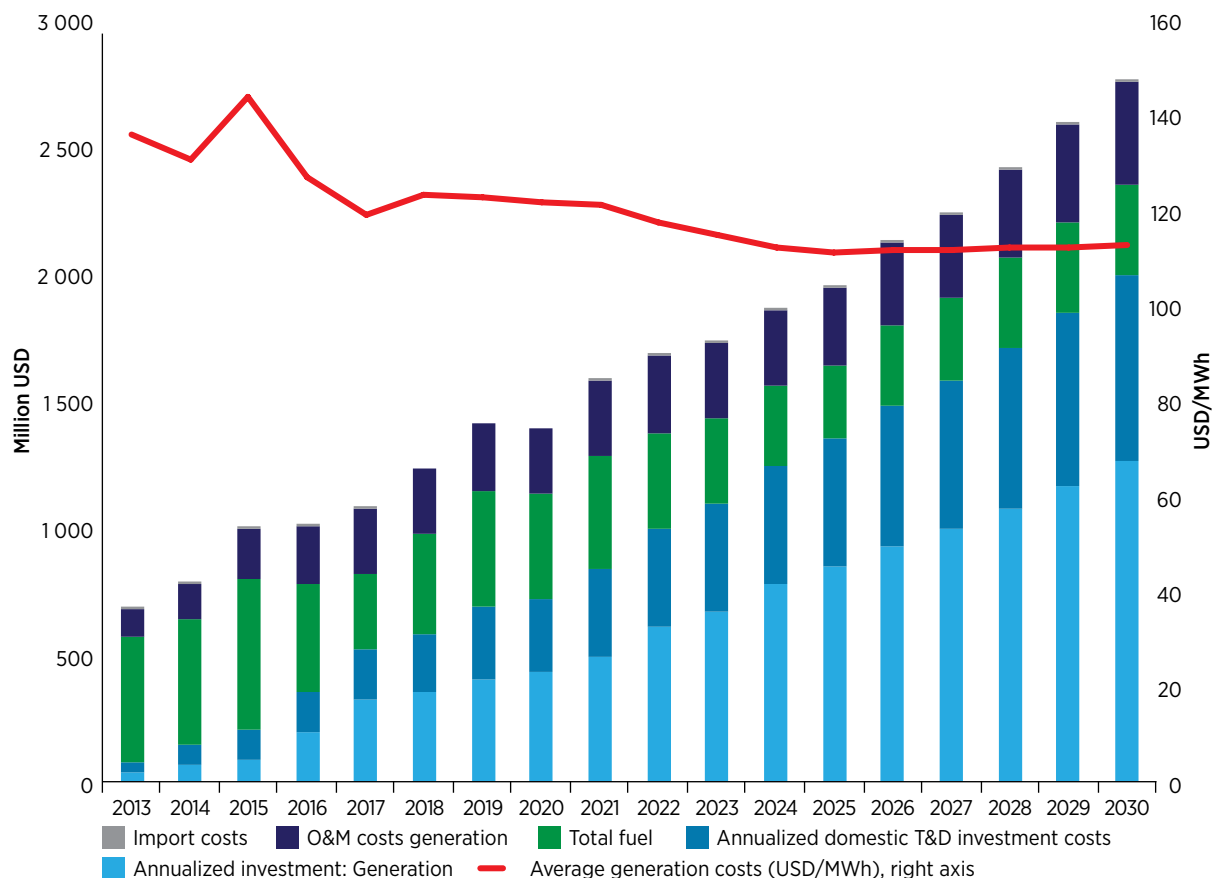
Figure 17: Capacity balance according to IRENA's assessment



As shown in Figure 18 below, a transition to such a system would require USD 11.4 billion investment in generation and USD 6.7 billion in transmission and distribution investment in 2013 - 2030. Operation and

maintenance (O&M) and fuel costs would amount to USD 4.9 billion and USD 6.5 billion respectively. The average generation cost would drop by 17% between 2013 and 2030.

Figure 18: Total undiscounted system costs according to IRENA's assessment



These may well be different from the perspective of the energy planners in Tanzania. Since the present assessment is strongly influenced by assumptions discussed above, IRENA encourages the energy planners in Tanzania to explore different policy assumptions and scenarios needed to justify or to work out the challenges associated with certain investment decisions.

RECOMMENDATION:

Revise national energy plans

Energy planners in Tanzania need to revise the country's plans by taking into account the latest studies on renewable energy potential and their associated costs. They need to explore different policy assumptions and scenarios to justify or to work out challenges associated with certain investment decisions. This can be followed by an updated "roadmap" for realising the desired investment strategy.

4.3 Policy and regulatory frameworks

The Electricity Act 2008 gives priority access to the grid for electric energy from a least-cost generation licensee. This is not conducive to power generation based on variable renewables, which is currently more expensive than local hydropower, coal or gas-based

power generation if capital costing is considered alone. Variability has been dealt with in the draft Electricity (Systems Operation) Act 2016, which is under approval. This gives priority for dispatch to the electricity generated from renewable energy sources and indigenous sources.

However, this act does not specify any guidelines for power forecast time. Current forecast times are not necessarily favourable to all renewable energy types, particularly given the variable nature of some sources (solar and wind). The best practice recommended forecast time is closer to real time, which will have a substantial impact on the cost-effectiveness of the renewable energy generators. Furthermore, the use of forecasts favourable to renewables will entail changes in the power systems operations given that the grid infrastructure and grid operators currently do not have the capacity to accommodate and manage grids with higher shares of variable renewables.

In Tanzania the distribution network operator bears the interconnection costs for projects within 10 km of a substation. However, there is no reference to connection and wheeling charges, so that the charges are related to the generation sources. Common practice shows that the charges are higher for renewables such as wind and solar because of their variability. To incentivise grid-tied renewable energy power, renewable energy generators in

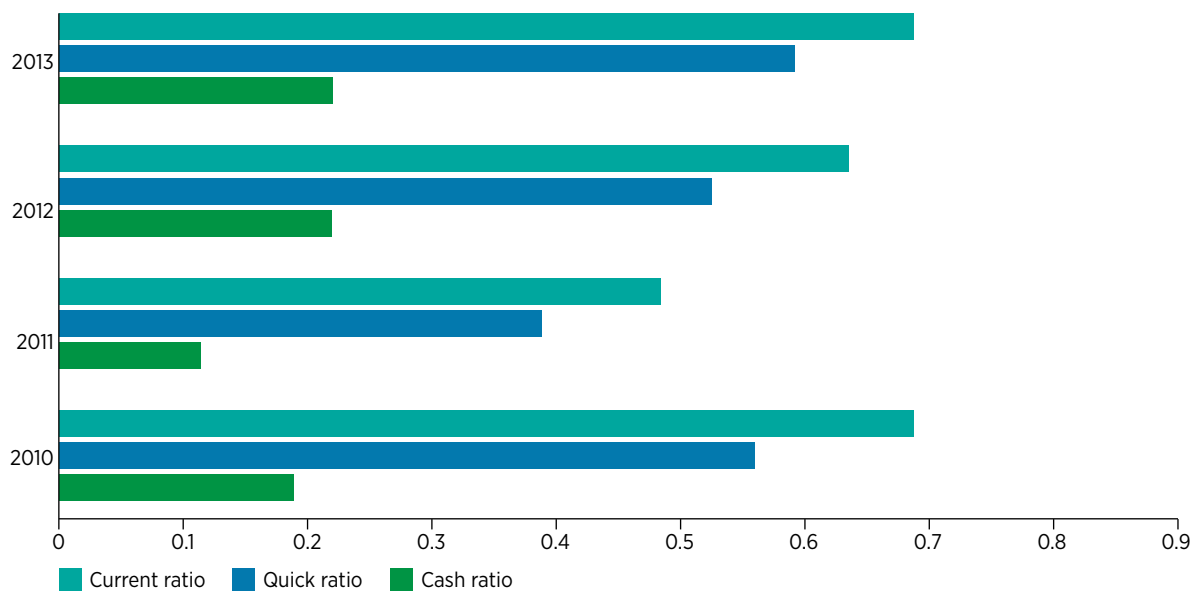
some countries are given the option to pay transmission and wheeling charges at a cost equivalent to the average unit cost of electricity wheeled through the grid.

Despite the existence of FITs and SPPAs for grid-connected projects, the weak financial position of TANESCO, the sole off-taker, means renewables-based power generation is not attracting private investors. This is confirmed by the latest TANESCO financial statements (2013, 2012 and 2011 annual reports)

highlighting that current assets minus inventories cover less than 55% of current debts, including deferred income. As the ratios below demonstrate, the liquidity of the company is below where it ought to be, and the cash ratio¹⁷ is relatively high (see Figure 19 below), which could indicate poor asset utilisation.

17 The cash ratio of a company should not exceed 0.1 because higher values could indicate poor asset utilisation.

Figure 19: TANESCO liquidity ratios 2010-2013

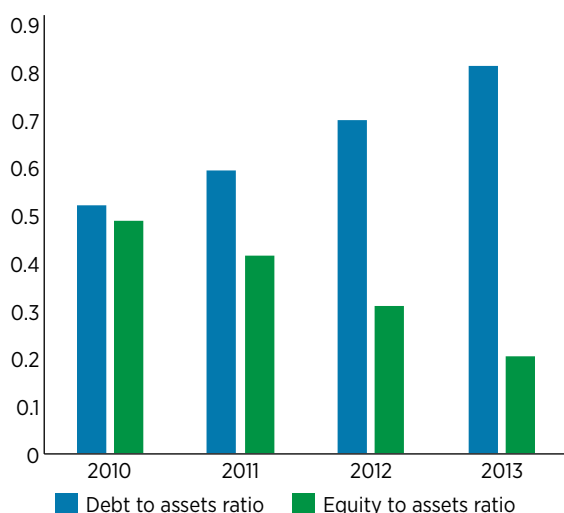


Based on TANESCO annual reports, 2011-2013

Furthermore, changes in debt-to-asset and equity-to-asset values,¹⁸ as well as the utility's negative returns on asset and on equity, indicate an increasingly high financial risk (see Figures 20 and 21 below).

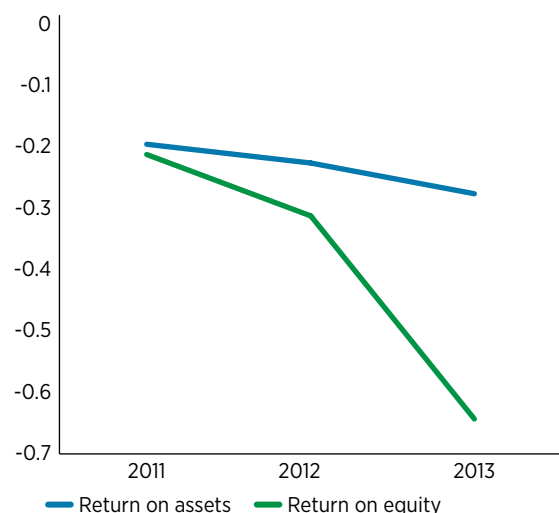
18 The combined values of the debt-to-asset and the equity-to-asset ratios is always equal to 1. However, the values of debt-to-asset ratios should be below 0.5, and equity-to-asset ratios above 0.5. This would indicate that the assets of the company are less tied to debt.

Figure 20: TANESCO debt-to-asset and equity-to-assets ratio



Based on TANESCO annual reports

Figure 21: Profitability ratios, 2011-2013



Based on TANESCO annual reports

The creditworthiness of TANESCO has been put into context through two other public utilities from the region: Botswana Power Company and Mozambique Electricity (Electricidade de Moçambique). The results of this analysis can be seen in Table 9.

Table 9: Financial ratio comparison table for sample utilities of southern and eastern Africa

Ratios	TANESCO (Tanzania)				BPC (Botswana)				EdM (Mozambique)				
	2010	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	
Liquidity	Current ratio	0.69	0.63	0.48	0.69	0.55	0.50	0.41	0.32	0.16	0.11	0.10	0.11
	Quick ratio	0.57	0.52	0.38	0.55	0.48	0.42	0.31	0.20	0.23	0.19	0.20	0.18
	Cash ratio	0.21	0.21	0.11	0.19	0.07	0.25	0.11	0.05	0.16	0.11	0.10	0.11
Debt	Debt to assets	0.52	0.59	0.69	0.80	0.50	0.65	0.71	0.73	0.59	0.58	0.52	0.58
	Equity to assets	0.48	0.41	0.31	0.20	0.50	0.65	0.71	0.73	0.59	0.58	0.52	0.58
	Debt to equity	1.07	1.44	2.25	4.03	1.01	1.82	2.48	2.66	1.43	1.36	1.09	1.35
	Interest coverage		-0.77	-3.34	-4.53	154.74	70.49	132.02	139.38	-0.07	-0.72	-0.75	-0.61
Profitability	Return on assets		-0.015	-0.053	-0.124	-0.116	-0.055	-0.109	-0.024	-0.010	-0.018	0.003	-0.002
	Return on equity		-0.36	-0.174	-0.623	-0.233	-0.156	-0.380	-0.086	-0.025	0.043	0.006	-0.004

Based on the annual reports of TANESCO, Botswana Power Company and Electricidade de Moçambique

The analysis of the ratios shows at first glance that none of the utilities analysed is significantly more profitable than the others. Yet TANESCO's profitability ratios have been in constant decline, while Botswana Power Company and Electricidade de Moçambique have been improving their positions in the timeframe analysed.

There seems to be increasing reliance on debt in Botswana Power Company and TANESCO, which gives both those utility companies a higher debt-to-equity ratio than 2 after 2012, going up to 4.03 for TANESCO in 2013. Through market mechanisms – mainly interest rate swaps – Botswana Power Company has managed to keep its financing costs low. This gave it a very positive interest coverage ratio (the quotient of earnings before interest payments by financing costs).

In the liquidity ratios, TANESCO seems to be keeping a very high cash position, highlighted by a cash ratio substantially higher than the recommended value of 0.1. This could indicate poor asset utilisation.

The conclusion of this ratio analysis emphasises the low creditworthiness of TANESCO, which weakens its position as off-taker to private investors venturing into power generation in Tanzania. This is exacerbated by the fact that if TANESCO defaults or delays payment, the Government of Tanzania cannot guarantee the payment, and no sanction can be taken against the off-taker. This increases the perception of risk on the part of the private sector and partly justifies its low involvement in the segment.

Finally, we recommend power output off-take beyond the capacity subscribed to in the power purchase agreement, partly to boost private operator confidence for further investments in grid-tied renewable energy installations.

RECOMMENDATION:

Provide incentives in Electricity System

Operation Rules

Given that Tanzania is a member of the SAPP, where the day-ahead market is already in place, the draft Electricity System Operation Rules 2016 need to be revised to include provisions in forecasts for better integration of renewable energy in power systems. This let renewables contribute more to meeting the growing power demand of the country.

For renewables to play a more relevant role in meeting increasing power demand, Tanzania could look into acquiring the necessary infrastructure, including sophisticated information and communication tools, for more efficient system-wide decision making. Furthermore, grid operators will need to acquire the ability to integrate forecast data into their daily operations to manage grids with a high share of renewables.

If Tanzania were eligible for the Regional Liquidity Support Facility, this could mitigate TANESCO's power off-taker risk, as further discussed below. IRENA and other international partners should work to facilitate Tanzania's inclusion into the facility.

Furthermore, Tanzania is recommended to consider adopting transmission and wheeling charges conducive to variable renewables. This should be clearly mentioned in the draft Electricity Systems Operations Act 2016. In addition, the private generators could be given the flexibility to sell their surplus power to the grid operator.

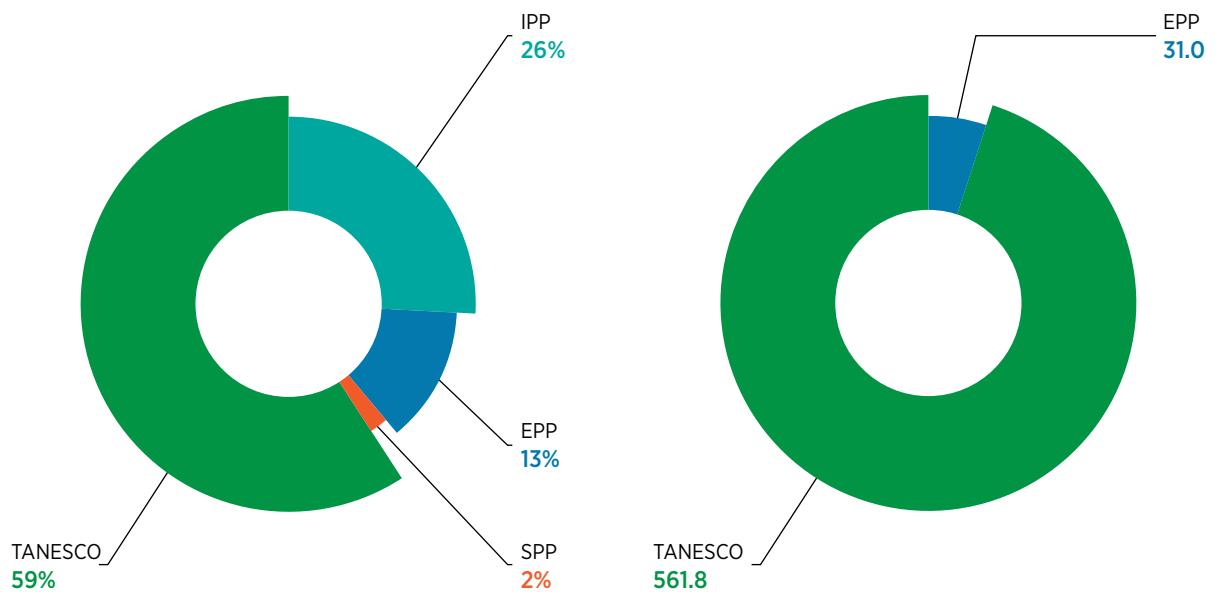
4.4 Private sector involvement

Private operators already participate a great deal in the provision of electricity in Tanzania although their installations are to a very large extent based on

thermal technologies (liquid fuel and natural gas). Operated by private actors, IPPs and emergency power producers, they together represented nearly 40% of installed capacity in March 2013 (AfDB, 2015). However, private sector participation in renewables-based technology development is still minimal, as Figure 22 demonstrates.

The private sector's low involvement in the renewable energy field is primarily due to the very restrictive financial environment. Obtaining investment loans is difficult because of the high cost of borrowing, which not only includes interest rates as high as 16% (Bank of Tanzania, 2016) but also high bank charges.

Figure 22: Renewables-based power generation market in Tanzania

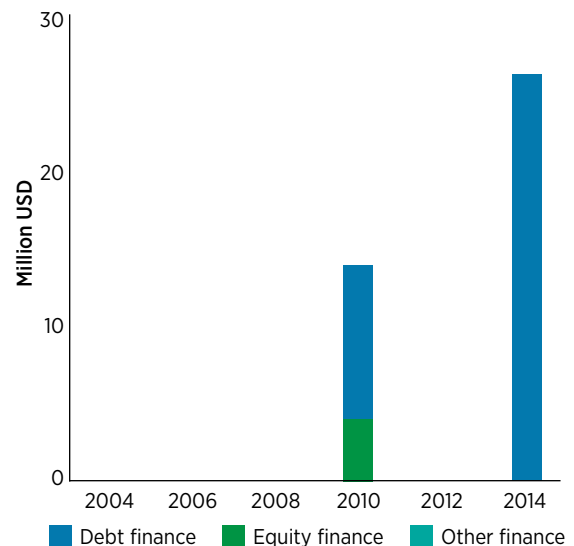


Based on "Renewable Energy in Africa: Tanzania Country Profile", AfDB, 2015

As discussed in the planning scenario, Tanzania will require USD 11.4 billion investment in generation, and USD 6.7 billion in transmission and distribution between 2013 and 2030. O&M and fuel costs would amount to USD 4.9 billion and USD 6.5 billion respectively. Average generation cost would decline by 17% between 2013 and 2030.

According to Bloomberg New Energy Finance, the finance flowing into the Tanzanian renewable energy sector amounted only to USD 88 million in 2014 (Bloomberg New Energy Finance, 2016). Most of this was provided through debt financing (as shown in Figure 23).

Figure 23: New build renewable asset finance in Tanzania by type



Source: Bloomberg New Energy Finance (2016)

The RRA discussions disclosed other concerns, which are described below.

Limited knowledge of renewables by the financial sector: Limited knowledge of the renewable energy sector among lenders who appraise projects obstructs the facilitation of financing for developing renewables in Tanzania. Despite the introduction of policy incentives, most domestic banks still lack capacity to plan, structure and evaluate projects using suitable financial instruments. This reinforces the perception that renewable energy is a high-risk venture, since there is a lack of awareness of the costs and of technology reliability.

Lack of established quality control and technical standard mechanisms: No well-established quality control mechanism has been devised for renewable energy equipment, even though such equipment is exempt from value-added tax and benefits from reductions in import duties. If no policy measures are taken, substandard products will flood the market, affecting the confidence of developers who invest in renewable energy and technology uptake. Moreover, the life span of projects could be affected, thus increasing the risk of higher operational costs and altering strategic financial management of the project.

The high collateral requirements: In line with the prudential regulations of the Bank of Tanzania, the borrower is required to provide a collateral of at least 125% of the credit accommodation. This is high and restricts potential borrowers because banks in Tanzania have developed stringent processes that do not permit fund disbursement before perfecting the collateral. In addition, the valuation methodology for collateral is lengthy. Such collateral in Tanzania includes real estate and tangible moveable property, for which valuation can be complex.

The mismatch between deposits and loans: The effect of the high collateral requirement is exacerbated by the inability of banks to provide long-term financing due to the mismatch between long-term deposits and long-term loans. The Bank of Tanzania sets a regulatory 20% minimum ratio between liquid assets and demand liabilities, which banks strive to follow by setting an even higher ratio. In March 2014, the weighted average loan-to-deposit ratio was 71.9%, up from 68.8% in 2013 (The Business Year, 2015). Those customer deposits provide very little room for manoeuvre for the provision of long-term loans if the proportion of short-term deposits and short-term loans is discounted.

High risk for the private sector: Liquidity concerns exacerbated by power off-taker risk undermine the creation of new IPPs, whose creditworthiness with

banks largely depends on power off-taker ability to guarantee timely and reliable payments. In the absence of a government guarantee mechanism, obtaining a letter of credit from a commercial bank would require full cash collateral from the off-takers. Yet due to their constrained liquidity and poor credit ratings, many off-takers like TANESCO are unable to put down cash collateral for a letter of credit. This cascading liquidity risk (arising from off-taker risk) can be overcome by a liquidity facility that would provide a short-term letter of credit or credit line to IPPs without additional cash requirements from utilities.

Other issues: Other factors obstruct renewables investments. For instance, potential customers have low purchasing power, especially in rural areas. Renewable energy upfront investment costs are high, and the project development lead time is too long. Land acquisition is a costly and lengthy process, and environment impact assessments and hydropower water use rights permitting are both cumbersome.

RECOMMENDATIONS:

To foster the participation of the private sector in renewable energy development, the following steps are recommended:

Promote long-term equity financing for renewable energy projects through non-banking financial institutions

Tanzania could consider the possibility of empowering the domestic financial sector to provide equity investments into renewable energy technologies, especially through the Dar es Salaam Stock Exchange. This would be welcomed by the Dar es Salaam Stock Exchange, which has appealed for an enabling environment that favours increased utilisation of the stock exchange by the private sector¹⁹ under the supervision of the Capital Markets and Securities Authority. Through the Dar es Salaam Stock Exchange, the government should also promote the use of mutual funds²⁰ to increase private sector participation as well as reducing the risk associated with financing renewable energy projects through pooling. The UK Green Investment Bank's Offshore Wind Fund created by the UK Government, which is also its sole shareholder, is an example illustrating the co-operation between energy and financial authorities to boost renewables.

¹⁹ Corporate bonds and most of the equity and government bond papers issued and listed on the Dar es Salaam Stock Exchange have been oversubscribed by up to twice the amount available. This shows the extent of liquidity in the hands of the Tanzanian private sector.

²⁰ These currently only represent 0.1% of asset allocations in the Tanzanian financial system.

UK Green Investment Bank Offshore Wind Fund

The UK Green Investment Bank Offshore Wind Fund was established with the aim of attracting capital into the UK's offshore wind sector from new, long-term investors seeking good, risk-adjusted returns. The fund is the world's first dedicated offshore wind fund and has a target size of GBP 1 billion (approximately USD 1.247 billion). The combination of natural resources (strong and consistent wind), favourable locations for turbines, a robust regulatory regime and a well-established and experienced industry has helped the UK secure its position as one of the global leaders in the development of offshore wind.

In addition to its own investments in the UK's offshore wind market, the UK Green Investment Bank established a fund through its wholly owned subsidiary UK Green Investment Bank Financial Services Limited to invest in operating offshore wind farms in the UK. Attracting new capital and creating a liquid market for operating assets is crucial to the continued growth of the sector and will also help to reduce the long-term cost of finance. New investors also allow the original developers to sell down their stakes and use the proceeds to finance new projects. The fund's portfolio currently consists of interests in five operational wind farms with an aggregate installed capacity of 1,177 MW.

Source: UK Green Investment Bank (2016)

Improve facilitation, collaboration and co-ordination among private sector and financial institutions

In line with the previous recommendation, the Government of Tanzania should establish a framework to enhance facilitation, collaboration and co-ordination among private renewable energy firms and financial institutions. This will increase financial institution knowledge of the renewable energy sector while giving private renewable energy firms more understanding of the inner working of the financial system. Close co-operation of this kind will help reduce the perception of risk in the renewable energy sector and thus encourage financing.

Create a risk mitigation mechanism for local investments

In light of the low participation of the Tanzanian private sector partly as a result of stringent requirements from the Tanzanian banking sector, a risk mitigation mechanism is a possible option to facilitate greater participation in priority development areas by local investors, including in energy.

Under the "Big Results Now" initiative promoted by the Office of the President, this risk mitigation facility could provide guarantees for viable local projects within the initiative to obtain substantial loans from the banking industry.

The size of the proposed risk mitigation facility would have to be co-ordinated with international partners and could build on the initial mobilisation of capital in the following ways:

- charges and levies on electricity concessions and electricity sold to end-users
- taxes on bulk electricity consumers
- taxes on mining and oil exploration
- taxes on transport and marketing of petroleum products
- taxes on commercial licences
- annual budgetary allocation by the state
- funding from development partners
- personal contributions from operators and other donors.

In addition, this risk mitigation facility could be considered from a regional point of view. A risk mitigation facility to empower local private investors could be established with the participation of the region's countries and facilitated through COMESA's Regional Investment Agency.

Tanzania could join the Regional Liquidity Support Facility²¹ under development by IRENA, German development bank KfW and the Africa Trade Insurance Agency. Its purpose is to resolve the type of liquidity risk affecting African power off-takers, and it will provide short-term credit lines to IPPs. It aims to enable financial closure for renewable energy projects and ease the cash flow constraints on utility balance sheets in five pilot countries in sub-Saharan Africa (Ghana, Kenya, Malawi, Rwanda and Zambia) (IRENA, 2016). Tanzania's eligibility for the Regional Liquidity Support Facility would help mitigate TANESCO's power off-taker risk. IRENA and other international partners should work to facilitate Tanzania's inclusion into the facility.

By disclosing the performance of utilities, the Regional Liquidity Support Facility also aims to improve the payment records of utilities and set a reliable benchmark for future lending practices.

Success in the pilot countries will enable the facility to expand to other countries in sub-Saharan Africa. If applied in Tanzania, this model may demonstrate a way to resolve TANESCO's low creditworthiness and its liquidity risk.

²¹ A funding proposal for the Regional Liquidity Support Facility has been submitted to the Green Climate Fund and was due to be reviewed by the fund's board by the end of 2016. Once its financing has been approved, the facility will be able to tackle shortfalls in short-term cash flow in the target countries. IRENA facilitates dialogue between governments, while KfW, the Green Climate Fund and the Africa Trade Insurance Agency will manage the cash collateral and provide short-term liquidity risk insurance for additional leverage on the Regional Liquidity Support Facility funds (KfW, 2015).

Like other types of incentives for private participation in the grid-tied power sector, the private sector should be given guarantees of priority place when funds are disbursed. This will be dependent on the legal agreements between TANESCO and its different debtors.

4.5 Human capacity and skills

The RRA process uncovered weaknesses in the availability of human resource and institutional capacities and skills in Tanzania’s renewable energy sector. These shortcomings will need to be adequately resolved if Tanzania is to overcome the challenges ahead. It needs to develop a renewable energy sector as well as meet future challenges related to goals in the Electricity Supply Industry Reform Strategy and Roadmap 2014 - 2025 and beyond.

Tanzania’s human resource capacity deficiencies are listed below:

- resource assessment
- renewable energy data collection through statistics to evaluate data, potential and progress, and to plan for a renewable energy future
- renewable energy project conceptualisation, preparation, appraisal and implementation
- local courses and training related to renewable energy.

The Tanzanian Electricity Supply Industry Reform Strategy and Roadmap 2014 - 2025 recognised that the availability of well-trained and skilled human capital is essential to meet targets set out in the roadmap, and that a human capital development programme needs to be created. The results of the planning work described in the second section of chapter 4 indicate that employment in the renewable electricity sector in Tanzania could reach 36,000 in 2030 under the renewable energy scenario. This is around six times as high as in 2015 (Figure 24a).

In 2015, the sector employed more than 6,000 people, mostly in hydropower and biomass projects. While most of these jobs were in centralised applications, around 1,000 people were also employed in construction and O&M of distributed small hydropower.

In 2030, distributed and centralised solar PV will be the largest renewable energy employer, with more than 20,000 jobs. This will be followed by small hydropower, large hydropower, wind and biomass (Figure 24b). Jobs in utility-scale solar PV are expected to rise sharply from 2020 as Tanzania moves ahead with plans for deploying around 3.8 GW by 2030. From 2023 onwards, wind energy employment may also grow as plans for deploying 1.8 GW by 2030 are set in motion. Jobs in large hydropower may remain stagnant due to lack of new investments after 2020 but jobs in small hydropower will rise with new installations.

Figure 24a: Estimates for jobs in renewable electricity by technology and year

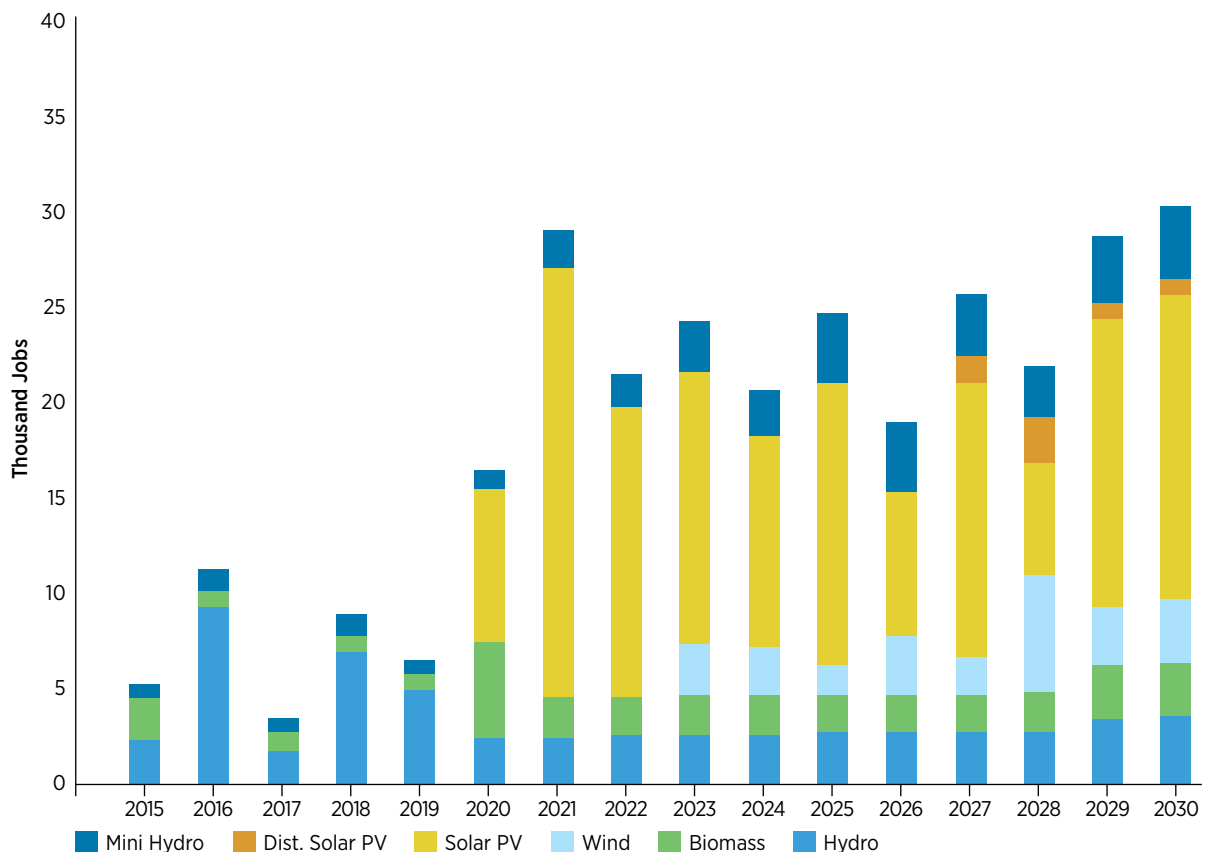
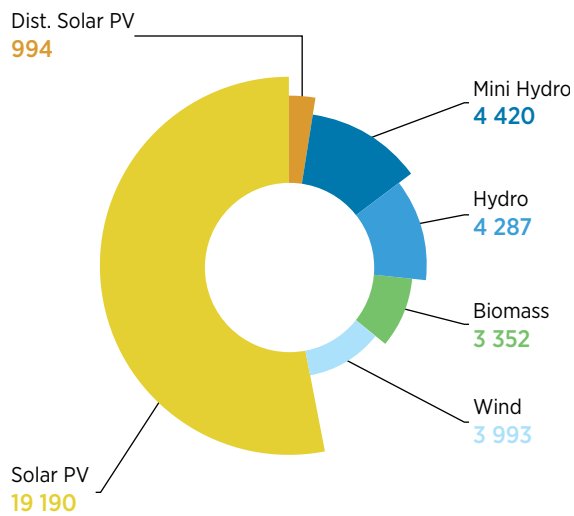
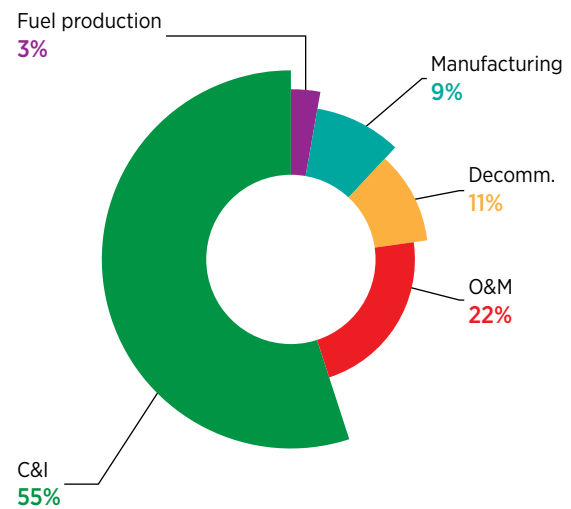


Figure 24b: Breakdown of jobs by technology in 2030



Analysis of the segments of the value chain provides further insights. In 2030, the construction and installation segment is expected to account for the bulk of the jobs, followed by O&M, decommissioning and manufacturing (Figure 25). Most of the construction and installation jobs are in solar PV project installation, which is likely to be filled by construction workers, technicians and engineers. Around 30% of O&M jobs are in large hydropower, and are mostly taken by managers, engineers and technicians. Though low to start with, the share of manufacturing jobs is likely to increase to 9% by 2030, and production of different components including electrical equipment, solar PV mounting structures and parts of wind towers will be local. Several other types of job opportunities will be

Figure 25: Renewable energy jobs in 2030 by value chain segment



created for experts in marketing, distribution and supply chain management in all technologies, especially the small-scale solar PV value chain.

The human capital development programme will thus need to be designed to cover all the different aspects of renewable energy project conception, implementation and operation. This includes but is not limited to technical, managerial, finance and evaluation.

In Tanzania, some higher education institutions offer related subjects in electrical engineering. However, the courses specifically tailored to renewable energy at higher education level are offered as shown in Table 10.

Table 10: Renewable energy higher education courses

Institution	Relevant programme	Level
University of Dar es Salaam	Master of Science in Renewable Energy	MSc
Arusha Technical College	Ordinary Diploma in Renewable Energy Technology	Undergraduate diploma
Dar es Salaam Institute of Technology	Ordinary Diploma in Renewable Energy Technology	Undergraduate diploma

At the vocational training level, only five of the 40 institutions across the country offer courses related clearly to the renewable energy projects value chain. These are listed in Table 11.

Table 11: Vocational training institutions offering courses relevant to electricity projects

Institution	Relevant programme	Level
Arusha College of Electronics	Certificates in electronics	Vocational training
Mafinga Lutheran Vocational Training Centre	Courses in mechanics, metal work and welding, masonry and building, plumbing and painting	Vocational training
Samanga Catholic Vocational and Training Center	Courses in electrical installation, welding and fabrications	Vocational training
Tanzania Institute of Commerce and Industries	Courses in electrical installation	Vocational training
Vocational Education and Training Authority	Electrical installation, electrical and telecommunications, welding and masonry	Vocational training

Given the country’s potential for scaling up renewables, the scale and range of courses on offer needs to be increased. They need to be expanded to all aspects of renewable energy project development at the technical, managerial and financial level.

Different skills will need to be continuously upgraded at all levels to reinforce local capacities starting from the conceptualisation stage of renewable energy projects all the way through to financial engineering, construction and O&M. They also need to be geared towards innovation – a key feature of the energy industry.

RECOMMENDATIONS:

Given these challenges and the current conditions in Tanzania, the recommendations that follow are intended to prepare the ground for renewable energy development in terms of human capacities and skills:

Intensify and expand renewable energy training

- **Higher education and vocational education**

The training institutions need to co-operate with technical institutions already offering electrical engineering courses while acquiring the capacity to diversify into renewables. These institutions include, for instance, the Nelson Mandela African Institute of Science and Technology, Mandela Institute of Technology and the Mbeya University of Science and Technology. They should also work with the Vocational Educational and Training Authority in order to benefit from its presence across the country.

The suggested expansion in vocational education should be regarded as a full programme of capacity enhancement which could foster a strong local

market in which there is a continuous supply of relevant skills. This should provide a solid pipeline that will support policies related to local content in renewable energy project development by foreign investors in Tanzania.

As explained above, construction and installation will account for around 20,000 of the 36,250 jobs that will be required in the renewable energy project value chain in Tanzania. Around 11,000 will be needed in fuel production, 2,900 in manufacturing, 4,000 in decommissioning and 7,900 in O&M. The Government of Tanzania needs to expand these various elements to all the vocational training centres across the country in order to meet these skills availability targets.

In addition, a renewable energy programme should be promoted within Tanzania’s top business schools, such as the Tanzania Business School. It should develop training courses and courses aimed at increasing the financial and business knowledge of projects based on renewable energy technologies in the country. This could help to bridge the gap between project development and project appraisal, which is one of the main constraints the local private sector faces as it develops and implements its projects.

This capacity enhancement at the vocational education level could be financed through charges applied on foreign investments, state allocations and other contributions.

- **On-the-job training**

New and young engineers entering the local job market, especially in the power sector, should be given the opportunity to work in different areas

of the power system. This will familiarise them with practical aspects of the value chain and will create well-trained engineers with a comprehensive overview of the power system. It will help improve the overall quality of human resources in the sector. The intensification and expansion of training related to renewable energy is beneficial because it reduces costs. Local staff is cheaper to employ than expatriates, and overall staffing costs incurred by project developers decrease as local human resource content increases. Value is retained along the value chain through the skills base created. This is not only an advantage to Tanzania but will spread across the region and continent.

However, for capacity enhancement schemes to be effective, incentives have to be put in place so that the labour force will acquire the necessary skills. Job security and job growth are among the incentives needed.

Design and implement local-content requirements for renewable energy projects

Local-content requirements generate broad benefits like secure job creation, ensuring that labour is employed and products manufactured within the country to feed or support renewable energy development. Tanzania could consider examples from other countries doing the same in the sub-Saharan African region such as South Africa, Kenya and Ghana.

South Africa follows a progressive model which set the local-content requirement at 35% in 2011 and is aiming for 60% by 2030. In Ghana, the local-content rule came into force in 2013 with a threshold of 10% aiming for 90%

by growing 10% each year. This array of models provides a basis from which Tanzania could form its own local-content requirement policy.

Establish a national renewable energy research centre

Given the inconsistency of statistical data and lack of quality control or standard-setting mechanisms, the Government of Tanzania should create and provide the capacity for a renewable energy centre whose mandate would be as follows:

- establish a legal and institutional framework for assembling renewable energy statistics
- collect and store all relevant statistics and resource information on renewables
- provide easier access to renewable energy information and resolve inconsistencies in the data
- conduct a data audit to ascertain data gaps.

This process should start off by equipping the statistics staff with the necessary knowledge of renewable energy statistical methods.

To make further use of the statistical data it stores, this renewable energy research centre could be equipped with testing facilities and given the capacity to establish standards and codes. This would ensure satisfactory guidelines for the quality, design, safety and O&M of renewable energy equipment used in small-scale applications to stimulate the response to the existing policy incentives. The formation of a methodological quality control and standards mechanism for renewable energy equipment could also feed into the recommended local-content requirement policy. The role of quality control will increase as more content is sourced locally.



5. SUMMARY OF RECOMMENDED ACTIONS

Action	Revise national energy plans
Theme	Resource assessment and planning
Description	Revise plans by considering latest studies on potentials and on technology costs and also by exploring different policy scenarios needed for investment decisions followed by an investment strategy roadmap
Actors	Ministry of Energy and Minerals
Timing	12 - 18 months
Keys to success	Capacitation and engagement of all stakeholders and creation of platform for interaction and information exchange among relevant institutions
Action	Provide incentives in Electricity System Operation Rules
Theme	Policy and regulatory frameworks
Description	<ul style="list-style-type: none"> • Forecasts to include assumptions of greater integration of renewable energy in power systems • Consider the adoption of transmission and wheeling charges conducive to variable renewables
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • EWURA • Tanzania Electric Supply Company
Timing	12 - 18 months
Keys to success	Capacitation and engagement of all stakeholders and creation of platform for interaction and information exchange among relevant institutions
Action	Promote long-term equity financing for renewable energy projects through non-banking financial institutions
Theme	Private sector involvement
Description	Empower the domestic financial sector especially by working with the Dar es Salaam Stock Exchange and the Capital Markets and Securities Authority to provide equity investment in renewable energy projects
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • Capital Markets and Securities Authority • Dar es Salaam Stock Exchange
Timing	18 - 24 months
Keys to success	Productive collaboration and knowledge-sharing between all relevant stakeholders from the energy and the financial industries

Action	Improve facilitation, collaboration and co-ordination among private sector and financial institutions
Theme	Private sector involvement
Description	Establish a framework to enhance facilitation, co-operation and co-ordination among renewable energy private actors and financial institutions so that the two sectors become better informed about each other
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • Bank of Tanzania • Ministry of Finance and Planning • Ministry of Industry, Trade and Investment
Timing	12 months
Keys to success	Awareness of the benefits of a multi-sectoral collaborative approach in the development of renewable energy

Action	Create a risk mitigation mechanism for local investments
Theme	Private sector involvement
Description	Create a local risk mitigation facility to encourage local private sector participation. It could provide liquidity support as well as guarantees and could facilitate access to substantial bank loans
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • Ministry of Industry, Trade and Investment • Ministry of Foreign Affairs, East African Community, COMESA • IRENA • Green Climate Fund • KfW • African Trade Insurance Agency
Timing	12 - 24 months
Keys to success	Engagement of all relevant stakeholders at national and regional level, as well as with international development partners

Action	Intensify and expand renewable energy training
Theme	Human capacity and skills
Description	Make full use of current wide vocational training facility networks as well as higher education institutions to create a local supply of relevant labour skills along the value chain of renewable energy project development
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • Ministry of Education, Science, Technology and Vocational Training • Planning Commission
Timing	12 - 24 months
Keys to success	Collaboration between the Ministry of Education and the Ministry of Energy as well as with the Planning Commission

Action	Design and implement local-content requirements for renewable energy projects
Theme	Human capacity and skills
Description	Implement local-content requirement for labour and manufactured products for renewable energy projects in order to create demand for relevant local labour
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • Planning Commission • Ministry of Industry, Trade and Investment
Timing	12 months
Keys to success	Assessment of the current and potential manufacturing capacities in the country

Action	Establish a national renewable energy research centre
Theme	Human capacity and skills
Description	Resolve inconsistencies in statistical data and the lack of a quality control mechanism by creating and providing capacity for a renewable energy research centre
Actors	<ul style="list-style-type: none"> • Ministry of Energy and Minerals • National Bureau of Statistics • Tanzania Bureau of Standards • IRENA
Timing	18 - 24 months
Keys to success	Engagement of all relevant stakeholders

6. REFERENCES

- AfDB (2015)**, “Renewable energy in Africa -- Tanzania country profile”, Renewable Energy in Africa, www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Renewable_Energy_in_Africa_-_Tanzania.pdf.
- AfDB, OECD and UNDP (2015)**, “African economic outlook 2015” in African Economic Outlook 2015, African Development Bank (AfDB), Organisation for Economic Co-operation and Development (OECD), United Nations Development Programme (UNDP), www.africaneconomicoutlook.org/sites/default/files/content-pdf/AEO2015_EN.pdf.
- Bank of Tanzania (2016)**, Monthly Economic Review, www.bot.go.tz/Publications/MonthlyEconomicReviews/MER%20MARCH%202016.pdf.
- Bloomberg New Energy Finance (2016)**, Newly Built Renewable Asset Finance in Tanzania by Type, Bloomberg New Energy Finance, available at www.bnef.com/core/country-profiles/tza.
- Botswana Power Corporation (BPC) (2014)**, Annual Report 2013, www.bpc.bw/about-us/Annual%20Reports/BPC%202013%20AR%20Final.pdf.
- BPC (2013)**, Annual Report 2012, www.bpc.bw/about-us/Annual%20Reports/BPC%20Annual%20Report%202012.pdf.
- BPC (2011)**, Annual Report 2010, www.bpc.bw/about-us/Annual%20Reports/BPC%20Annual%20Report%202011.pdf.
- CAMCO Clean Energy (2014)**, Biomass Energy Strategy (BEST) Tanzania, www.euej-pdf.org/sites/default/files/field_publication_file/BEST_Biomass_Energy_Strategy_Tanzania_Final_Version_April_2014.pdf.
- COMESA (2008)**, The COMESA Model Energy Policy Framework, Common Market for Eastern and Southern Africa, <http://programmes.comesa.int/attachments/article/133/Model%20Energy%20Policy%20Framework.pdf>.
- Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation Agency) (2009a)**, Project Development Programme in East Africa: Tanzania’s Solar Energy Market. <https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-solar-tanzania.pdf>.
- Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation Agency) (2009b)**, Project Development Programme in East Africa: Tanzania’s Wind Energy Market. Project Development Programme East Africa. <https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-wind-tanzania.pdf>.
- Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation Agency) (2009c)**, Project Development Programme in East Africa: Tanzania’s Small-Hydropower Energy Market. <https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-hydro-tanzania.pdf>.
- EdM**, “Demonstrações financeiras da electricidade de Moçambique até 31 de Dezembro de 2013 (Financial Statements of Mozambique Electricity to 31 December 2013)”, Electricidade de Moçambique (Mozambique Electricity), www.edm.co.mz/index.php?option=com_docman&task=doc_download&gid=185&Itemid=68&lang=en.
- EdM**, “Demonstrações financeiras da Electricidade de Moçambique até 31 de Dezembro de 2012 (Financial Statements of Mozambique Electricity to 31 December 2012)”, www.edm.co.mz/index.php?option=com_docman&task=doc_download&gid=187&Itemid=68&lang=en.
- EdM**, “Demonstrações Financeiras da Electricidade de Moçambique até 31 de Dezembro de 2011 (Financial Statements of Mozambique Electricity to 31 December 2011)”, www.edm.co.mz/index.php?option=com_docman&task=doc_download&gid=186&Itemid=68&lang=en.
- Engery4Impact (2016)**, Six Mini-Hydropower Projects in Tanzania Closer to Realising Goal of Power Generation, viewed on 6 November 2016 at www.enery4impact.org/news/six-mini-hydropower-projects-tanzania-closer-realising-goal-power-generation.
- Food and Agriculture Organization (2010)**, “Global forest resources assessment 2010 -- country report Tanzania”, Food and Agriculture Organization, Rome, Italy, www.fao.org/docrep/013/al657E/al657E.pdf.
- Gebrehiwot, Z. (2013)**, “Eastern Africa Power Pool” in IRENA Workshop for Africa Clean Energy Corridor, http://web.vdw.co.za/Portals/15/Documents/Presentations/EAPP%20presentation_to_AFSEC-%205.pdf.
- German Chambers of Commerce Abroad (Deutsche Auslandshandelskammern) (2013)**, Target Market Study Tanzania Solar PV and Wind Power, Nairobi, Kenya, www.africansolardesigns.com/resources_32_493092621.pdf.
- Government of the United Republic of Tanzania (2011)**, The Tanzania Development Vision 2025, Government of the United Republic of Tanzania, Dar es Salaam, United Republic of Tanzania, www.mof.go.tz/mofdocs/overarch/vision2025.htm.
- Government of the United Republic of Tanzania (2014)**, Invest in Tanzania, www.newsdeskmedia.com/images/Upload/PDFs/Invest-in-Tanzania-2014.pdf.
- Government of the United Republic of Tanzania (2015)**, webpage, viewed 21 July 2015 at www.tanzania.go.tz/home/pages/19.
- Hansen, U. E., M.B. Pedersen and I. Nygaard (2014)**, “Review of solar PV market development in East Africa”, United Nations Environment Programme, www.unepriaoe.org/URC-Working-Paper-Series.
- International Energy Agency (2012)**, “IEA statistics -- energy balances of non-OECD countries”, International Energy Agency, Paris, France, http://doi.org/10.1787/energy_bal_non-oecd-2013-en.

Innovation Energie Développement (2014), National Electrification Program Prospectus, www.ied-sa.fr/index.php/en/documents-and-links/publications/send/3-reports/33-national-electrification-program-prospectus.html.

IRENA (2016), Unlocking Renewable Energy Investment: the Role of Risk Mitigation and Structured Finance, International Renewable Energy Agency, Abu Dhabi, United Arab Emirates, www.irena.org/DocumentDownloads/Publications/IRENA_Risk_Mitigation_and_Structured_Finance_2016.pdf.

IRENA (2015a), Africa Power Sector: Planning and Prospects for Renewable Energy, IRENA, Abu Dhabi, United Arab Emirates, www.irena.org/documentdownloads/Publications/IRENA_Africa_Power_Sector_synthesis_2015.pdf.

IRENA (2015b), Djibouti Renewables Readiness Assessment, IRENA, Abu Dhabi, United Arab Emirates, www.irena.org/DocumentDownloads/Publications/IRENA_RRA_Djibout_2015_EN.pdf.

IRENA (2015c), Africa 2030: Roadmap for a Renewable Energy Future, IRENA, Abu Dhabi, United Arab Emirates, www.irena.org/DocumentDownloads/Publications/IRENA_Africa_2030_REmap_2015_low-res.pdf.

IRENA (2013), Southern African Power Pool: Planning and Prospects for Renewable Energy, IRENA, Abu Dhabi, United Arab Emirates, www.irena.org/documentdownloads/publications/.pdf.

IRENA and LBNL (2015), Renewable Energy Zones For The Africa Clean Energy Corridor. Multi-Criteria Analysis For Planning Renewable Energy, IRENA, Abu Dhabi, United Arab Emirates, www.irena.org/DocumentDownloads/Publications/IRENA-LBNL_Africa%20RE%20CEC_2015.pdf.

Kibodya (2006), The Taking and Enforcement of Collateral – Financial Sector Review, <http://info.worldbank.org/etools/docs/library/233790/Kibodya%20TBA.pdf>.

Larsson, L., Davy, T., Jönsson, M., Hagström, L. and John, G. (2013). Draft Final Report: SIDA AND MEM Consultancy Services for the Joint Energy Sector Review (JESR) 2012/13, Tanzania. Pöyry SwedPower AB, Sweden.

Massachusetts Institute of Technology (2012), Tanzania (TZA) Profile of Exports, Imports and Trade Partners, The Observatory of Economic Complexity, viewed 23 July 2015 at <https://atlas.media.mit.edu/en/profile/country/tza/>.

Mayalla, J. et al. (2011), “Geothermal development in Tanzania”, in Kenya Geothermal Conference 2011, Nairobi. Kenya, www.gak.co.ke/nibs/web_resources/GEOTHERMAL%20DEVELOPMENT%20IN%20TANZANIA.pdf.

MEM (2013a), “Power system master plan (May)”, pp. 333–335, www.tanesco.co.tz/index.php/investments/investment-report/22-power-system-master-plan-2012-update/file

(MEM, 2013b), Investment Plan for Tanzania -- Scaling-up Renewable Energy Programme, Ministry of Energy and Minerals (MEM), www.cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/srep_tanzania_investment_plan_design.pdf.

MEM (2013c), Joint Energy Sector Review (JESR), www.tzdpdg.or.tz/fileadmin/documents/dpg_internal/dpg_working_groups_clusters/cluster_1/Energy_and_Minerals/Key_Documents/JESR/JESR_Final_Report_2012-2013.pdf.

MEM (2014), Electricity Supply Industry Reform Strategy and Roadmap 2014-2025, www.gst.go.tz/images/TANZANIA%20ELECTRICITY%20SUPPLY%20INDUSTRY%20REFORM%20STRATEGY%20&%20ROADMAP.pdf.

MEM (2015a), The Draft National Energy Policy 2015, <https://mem.go.tz/wp-content/uploads/2015/02/NATIONAL-ENERGY-POLICY-2015-Feb-2015.pdf>.

MEM (2015b), Tanzania Energy Sector -- Challenges and Opportunities, Ministry of Energy and Minerals, Dar es Salaam, United Republic of Tanzania.

MNRT (2015), National Forest Resources Monitoring and Assessment of Tanzania (NAFoRMA), Ministry of Natural Resources and Tourism (MNRT), www.fao.org/forestry/43612-09cf2f02c20b55c1c00569e679197dcde.pdf.

Mnjokava, T. T. (2012), “Geothermal development in Tanzania – a country update”, in ARGEO-C4 Conference, Nairobi, Kenya.

Mnjokava, T. T. (2014), “Geothermal development in Tanzania – status report”, in Short Course IX on Exploration for Geothermal Resources, pp. 1–11, organised by UNU-GTP, GDC and KenGen at Lake Bogoria and Lake Naivasha, Kenya, 2-23 November 2014, Lake Bogoria and Lake Naivasha, Kenya.

Moremi, M. (2012), Business Financing in Tanzania (Challenges & Opportunities), www.globalskill.co.tz/docs/Moremi.pdf.

Nile Basin Initiative (2012), NELSAP at a Glance, nelsap.nilebasin.org/attachments/article/34/NELSAP%20AT%20A%20GLANCE.pdf.

Nzali, A. H. and S. J. S. Mushi (2006), “Wind energy utilization in Tanzania”, Science and Technology, 1–14, <http://ewbusa.tizqee.com/files/2015/06/tanzaniawind.pdf>.

OECD (2011), Effective support for Agricultural Development, Organisation for Economic Co-operation and Development, Paris France, www.oecd.org/dac/dac-global-relations/Final%20Report%20on%20Joint%20Study%20Visit%20to%20Tanzania.pdf.

OJK (2016), “OJK and energy and mineral resources ministry build cooperation in energy development”, press release, www.ojk.go.id/en/kanal/iknb/berita-dan-kegiatan/siaran-pers/Documents/Pages/Press-Release-OJK-and-Energy-and-Mineral-Resources-Ministry-Build-Cooperation-in-Energy-Development/PR%20MOU%20OJK%20-%20ESDM.pdf.

Ondraczek, J. (2013), “The sun rises in the east (of Africa): a comparison of the development and status of solar energy markets in Kenya and Tanzania”, Energy Policy, 56, 407–417, <http://doi.org/10.1016/j.enpol.2013.01.007>.

REEEP (2014), Tanzania -- Policy and Regulatory Overviews, Renewable Energy and Energy Efficiency Partnership, www.reegle.info/policy-and-regulatory-overviews/TZ.

Risø National Laboratory and Danish International Development Agency (2003), Wind Measurements and Wind Power Feasibility at Selected Sites in Tanzania 2000-2003 – Final Report.

Rural Electrification Corporation (2011), Power Sector Reform Strategies in Tanzania, www.academia.edu/5772406/Power_Sector_Reform_Strategies_in_Tanzania_Prepared_and_Presented_by_ACKNOWLEDGEMENT.

Scaling up Renewable Energy Programme (SREP) (2013), Investment Plan for Tanzania, https://www-cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/srep_tanzania_investment_plan_design.pdf.

Snec Lavalin and Parsons Brinckerhoff (2011), Regional Power System Master Plan and Grid Code Study, www.eac.int/energy/index.php?option=com_docman&task=doc_download&qid=89&Itemid=70.

TANESCO (2013), TANESCO Tariff Review Application, www.newsite.ewura.go.tz/attachments/article/119/TANESCO%20Tariff%20Application%202013.pdf.

TANESCO (2014), TANESCO'S Transmission Network, viewed 24 July 2015 at: www.tanESCO.co.tz/index.php?option=com_content&view=article&id=51&Itemid=159.

TANESCO (2015), "Tanzanian solar PV-hybrid" in P. Tsakhara (ed.), presentation at the Tanzanian solar PV-hybrid workshop, Berlin, Germany.

Tanzania National Bureau of Statistics (2013), "Tanzania in figures 2012", www.nbs.go.tz/nbs/takwimu/references/Tanzania_in_figures2012.pdf.

Tanzania National Bureau of Statistics (2015), "National accounts of Tanzania mainland 2007-2014", www.nbs.go.tz/nbs/takwimu/na/National_Accounts_of_Tanzania%20Mainland_Publication_2014.pdf.

Tanzania Geothermal Development Company (2015), Geothermal Development in Tanzania – a Country Update, Dodoma, Tanzania, www.geothermal-energy.org/pdf/IGAstandard/ARGeo/2012/Mnjokava.pdf.

The Business Year (2015), "Tanzania takes account", The Business Year, www.thebusinessyear.com/tanzania-2015/tanzania-takes-account/review.

The United Republic of Tanzania -- National Audit Office (2013), "Report of the controller and auditor general on the financial statements of Tanzania Electric Supply Company Limited for the year ended 31 December 2012", www.tanESCO.co.tz/index.php/media1/downloads/financial-statements/15-tanESCO-audited-accounts-2012.

The United Republic of Tanzania -- National Audit Office (2015), "Report of the controller and auditor general on the consolidated financial statements of Tanzania Electric Supply Company Limited for the 18-month period ended 30th June 2015", www.tanESCO.co.tz/index.php/media1/downloads/financial-statements/61-report-of-the-controller-and-auditor-general-on-the-consolidated-financial-statements-2014-15.

Thomson Reuters (2015), "Tanzania in talks with China on funding for wind farm", viewed 25 July 2015, Reuters, <http://af.reuters.com/article/investingNews/idAFKBNOM81NC20150312>.

UK Green Investment Bank (2016), Delivering Value in the UK's Offshore Wind Market, www.greeninvestmentbank.com/funds/offshore-wind-fund/.

UNCTAD (2014), World Investment Report 2014: Investing in the SDGs: an Action Plan, United Nations Conference on Trade and Development, http://unctad.org/en/PublicationsLibrary/wir2014_en.pdf.

UNECA (2014), Energy Access and Security in Eastern Africa. Status and Enhancement Pathways, United Nations Economic Commission for Africa, www.uneca.org/sites/default/files/publications/energy_access_and_security_in_ea_eng_fin_lowres_27dec2013.pdf.

UNFCCC, Information Note: Default Values of Fraction of Non-Renewable Biomass for Least Developed Countries and Small Islands Developing States (Version 01.0), EB67 Report Annex 22, United Nations Framework Convention on Climate Change, Bonn, Germany, <http://cdm.unfccc.int>.

World Bank (2016), Private Participation in Infrastructure database, website available at http://ppi.worldbank.org/explore/ppi_exploreCountry.aspx?countryId=43.

World Bank (2015a), "Country data Tanzania", World Bank, Washington D.C, US, <http://data.worldbank.org/country/tanzania>.

World Bank (2015b), Wind Resource Mapping in Tanzania -- Mesoscale Modeling Report, <http://documents.worldbank.org/curated/en/758141468186533619/Wind-resource-mapping-in-Tanzania-mesoscale-modeling-report>.

World Bank (2015c), "Tanzania: solar wind potential could help meet future power generation goals", www.worldbank.org/en/news/feature/2015/06/09/tanzania-solar-and-wind-potential-could-help-meet-future-power-generation-goals.

World Health Organization, Global Environment Facility and United Nations Development Programme (2009), Transformation Of Rural Photovoltaic Market In Tanzania Project, www.climate-eval.org/sites/default/files/evaluations/367%20Transformation%20of%20Rural%20Photovoltaic%20Market%20in%20Tanzania%20Project.pdf.

Zorita, E. and F.F. Tilya (2002), "Rainfall variability in Northern Tanzania in the March – May season (long rains) and its links to large-scale climate forcing", Climate Research, 20 (1), 31–40, <http://doi.org/10.3354/cr020031>.



P.O. Box 236
Abu Dhabi, United Arab Emirates
Tel: +971 2 4179000
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