A STUDY ON SUSTAINABLE ELECTRICITY:
The Use of Energy Mix in Modernizing Tanzania

By

KAPINGA, Severin

THESIS

Submitted to
KDI School of Public Policy and Management
in partial fulfillment of the requirements
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MASTER OF PUBLIC POLICY

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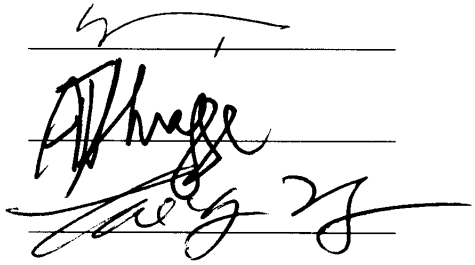

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ABSTRACT

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The world demand and consumption of energy is increasing drastically and it is likely to be a continuing situation as years goes on. There are many challenges towards the global energy inefficiency especially in the developing world. The developing countries are less aware of the energy demand and supply problem because many of them have failed to balance between the aspects of demand and supply of energy where the demand has been higher than supply. This situation implies that these countries will likely face energy shortage in future if the problem is not intensively addressed. This study intends to explore on the use of energy mix in Tanzania through extraction of the resources available for alternative electricity sources than solely depending on hydropower which has become unreliable source of electricity. The study will focus on the methods which Tanzania can use to generate electricity from natural gas, coal, uranium, wind, hydropower and other renewable in a form of energy mix in order to build a modern society. Some recommendations will be presented in order to achieve the sustainable electricity for the sustainable development and modernization of Tanzania.

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I am greatly obliged to the ongoing assistance and support from my supervisors; Prof. Kim Teajong who provided me with the valuable ideas and comments from the beginning of this study. Special thanks given to Prof. Abraham Shragge, a member of my project committee. He has been very kind and consistent on providing me with generous guidance and all necessary help to improve my research and keep it on the proper direction.

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ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
AICD	Africa Infrastructure Country Diagnostic
BOT	Bank of Tanzania
CBO's	Community Based Organizations
CCS	Carbon Capture and Storage
EU	European Union
EWURA	Energy and Water Utilities Regulatory Authority
FDI	Foreign Direct Investment
ICT	Information Communication Technology
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	International Panel on Climate Change
IPTL	Independent Power Tanzania Limited
KWh	Kilowatt-hours = 1,000 watt hours
MDG's	Millennium Development Goals
MEM	Ministry of Energy and Minerals
MoFEA	Ministry of Finance and Economic Affairs
MW	Megawatt = 1000,000 watts
NGO's	Non-Governmental Organizations
NSSF	National Social Security Fund
OECD	Organization for Economic Co-operation and Development
REA	Rural Energy Agency
REB	Rural Energy Board
REF	Rural Energy Fund
TACT	Tanzania Automotive Technology Centre
TANESCO	Tanzania National Electric Supply Company
TIC	Tanzania Investment Centre
TRA	Tanzania Revenue Authority
UNFCC	United Nations Framework Convention on Climate Change
US EIA	US Energy Information Administration
URT	United Republic of Tanzania
WB	World Bank
WEO	World Energy Outlook

1.0 INTRODUCTION

1.1 Background

Sustainable energy (electricity) supply is an engine and a catalyst to a modernization of a country. In contrast, if a country has an unreliable energy supply, it faces economic backwardness due to lack of investors, ineffective local industries, and unproductive sectors such as agriculture, mining, fishing and decline of small businesses, all of which depend on the availability of electricity. The electricity supply in Tanzania has not been sustainable and sufficient since independence in 1961, and a critical energy crisis has emerged, creating an unreliable electricity supply to the present time. This is a problem that needs to be addressed in order to have a reliable and efficient electricity supply to support economic growth by attracting investors, improving productivity and living standards, reducing poverty, facilitating and strengthening growth of sectors such as agriculture, mining and fishing by establishing small and large-scale industries.

In order to create sustainable development and transform from traditional society to an urbanized and industrialized society, Tanzania must harness its diverse energy resources so that it may reduce dependence on hydropower for electricity generation in the process of modernization. The government needs to have clear strategy, approach and political will to invest in the resources available in order to generate sufficient energy. This study will explore the use of an energy mix as a source of electricity supply in Tanzania because the country has various abundant sources which can generate electricity, including coal, oil, uranium, wind, and natural gas, to support the current local hydropower.

The study explains the limitations of hydropower, explores the alternative sources of energy, and then demonstrates how a coherent and sustainable energy policy will lead to economic growth.

The current status of Tanzania's energy supply is facing different limitations and challenges including the effects of climate change upon water resources as a power source. Water resources contribute to the production of electricity; about half of the nation's electricity is generated by using hydropower installations and since 2006 the country has faced dramatic drought and shortage of rainfall that affects the generation of hydropower electricity. Some researches concluded that, "While future rainfall patterns were uncertain, some areas of the country, especially the central region, might receive less rainfall."[1]

Tanzania is facing a challenge on energy supply because the demand for electricity is increasing every year and the current hydropower source is unable to overcome the growing rate of electricity demand. According to a European Commission, "Starting from 2006 Tanzania Electricity Supply Company (TANESCO) took initiatives to build several power plants to enhance electricity supply; however, the problem is not minimized."[2]

The electricity shortages seem to be a problem in Sub-Sahara countries because no considerable efforts have been put in place to address the problem by the use of alternative sources of energy including coal, oil, uranium, wind, and natural gas, and hydropower (energy mix). Research shows that Tanzania has large reserves of coal that can produce energy enough for itself and sell to other neighboring countries for many years, as pointed

[1] Jack, Chris, "Climate Projections for Climate Systems Analysis Group" (University of Cape Town, 2010).

[2] European Commission Funded Project (MIRREIA), 2007. http://mirreia.energyprojects.net.

out by the European Commission Report: “Coal reserves in Tanzania are being used for industrial applications but this major resource is to be exploited for its full potential.”[3] There is a need for the government to establish energy strategies that can enhance the combination of all energy sources as energy mix production instead of depending on few sources especially hydropower.

1.2 Statement of the problem

This study investigates the alternative sources for reliable electricity that will enhance modernization of Tanzania through rationalization of the electricity generation and distribution system. The research responds thoroughly to different questions by exploring the various aspects of electricity production in Tanzania. The questions are worthwhile because they focus on the key elements that will help us acquire broad understanding and be informed on the energy sector in Tanzania. In a specified way, the study intends to answer the following questions: What is the source of the electricity crisis in Tanzania? For how long has the country faced the electricity crisis and its effects? What strategies have been taken by the government to address the electricity crisis? What are the major issues to be addressed by the government in order to have reliable electricity? What will be the impact of an adequate and reliable electricity supply in Tanzania?

1.3 Research objective

The objective of this research is to find out the various causes of electricity shortage in Tanzania and provide coherent approaches to be employed in addressing the problem. The study involves an investigation on demand and supply of electricity and searching out the

[3] European Commission Funded Project (MIRREIA), 2007. http://mirreia.energyprojects.net.

alternative sources of energy so as to meet the required electricity in industries, institutions, and households. Moreover, it intends to recommend the adoption of an energy mix model of electricity generation to the Tanzania government.

1.4 Significance of the study

Scholars and experts on energy have investigated and explained inadequate electricity and ineffective energy policies in Sub-Sahara Africa. However, in Tanzania's case, few studies have been conducted; from this dimension more studies with different perspectives are required in the field of electricity generation. This research could obtain results that can be valuable in establishing a workable energy policy and strategy that will enhance the effective and efficient utilization of the alternative energy sources for sustainable development in Tanzania.

1.5 Scope of the study, data source and methodology

The research results suggest a significant method of energy mix by use of alternative energy sources in Tanzania as a solution to the long period of prevailing shortage in electricity caused by overdependence on hydroelectricity generation. The study focuses on the trend of total electricity demand and generation capacity in units of megawatt (MW) referred to the data from 1995 – 2010.

Data sources

Data collection for the study will be conducted through gathering information in primary and secondary data from books, articles, journals, dissertations, government and institutional reports, working papers, internet sources, news papers, and TV programs.

Hypothesis

1) The overdependence on the hydroelectricity system causes electricity shortage in Tanzania.

2) Tanzania has sufficient diverse resources to upgrade its energy generating capacity.

3) The use of energy mix system in generating electricity can help to address the problem of electricity shortage in Tanzania

4) A sustainable and reliable supply of electricity will act as a catalyst for modernization of Tanzania.

1.6 Limitation of the study

The contemporary world has many sources of energy and some energy sources are still being discovered and developed. Nonetheless, this research will be limited to the best known fossil-fuel and renewable sources of energy. The main concentration and discussion focus on the generation of electricity by use of energy mix (coal, natural gas, oil, uranium, hydro, and other renewable) available in Tanzania. The results and conclusions of the research might not apply to some countries of the world. Much attention has been directed to the energy sources of electricity production in Tanzania in comparative approach to countries with similar natural resources of energy that have been doing well in electricity generation. The presentation of data refers to Tanzania's energy mix sources, some selected countries, and total world energy sources.

The study will also cover the potential risks associated with electricity generated from fossil-fuels and nuclear power towards pollution, the government budget constraints for project establishment and implementation. However, the research cannot cover all the

aspects associated with the energy mix project establishment. Some measures for addressing the challenges and environmental risks will be discussed later in this research project.

Overall, the study is expected to provide a significant investigation and broad understanding on important energy sources available in Tanzania. This research project introduces the concept of energy mix, however, the main focus will be specifically on generating electricity by use of different energy sources. There will be some answers responding to established research questions that lay the foundation of the study.

2.0 LITERATURE REVIEW

Tanzania is a country in East Africa with abundant energy resources that can be exploited to generate electricity for domestic and industrial use. Regardless of the resources available for energy production, there is no clear strategy and commitment on the utilization of resources for electricity supply in both urban and rural areas so as to support other sectors like tourism, industry, mining and agriculture. In order to create sustainable development, Tanzania must harness its diverse energy resources so that it may reduce its dependence on hydropower. Sustainable energy supply is an engine and a catalyst to economic, social and political development of a country. It facilitates economic transformation and change to export orientation because it should feature well functioning industries and other production sectors capable of generating sufficient surplus for export purposes. Resources available in Tanzania for generating electricity are coal, oil, uranium, wind, and natural gas, all of which can augment the current hydropower.

2.1 Unproductive Investment on Electricity in Tanzania

Bartholomew M. Lyimo explains in his article about energy sustainability in Tanzania and claims that the government plan for energy has put more emphasis upon large-scale hydropower and thermal units, which it anticipates to increase the electricity production level from "10% to 15% by year 2015 or stabilize the electrification at 10% until year 2010."[4] However, this has not been the case because the hydropower and thermal units have not been doing well, especially since 2006. The rise of oil prices has led to the steeply increased price of electricity sold by Independent Power Tanzania Limited (IPTL) to Tanzania National Electric Supply Company (TANESCO). This trend increased the government expenditure in subsidizing TANESCO as it cannot increase the tariffs to customers. Lack of electricity has resulted in a low level of industrialization which has negative results to other sectors.

The World Bank reports that the inadequate and unreliable electricity supply has plunged the country into a power crisis which has caused the decline of economic growth. The report stated that, "power rationing was 'causing huge losses' in a number of sectors and put the cost to the economy at $1.7 million per day."[5]

The article by Mr. Lyimo provides some significant views on the trend of electricity production and supply in Tanzania over a period of time and the unreliable electricity caused by too much reliance on hydropower. From this perspective the government has been striving to take actions of energy investment which are not

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[4] Bartholomew M. Lyimo, Energy and Sustainable Development in Tanzania: *Sustainable Energy Watch 2005/2006, 4.*

[5] E.A. Kalisti, "Problems and Prospects for Hydropower Development in Africa:" *Work shop for African Energy Experts UN Energy, June 2003*, 16.

productive because it doesn't solve the electricity crisis that has become a source of shrinking of the country's economy. The Central Bank of Tanzania points out that the economy growth in 2007 declined to 1.1 percent less than expected due to energy crisis (NAPA, 2007).

On one hand, I agree with Mr. Lyimo's idea that the energy sub-sector is not well developed due to insufficient funds from the government; on the other hand, I find the government is not consistent and committed enough in dealing with the electricity problem as it has failed to establish enormous strategies and new mechanisms that could help fast development of alternative energy instead of relying on hydropower. For a number of years in comparison the amount of electricity generated does not correlate to the demand due to low electricity generation compared to the demand.

2.2 Diversification and Intensification of Electricity Generation

More investigations have been done to find the significance of sustainable energy and energy efficiency in Tanzania in the process of economic development. Mr. Lyimo suggests that solar power can be one of the alternatives and solutions to the electricity shortage. He advocates the use of alternative of energy sources, arguing that Tanzania has various energy resources which are untapped, including "biomass, hydro, coal, natural gas, geothermal, solar, wind, uranium, and ocean."[6] With the exception of hydropower and natural gas, other resources of energy have not been extracted. Research shows that until 2006 only 10% of Tanzanians had access to electricity and less than 2% of the rural population used electricity.

[6] Lyimo, Energy and Sustainable Development in Tanzania

Mr. Bartholomeyo Lyimo and Livin Mosha in their articles contribute to a significant base of the study because they both provide an in-depth idea on the effective use of alternative sources of energy in Tanzania that can be fully tapped and exploited in order to eliminate the electricity crisis. Although they have discussed diversification of energy sources, they seem to overlook the means which the government can apply to harness the resources for energy generation. To be more constructive and focused the government should encourage substantial and productive investment in the alternative sources of electricity in order to better utilize the natural resources for sustainable development at a low cost.

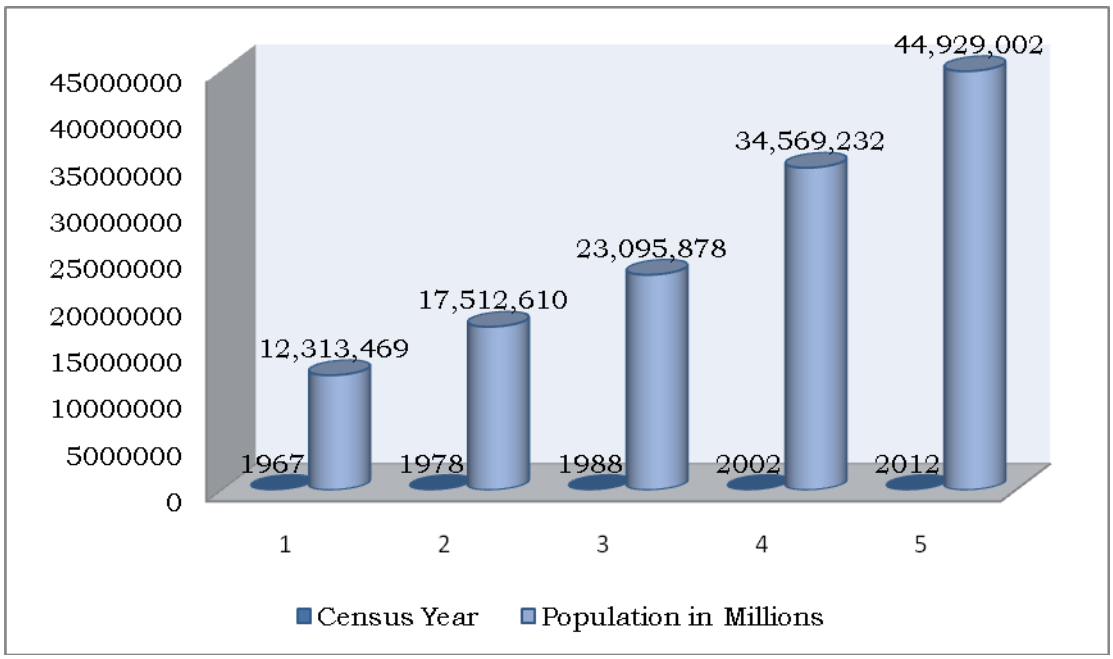
There are some predictions on the future of energy in Tanzania obtained by analyzing the current energy mix in use. Mr. Msaki argues that "the current energy mix in Tanzania is 61% hydro, 27% oil, and 12% natural gas."[7] He claims that the demand will increase by 10% in 2025, when there will be a need for more initiatives to seek alternative energy use. I agree with his idea of including nuclear energy as an initiative for a reliable energy mix by the year 2035, and enhancing capacity building by preparing expertise with special knowledge and skills in the nuclear industry. Conversely, Mr. Msaki's projections ignore the immediate actions to address the long extant problem of electricity in the country. Based upon the intensive energy crisis in Tanzania his idea seems to lack a sense of urgency and there is a crucial need for investing in efficient and effective energy generation at the present time so as to save the country's economy.

[7]Peter K. Msaki, "The Nuclear Energy Option for Tanzania:"*All Economic Developmental Vision for 2035*, Department of Physics, University of Dar es Salaam, Tanzania, 1, (n.d).

2.3 Population growth and increased demand for electricity

The National Energy Policy notes that "domestic energy demand has grown rapidly due to population growth."[8] Tanzania's energy policy includes bio-mass fuel, mostly used in charcoal and wood fires. It is the major source of energy in rural and urban areas. The national energy policy shows that about 90% of energy use is biomass-based fuel, 8% of commercial energy sources are petroleum and electricity, 1.2% from primary energy used and less than 1% of energy used comes from coal, solar, and wind. The energy policy expresses that "10% of the population has access to electricity. In the rural areas, only below 2% is reached by electricity."[9]

Figure 2.1: Tanzania Population Trends from 1967 - 2012



Source: 2012 Tanzania Population and Housing Census Volume 1.

[8] *Tanzania National Energy Policy*, February, 2003, 6.

[9] *Tanzania National Energy Policy*, February, 2003, 19

The government must set strategies that will focus on the next decades for the country to have a reliable and adequate supply of electricity instead of dealing with temporary and emergency measures for generating electricity from thermal power plants which use imported oil. Much has to be done so as to make electricity reliable, and affordable, and to increase access to many Tanzanians living in scattered parts of the country and meet the electricity demand which has been increasing drastically.

2.4 Human Capital Development, Research and Innovation

Human capital development is an important aspect in the energy sector where skills, knowledge and competencies are imparted to energy experts for them to become productive. This can be achieved through exchange of energy experts from countries with effective and efficient energy system in which they can share experience and knowledge. Provide civic education to all citizens concerning best practices on energy conservation and use.

Furthermore, the government can incorporate energy subject as compulsory course in schools, college, vocational training centers, and universities in order to make every citizen acquire energy skills purposely for basic knowledge on handling energy. Moreover, the government should subsidize engineering programs in the energy sector at the college level and universities to strengthen and build stable energy systems in the country particularly in power production, transmission, and supply.

The national energy policy provides priorities on research and development in order to encourage and facilitate technological innovation and invention in the field of energy. However, from the energy policy perspective, there are no clear practical techniques and framework set for effective energy generation and supply.

The policy acknowledges the availability of energy sources in Tanzania but it doesn't provide a way forward or direction on when and how to harness and tap the resources. So, it is important for the government to have a better energy policy that will explore all areas necessary for energy production including capacity building, technology importation, capital investment, expected time for the project to takeoff, research fields and international cooperation with external countries and institutions to gain experience in energy generation.

2.5 Electricity consumption in the Developing countries

The article by Mr. Balat investigates the amount of the electricity consumption in the developing countries in which he states, "at present developing countries with more than 75% of world's population, account for only about one-third of the world's electricity consumption."[10] According to Mr. Balat the world electricity consumption will likely double in the coming two decades because of the increase in electricity demand from average of 2.3 percent per year ranging from 13,290 billion KWh in 2001 to 23,072 billion KWh in 2025. He contends that "The consumption of electrical energy with its easy use, possibility of conversion into the other sorts of energy, and widespread availability in daily life constitutes one of the important indicators of the development level of the countries."[11]

The US Energy Information Administration (EIA), 2004 report suggests that reliable and adequate electricity production and supply to the developing countries and

[10] Mustafa Balat, "Electricity from Worldwide Energy Sources:" Sila Science, TrabzonTurkey. Energy Source Part B, 2006, *369.*

[11] Balat, "Electricity from Worldwide Energy Sources,"395

emerging economies is significantly important in boosting the economic growth of a country and region. To achieve this goal many governments of the developing world are struggling to increase the electricity supply to the citizens.

The sources above are useful to this study because they present the current situation of the energy consumption and its significant use in the developing countries, including Tanzania. In spite of the remarkable views given in the article and the EIA report, the authors did not explain on specific steps to be taken by the governments in boosting the amount of electricity used in the developing country from the present one third. This study will explore and suggest methods that Tanzania's government can adopt so as to increase the amount of energy consumption by ensuring the availability of electricity.

2.6 Climate Change and its Impacts on Electricity Generation

Hydropower in Tanzania contributes over 50 percent of the total. This trend has changed since 2006 with droughts adversely affecting many parts of the country. The low rainfall has reduced hydropower sources in the country which to a large extent has decreased the production of electricity.

Dr. Frauke Urban and Dr. Tom Michell address the impacts of climate change and disaster risks on energy infrastructure for reliable and efficient electricity generation. The authors reveal that climate change can cause decline in energy production which results in economic and political forces that need to be addressed by new strategies by the energy sector. The climate change causes challenges that affect the energy sector as well as electricity infrastructure. The unpredicted disasters including floods, storms and droughts can destroy and disorganize electricity generating means and this affects economic activities and people's lives.

The authors explain about the impacts of climate change on electricity generation as pointed out by the Intergovernmental Panel on Climate Change (IPCC) reports, which states, "climate change could affect energy production and supply, (a) if extreme weather events become more intense, (b) where regions dependent on water supplies for hydropower and/or thermal power plant cooling face reductions in water supply."[12] The climate change in Tanzania has caused drought in areas of river basins where hydropower dams are situated, particularly at Mtera power dam. As a result, energy production and supply have dropped to an extent that the government has to initiate other ways for generating electricity using expensive A1 jet fuel.

According to the World Bank Report 2010, Tanzania faces 63 days of power outages on average per year. During the power outages large scale business and few well-off households use small generators that many small businesses and a majority of households cannot afford.

The article paves a way forward on dealing with climate change that causes low supply of water in the river basins and dams for hydropower generation. The United Nations Framework Convention on Climate Change (UNFCCC) report contends "that a diversification of energy and electricity generation options is needed as an adaptation strategy to climate change."[13]

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[12] Frauke Urban and Tom Michell, "Climate Change, Disasters and Electricity Generation," *Strengthening Climate Resilience Discussion Paper 8*, 2011, 10.

[13] Frauke Urban and Tom Michell, "Climate Change, Disasters and Electricity Genera tion," *Strengthening Climate Resilience Discussion Paper 8, 2011*, 26.

Table 2.1: Climate change and disaster risks on hydropower generation.

Change in meteorological variable	Impact on hydropower plant/ resources	Impact on electricity generation
Temperature increase	Increased evaporation, reduced river run-off and lower water levels.	Decreased electricity generation
Increase in average precipitation	Increased river run-off and higher water levels.	Increased electricity generation.
Decrease in average precipitation	Reduced river run-off and lower water levels.	Decreased electricity generation.
Droughts	Reduced river run-off and lower water levels.	Decreased electricity generation
Glacier melting	Increased river run-off and higher water levels.	Increased electricity generation
Floods	Increased river run-off and higher water levels. Flood gates are opened.	Increased electricity generation.
Increased frequency and/or strength of storms/cyclones	Risk to power plant equipment, reservoir and dams.	Decreased electricity generation if power plant, reservoir or dam is destroyed or damaged.

Source: Climate change, disasters and electricity generation (Frauke Urban and Tom Michell), 2011

Drs. Frauke and Tom's article establishes down a base for this study in which climate change and its impact on electricity production is the central idea of the research discussion towards the shift from hydropower dependency to mixed energy use in Tanzania.

From the literature reviewed above we find that Tanzania is depending predominantly on hydropower electricity but that climate change has negative effects on hydro generation because of low rainfall and drought in river basin sources. To have adequate and sustainable energy for the future the government needs to invest in energy generation by use of coal, natural gas, uranium, oil, wind, and hydropower. The availability of electricity will strengthen the growth of other sectors including agriculture,

mining, industry, fishing and tourism to facilitate and create strong economic development. In light of these issues, we need to establish a more accurate and comprehensive energy policy with specific focus and methods to be used in addressing energy shortage in Tanzania. In addition, reliable and adequate electricity will act as a catalyst to the achievement of the Millennium Development Goals (MDGs) and decrease in dependency on the developed countries.

3.0 ELECTRICITY GENERATION IN TANZANIA

3.1 General trend on electricity production

The main commercial energy sources in Tanzania are hydropower, petroleum and coal. Biomass energy including forest and wood fuel are mostly used by the large population, ranging to 90 per cent of the country's total energy consumption. Biomass is used traditionally for heating and cooking in both rural and urban areas. Dar es Salaam is mostly connected to electricity but less than 50 per cent of all households have access to electricity.

Broadly speaking, the trend of electricity production in Tanzania has been declining compared to the actual demand in electricity. The increase in the need for electricity does not match with the total electricity generated from different sources. The ongoing decrease in electricity production, distribution, and transmission has opened a new phase of life in Tanzania because it affects all spheres of people's lives socially, politically, and economically. Based upon the data found by the Ministry of Energy and Minerals we can see that for the last 16 years (1995-2010) the demand has been increasing in a very small amount in megawatts (MW); however, the electricity generation has always been low while the demand is high as shown on the table below.

Table 3.1: Electricity Generation and Demand Trend in Tanzania

Year	Electricity Demand (Industries and Domestic in MW)	Electricity Generation (MW)	Electricity Deficit (MW)
1995	333	215	118
1996	338	231	107
1997	339	226	113
1998	368	253	115
1999	394	271	123
2000	430	290	140
2001	465	320	145
2002	475	333	142
2003	506	366	140
2004	509	388	121
2005	552	419	133
2006	603	410	193
2007	653	481	172
2008	693	505	188
2009	755	438	317
2010	833	151	682
Total	**8246**	**5297**	**2949**

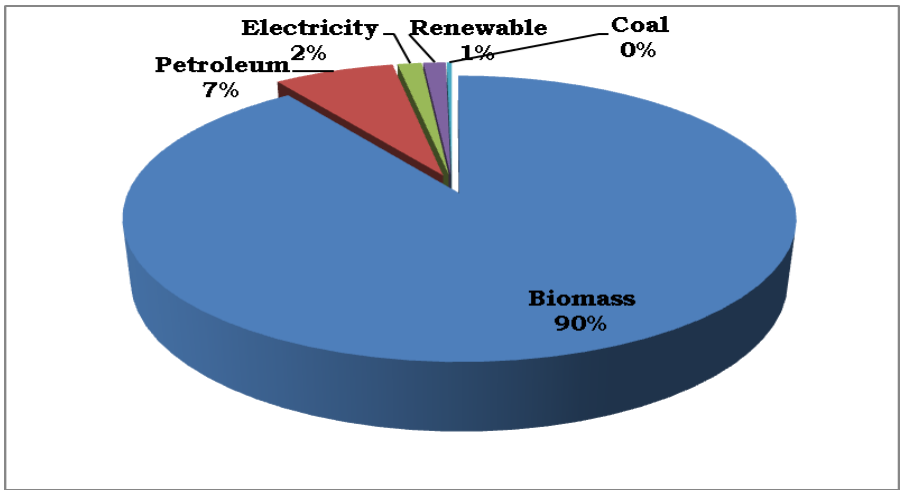
Source: Ministry of Energy and Minerals, Tanzania

3.1.1 Primary sources of energy

Electricity and petroleum imported or produced in the country are the energy sources upon which all sectors depend. The shown demand and supply of energy in Tanzania implies low level of sector development that includes industries, transportation, commerce and households. Electricity demand is growing fast as pointed out by Damian Casmir: “Demand rose by 8% from 2003-2006 despite of prolonged period of power shedding due to drought and insufficient rainfall for hydropower reservoirs.”[14]

[14] Damian Casmir, Energy Systems:Vulnerability-Adaptation Resilience (VAR),Regional Focus, Sub-Saharan Africa Tanzania, 2009, 16.

Figure 3.1: Primary sources of energy in Tanzania



Source: www.helio.international.org/VARTanzania, 15.

The figure on primary sources of energy above show that biomass fuels are highly used for heating and cooking in both urban and rural areas compared to other sources of energy. Though electricity is greatly needed to boost other sectors its generation accounts for only 2% of the total amount of energy required in Tanzania.

In comparison with other world country's sources of energy Tanzania need to put more emphasis in energy mix investment through establishment of energy projects that will enhance effective utilization of coal, natural gas, uranium, hydro, and other renewable sources. If the share of electricity will rise above the 2% level would support the country to develop further and industrialize in different sectors. The table below shows the combination of electricity generation by sources in some countries in the world.

Table 3.2: Country's electricity generation by sources

No.	Country	Coal (%)	Natural Gas(%)	Petroleum/ Oil (%)	Nuclear (%)	Hydro (%)	Other renewable (%)
1	U.S.A	44.5	23.6	1	20.2	6.8	3.9
2	Canada	16.6	6.6	19	15.6	59.3	1.6
3	Sweden	27	23	36	8.5	6.3	0.9
4	Australia	26.5	20.9	34.1	5.9	2.2	10.4
5	South Africa	71.1	3.1	12.8	2.5	0.1	10.4
6	Korea, South	26	14	45	14	-	1
7	England	32.9	43.3		15.5		8.5
8	Philippines	26	18	23	-	21	12
9	China	71	3	19	1	6	0.2
10	Brazil	5	8	50	1	34	2
11	Russia	16	58	14	6	6	-
12	Peru	5	17	50	-	27	1
13	Mexico	4	30	58	1	5	2
14	Japan	21	17	46	11	3	1
15	United Arab Emirates	-	70	30	-	-	-
16	Venezuela	-	29	44	-	27	-
17	Libya	-	28	72	-	-	-
18	Iran	1	53	44	-	2	-
19	Saudi Arabia	-	44	56	-	-	-
20	India	40.8	5.6	23.7	0.7	1.8	27.4
21	Egypt	1	49	45	-	5	0.3
22	Colombia	9	18	42	-	31	1
23	Malaysia	5	48	44	-	3	-

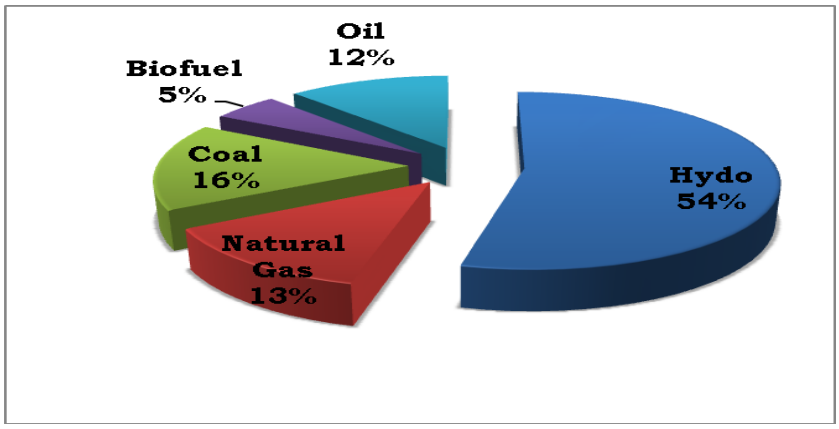
Source: EIA (2008)

3.1.2 Discovered sources of electricity

For a long time there have been discoveries of potential electricity sources in Tanzania. Some discovered reserves are coal estimated at about 1,200 million tones found in coal sites at Kiwira, Northwest of Lake Nyasa, Mchuchuma/Katewaka and Ngaka, natural gas 45 billion m^3, hydroelectricity has capacity of 4700 MW and other resources include uranium and renewable energy (eg. solar, wind, and geothermal energy).

In the case of uranium, which was recently discovered in some parts of the country, the plan is to begin mining in 2011 – 2012. However, there is a challenge whether the government can invest heavily in nuclear energy to generate electricity which will strengthen the mining schemes for gold, diamond, and tanzanite. Furthermore, questions exist whether Tanzania can address the long-term problem of inadequate electricity and succeed in supplying electricity to other Sub-Sahara African countries as it is expected to become one of the leading uranium-producing countries in the world. This is revealed by discoveries in recent years which show many parts of the country have large deposit of uranium.

Figure 3.2: Composition of electricity sources in Tanzania



Source: Tanzania Investment Centre (TIC), 2008

3.1.3 Energy institutional foundation in Tanzania

Government and non-government stakeholders engage in the field of energy. Their involvement depends on specific activities undertaken such as acquisition of energy production machines, funding the projects, conducting research, policy making, and setting the legal framework for the energy sector developing the projects, distributing the power, etc.

The main actors in Tanzania's energy sector are "the Ministry of Energy and Minerals (MEM), Ministry of Finance and Economic Affairs (MoFEA), Rural Energy Board (REB), the Rural Energy Agency (REA), Rural Energy Fund (REF), and the Energy and Water Utilities Regulatory Authority (EWURA)"[15] and other International institutions including the World Bank (WB), the African Development Bank (ADB), and the Swedish and Norwegian Agencies, which assist in international development.

The legal instruments for energy in Tanzania are the Electricity Act of 2008, Energy and Water Utilities Regulatory Authority Act of 2001, Petroleum Act of 2008, Gas Bill of 2009, and Rural Energy Agency Act of 2005.

3.1.4 Electricity generating agency and companies

Tanzania National Electric Supply Company (TANESCO) had the role of generating, transmitting, and distributing electricity to all parts of the country. TANESCO started to outsource some of its functions to private companies engaged in power trading in 1992. There was an increase in private power generating companies after the government

[15]Power System Master Plan. 2009, 2-6.

allowed them to produce electricity from different sources, mainly petroleum and natural gas, and sell to TANESCO and other consumers.

The private companies that generate electricity are Independent Power Tanzania Limited (IPTL), Symbion Company, and Agrreko Company. Some of these companies are owned by religious institutions, local industries, and Community Based Organizations (CBO's). According to the TANESCO report of October, in 2011 a total of 766.8 MW has been generated from all electricity sources, which equated to 63.9% of 1,200 MW required for the country.

Generally, electricity production trend is very low compared to the demand from industries, institutions, commercial and residential areas. Given the potential sources of alternative electricity generation it is important to secure means through which power generation projects can be established and developed. The energy institutions need to be focused and committed in the whole process of setting plans and strategies for electricity production.

3.2 Comparative approach of electricity production

3.2.1 Historical context of the Canadian model of electricity generation and distribution

Canada is the fifth largest producer of energy in the world, generating 6% of the global energy supply. It is famous for producing 1/3 of the world's uranium and leads in hydroelectricity with 13% of world production. Because of high energy production Canada has secured an energy market in the United States of America where it sells about 98% of the total energy export it produces. Due to its huge deposits Canada exports uranium and coal to Asia, Europe and Latin America. The government has successfully managed to turn

and harness the natural resources into more profitable use for the nation. Apart from extracting and using the available resources for power generation, Canada exports the surplus of uranium, crude oil, natural gas, coal and electricity to the United States.

An important and remarkable role has been played by the electricity sector in Canada through its significant contribution to the economic and political sphere of the country since the late 19th century. A key function of the government is to ensure the availability and construction of integrated public utilities which generate, transmit and distribute the electricity to homes, offices and factories. Canada is using hydroelectric, nuclear, coal and natural gas along with emerging and growing wind power. The power production system is effective and efficient because different projects established are based on provincial agencies due to the large size of the country. Every province is responsible for energy production projects which are also subsidized by the government. For example Ontario, the most populated province, generates 9,600 MW per year by use of nuclear reactors, coal, and natural gas and hydro facilities.

Before the advancement of energy sources Canada used wood and human muscles in many activities which required the use of energy. This was replaced by animals, particularly horses from Europe. The discovery and development of coal and petroleum as energy sources brought significant changes in the country by uniting Nova Scotia, New Brunswick, Quebec and Ontario that necessitated control of natural resources to the provinces. Canada began to invest in and generate electricity from coal in the 1960's in Alberta and Saskatchewan. Following the Second World War hydroelectric capacity in Canada was insufficient due to the growing demand so the government started to use coal and nuclear power in the 1950's and 1960's as an alternative source of power. Furthermore, the rise in the price of oil in the 1970's and 1980's increased demand for coal in the world.

The energy policy in Canada is very successful because of the energy mix generated from coal, natural gas, nuclear power, hydroelectricity, and renewable energy. Canada has successfully harnessed its domestic resources through energy production which contributes to sustainable development of the country and the people. About 59.3 percent of the electricity is generated from hydroelectricity, making Canada the world's leading country in hydroelectricity production. The energy mix method of power generation to support the electricity demand in Canada has been growing since 1990 at an average rate of 1.2 percent annually. The International Energy Agency (IEA) Report points out that power sources in Canada account hydroelectricity 59.3 percent, coal 16.5 percent, nuclear power 15.6 percent, natural gas 5.2 percent, petroleum 1.9 percent, and non-hydro renewable sources 1.6 percent.

The Canadian government delegated responsibility for generating electricity to provincial governments in which they set programs and projects that enhance the production of electricity to meet the demands within their province. The provincial responsibilities towards generation of electricity contribute to effective planning and implementation of electricity projects for successful achievements in energy production, transmission and distribution. Given the resources of coal, natural gas, oil, uranium, hydro and non-hydro renewable, Canada attempted to convert them to electricity which has become the energy used in industries, offices, commercial institutions and households. The surplus electricity generated is sold to United States where in 2006 Canada sold 41 billion Kilowatt-hours, raising revenue of $ 2.5 billion (IEA Report). From this perspective, we can see how a country can raise its economy by exporting electricity to neighboring countries. Canada is investing more in nuclear power for the future use because of constant, stable, and reliable electricity generated from it.

Canada Energy Strategies

Canadian energy is regulated by Canada's National Board which is an independent federal agency. This board monitors international and interprovincial aspects of energy including "safety, security, the environment, and efficient oil, gas and electric utility infrastructure and market."[16] Energy resources in Canada are centered in province where each province has jurisdiction in energy resource management reflecting their action plans with key areas of focus and implementation. Despite of provincial decentralization in power generation, all provinces share same key aspects of energy strategy regulated and monitored by the Canada's National Board of energy. Below are the key aspects of Canada energy strategy;

Development of energy projects

Provinces concentrate on providing unique energy mix based on resources available in a particular area. The kind of energy mix used is determined by the nature of the energy resources available in a given province. For instance in Quebec there are numerous hydro projects, Alberta is designated for oil and natural gas industry. Based upon the resources available different energy mix projects are developed for future requirement.

Electricity generation according to the demand

Electricity is generated to meet the growing demand and improve its use and increase the transmission networks to the end-users. Developing provincial electricity transmission includes establishment of effective and efficient networking based on

[16] Canadian Leadership in Energy. 11, www.centreforenergy.com

technology called “smart grid”[17] and improve provincial infrastructure capacity for import and export of electricity.

Diversification and emission

With strong established energy source infrastructures such as hydro, oil, and natural gas the emphasis on reducing emissions has increased the use of renewable sources including wind and solar. It has broaden the use of energy mix in provinces where in their plans every province intend to increase electricity generation from wind source, for example Prince Edward Island will add 500 MW generated from wind power by 2013. More efforts for emission are done by introducing greenhouse gas reduction in which energy projects established are accompanied by strategies to reduce emissions.

Innovation

Initiatives are employed in every province to involve changes and new methods in order to improve technology and shift from the current technology. The focus is on developing potential technologies and skills that will create specialists in energy field.

Generally, these are the major aspects of Canada energy strategy in which its implementation varies from one province to another depending on the nature of energy resources available in the area.

3.2.2 Tanzania adoption on Canadian model

Canada has the same natural resources for generating energy as well as same needs for energy that Tanzania has. The Canadian model of an energy mix for power generation, transmission and distribution is useful to Tanzania if it can adopt this kind of structure.

[17] Canadian Leadership in Energy. 11, www.centreforenergy.com

Despite of the differences in climate, political, social, and economic stability, Canada has the same natural resources for electricity generation abundant in Tanzania, including natural gas, coal, oil, uranium, hydropower, wind and solar. This method of energy generation enhances intensive extraction of available resources through electricity production and turns it to a more productive system that contributes to sustainable development of a country as it has been the case in countries with stable, reliable and efficient electricity.

Tanzania requires a well-defined energy policy and clear strategies that pave a way forward for effective use of the abundant resources to generate large amount of electricity in order to overcome the long persisting problem of electricity shortages. The country has huge deposits of coal at Mchuchuma in Iringa, Kiwira in Mbeya and Ngaka in Ruvuma; as well as natural gas at Songo Songo Island, Mnazi Bay, and Kimbiji; oil along the coast of Indian Ocean, Zanzibar and Pemba; uranium in Ruvuma region and other parts of the country; hydro-river basins at (Pangani Falls, Kidatu, Hale, Mtera, Rufiji, Nyumba ya Mungu and Kihansi); and wind in Makambako and Singida. The combination of these remarkable resources can generate a sufficient amount of electricity, enough to be used in industries, offices, commercial institutions and households.

Moreover, the country can earn revenue from selling the surplus electricity to neighboring East African countries such as Kenya, Uganda, Rwanda and Burundi and Sub-Sahara Africa including Malawi, Mozambique, and Zambia. Tanzania Investment Centre (TIC) reveals that Tanzania has potential to generate over 6000 MW of power over a long

period of time and sell to neighboring countries "more than 400 MW"[18] earning over $1 billion revenue per year.

Table 3.3: Sources of Energy in Tanzania

Potential Supply	**Potential Capacity (MW)**	**Observation**
Hydro	2100	Stigler's Gorge Dam and others
Gas	500	Power generation using gas from the Songo Songo and Mnazi Bay field
Coal	600	Power generation using coal from Mchuchuma and Kiwira in the Southern part of the country
Biofuels	200	Power generation using ethanol from sugar, biodiesel from palm oil and jatropha
Oil	450	Shell, Petrobras and others have already acquired rights for a number of oil exploration blocks of the Mainland Coast and around Zanzibar and Pemba.
Total **Projected Demand in 2020**	**3850 MW** **1600 MW**	**2250 MW Capacity available for export to the region**

Source: Tanzania Investment Centre, 2008

Sustainable electricity is a key element in transforming the country's economy from traditional and local industry to modern and heavy industries. Generation of sufficient and reliable electricity will stimulate the transformation of Tanzania economy from existing small-scale industries to a modern and heavy industries that enhances manufacturing sector and improves export products. Furthermore, there is high opportunity

[18] Tanzania Investment Centre (TIC): Tanzania Investment Guide 2008 and Beyond.26 www.tic.co.tz

of achieving the government strategy to shift from the agricultural economy to a manufacturing industry economy by the year 2025.

Nevertheless, sustainable and reliable electricity does not guarantee the development of a country without considering other complementary aspects of changes including improved technology, skilled human capital, stable government, strong financial institutions, and well established strategies for economic development.

The implementation of many government strategies requires electricity and there are projects that need to be implemented in current and future years, including Mchuchuma and Liganga steel and iron ore mine which require 300 MW, as well as mining projects, and oil research projects. The Minister of Industry and Trade, Hon. Cylil Chami, pointed out that Tanzania needs to generate about 1,800 MW by the year 2018; however, this plan cannot be achieved if there is no comprehensive strategy for mixed energy production from alternative energy sources that Tanzania possesses, for depending on hydroelectricity has failed to generate adequate power.

In sum, Tanzania has to learn from other countries' methods of electricity production and adopt the method from the country that suits most then develop the energy mix system of electricity production depending on the nature of the country and ability. It might not be the same in terms of amount of electricity generated, quality of technology used, and capital invested because each country has its own capability in capital, technology, and electricity requirements according to the demand.

3.3 Electricity for sectors development

Human development and changes have occurred due to different factors of transformation and transition that include good transportation system, and a infrastructures,

good governance, better market system, and better education system. Many people overlook and forget a central aspect for those changes which occurs from time to time. If we pay more attention to electricity it can be considered as a central factor for all technological innovations and inventions we see today. Electricity has been a complement and potential element for development in many sectors. In broad perspective, electricity has made a significant contribution in development and the industrialization history of the world.

3.3.1 Manufacturing sector

The sole power used by machines in industries is electricity which runs the equipment during the production of the goods. The current electricity situation in Tanzania is insufficient, which greatly affects many industries, such as cement, cigarettes, plastic, beverage, and textile, as they cannot meet their targets of production. This reduces the industrial profits, causing workers to be laid off because employers cannot afford to continue paying the employees. In a situation where there is effective and sufficient electricity, industries perform well and employment is created. In the long run, this situation contributes to the country's economy and boosts individual income and living standards.

The country has enough resources where with adequate electricity there will room for domestic and foreign investors to excavate them intensively. Given the resources such as iron ore at Liganga and other regions of Tanzania the government can ensure availability of enough electricity and attract investors to invest in heavy steel and iron industries. From the steel products produced within the country, it can enhance other industries including automobiles by strengthening the Tanzania Automotive Technology Centre (TATC) which started to assemble cars. The establishment of iron and steel

industries can produce surplus steel to be sold to other African countries instead of them importing steel from outside Africa.

Adequate and reliable electricity can lead to the establishment of domestic ship (small ship) building companies for local and regional use. Tanzania has several lakes,-- Lake Victoria, Tanganyika, and Nyasa – which are connected to the neighbor countries such as Malawi, Burundi, Congo, Uganda, Kenya, and Mozambique. There is a problem of ship transportation between the countries and regions in East Africa; from this perspective the ship industry will enable Tanzania become self-sufficient in internal ship transportation between the countries, regions, and districts. Furthermore, the investment in a ship industry may facilitate the growth of the tourism sector where tour boats can be made and used in Zanzibar Island and other parts of the country with water bodies suitable for tourism. Many projects can be established and implemented from availability of electricity. In total, all these strategies will contribute to the sustainable development of the country.

3.3.2 Information and Communication Technology

The government is in the process of changing its system from paper-work record keeping to e-Government by strengthening the Information Communication Technology (ICT) sector. Considering the importance of electricity in ICT and communication, there is a need to establish strong mechanisms for electricity generation and supply to enhance government and private sector activities. Electricity is essential in communication and online transfer of documents, money, and revenue collection that will highly contribute to the economic growth of Tanzania.

The presence of electricity is likely to promote good governance because of reduced unnecessary bureaucracies that cause delays in government actions and activities

especially in the area of communication. The improved government system of e-Government system of communication will increase efficiency in government performance hence achieve fast development. However, this can be possible if the government has good plans, sufficient budget, diligent and commitment skilled personnel capable to implement the programs set.

3.3.3 Health sector

Treatment in hospitals requires electricity where surgeons are able to undertake operations; X-ray machines depend on electricity, as do other health services. Health facilities require reliable and sufficient electricity which help in air flow, supply of water, and temperature control in treatment and disease prevention. Hospitals and health facilities in Tanzania suffer from electricity shortage especially in rural areas where the national electricity grid is not connected. Following the shortage in electricity it is difficult to store drugs in refrigerators and most of the drugs expire before their time causing more cost to the government. From this view we can see the government has to ensure the availability of the electricity in the country in order to protect and guarantee people's health. In other words, we can agree that electricity is important in ensuring the availability of health human resources who can work and engage in national building.

3.3.4 Agriculture and Livestock industry

Over 80% of the population in Tanzania depends on agriculture activities in which they engage in growing different crops. The availability of electricity can support agriculture sector through establishment of agricultural processing industries and improve the price of the agricultural products. This can change the existing forms of export

agricultural products from raw materials to refined and processed form of products that will add value and more earnings to the government.

This sector contributes about 28% of the country's GDP (2010 statistics), so it is important for the government to look forward for the adequate electricity generation in order to support agricultural growth. Reliable electricity may facilitate the establishment of agricultural processing industries in rural areas such as juice factories, corn milling, meat packaging, and animal skin factories whose products can be exported and increase national income.

Despite of many people's involvement in agricultural activities, still they produce for subsistence and most of them are peasants. The availability of electricity to all parts of the country can motivate investment on agricultural industries that can promote large scale farming. These industries will create the demand for different agricultural raw materials including coffee, tea, sisal, cotton, cashew nuts, maize corn, cassava, wheat, beans, and millet.

3.3.5 Fishing industry

The country has potential fishery resources of Indian Ocean, lakes, rivers and ponds. The sources are essential for fishing though little invested. Lack of electricity is one of hindering factor for full utilization of these resources. The fishing industry depends much on electricity for fish storage and other aspects. Currently there has not been a well functioning fish industry in the country because investors are being discouraged from investing much because of inadequate electricity. It is important for the government to take initiatives in stabilizing the production and supply of the electricity so as to support fishing activities and industries.

3.3.6 Mining industry

The mining industry requires more electricity for the machines and other equipments to operate. The main focus of the mining companies is efficiency and cost minimization for profit maximization. There are many mining companies in Tanzania including Africa Barrick Gold Plc, Canada Gold Corporation, Lake Victoria Mining Company, Uranium Resources Plc, and Bright Star Resources. Some of the mining companies use their own source of electricity which has been a source of increase in production costs. According to the Tanzania Chamber of Minerals and Energy (TCME) companies that produce their own electricity are Geita Gold Mine Limited (23MW) and Tulawaka (5MW).

There has not been much focus on the use of electricity in drilling for gas, minerals, coal, uranium, and iron ore. Mining activities involve diverse and comprehensive use of electricity in the processes of mine excavation, move material from one place to another, and preparation and separation of minerals. The electricity use in mining industry includes the management of water and wastes from the mines and it helps to protect the surrounding environment from being distracted.

The mining industries consume large amount of electricity as observed in some of countries such as South Africa where mining industry consumes 6% of the country electricity and Brazil 4%.

Mining sector in Tanzania is growing in terms of export which is estimated to be 48.2 percent in the year 2007. Furthermore, this sector has been contributing to the country GDP growth as shown below.

Table 3.4: Contribution of mining sector to GDP growth (2002-2009)

	2002	2003	2004	2005	2006	2007	2008	2009
Mining Contribution to GDP	**1.9**	**2.1**	**2.3**	**2.4**	**2.6**	**2.7**	**3.4**	**3.3**

Source: Tanzania *Ministry of Energy and Minerals, 2007*

The government should pay more attention to the electricity supply in mining industries because technically this industry has to run at maximum efficiency. This action can enhance the increase in monthly bills more than Tsh 3.9 billion to TANESCO currently paid by mines connected to the national grid and increase employment to more than 13,000 people who are currently employed in mines.

Generally, electricity is an essential component of our daily life because it facilitates and complements the growth of all sectors including agriculture, mining, industry, health, fishing, communication, and other sectors not discussed above such as transportation and tourism industry.

4.0 FINDINGS AND OBSERVATIONS

This chapter responds to the key subject and questions of my study as introduced in chapter one. This section provides some information investigated during the research with possible answers to the questions posed. It is difficult to find single answers or explanations because of many factors associated with each question. The section focuses on finding the sources of the electricity crisis in Tanzania, the effects of the crisis, initiatives and strategies taken, and the importance of a reliable electricity supply.

4.1 Sources of electricity crisis in Tanzania

Lack of political will to adopt other means of energy generation through the use of alternative sources including coal, natural gas, uranium, wind, and other renewable sources may be a source of the energy crisis in Tanzania. According to Stephen Asek in his article political will refers to the "desire and determination of political actors to introduce as well as embark on reforms that will bring significant and persistent changes in the society."[19]There is discussion and acknowledgement by the government on the deposits of different energy sources found in the country but very little effort has been made to exploit and tap them in order to invest in energy generation. For a long time there has been less focused strategy and planning that aim at establishing exhaustive and mixed energy generation by exploiting all the available sources of energy so as to guarantee sustainable and reliable electricity in Tanzania. From this perspective I see the need to introduce strategies that will enable the achievement of the national energy policy objective as it states, "to provide an input in the development process by establishing an efficient energy, production, procurement, transportation, distribution, and end-user system."[20] The political will and government decision to invest in mixed energy generation plays a significant role for a country to have well and clearly defined approaches to electricity production through committing budget, attracting investors, searching for grants and loans from donor countries or raising domestic revenue that can facilitate the different energy mix generation projects.

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[19] Stephen N. Asek, Human Rights, Sustainable Development, July, 2006

[20] *Tanzania National Energy Policy*, February, 2003, 5.

Low rainfall is among the sources of the energy crisis in Tanzania because over 50 percent of the required electricity is generated from hydropower. However, the hydropower generation has proved inefficient and ineffective because of the existing drought that has been an aspect contributing to low flow of water in the established dams for electricity generation.

Most of the hydro power plants installed seem to be old with low production capacity which cannot meet the electricity demand. Lack of modern infrastructure for energy generation contributes to inadequate electricity generation as pointed out by Tanzania Investment Centre (TIC) that Tanzania "has ample resources for power generation including hydro, gas, coal, oil, and bio fuels but lacks the infrastructure necessary to harness them."[21]

Table 4.1: Hydropower Age and Capacity (MW) in Tanzania

Name	Age	Generating Capacity (MW)
Hale	43	21
Nyumba ya Mungu	42	8
Kidatu	35	204
Mtera	22	80
Pangani Falls	15	68
Kihansi	10	180
Total Generating Capacity (MW)		**561**

Source: URT (2009a)

The information on the table above reveals that despite the country's high dependency on hydropower for generating electricity, still the power plants installed are old and have low capacity to generate the amount electricity that can meet demand.

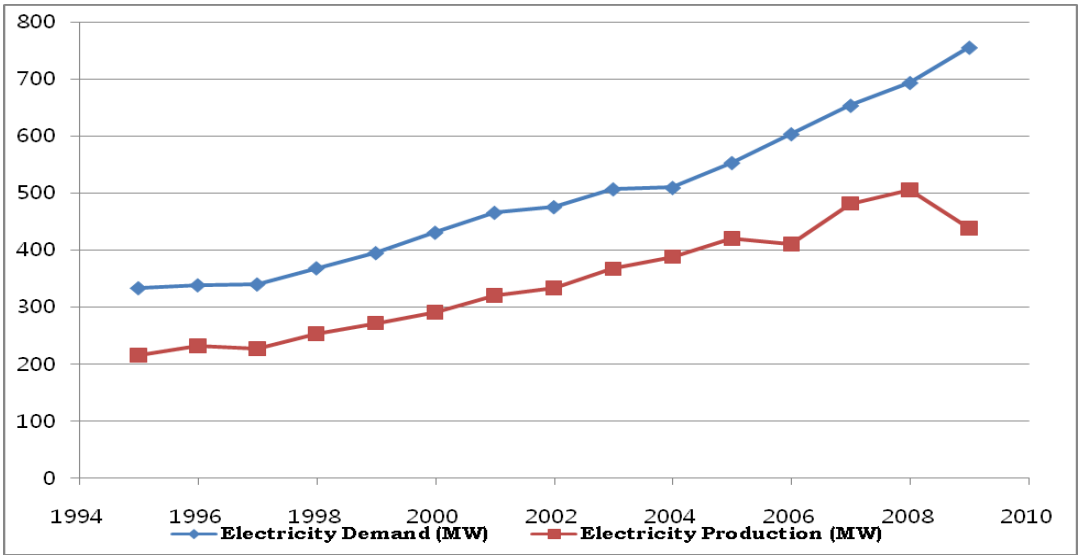
[21] Tanzania Investment Centre (TIC): Tanzania Investment Guide 2008 and Beyond.26 www.tic.co.tz.

4.2 Electricity crisis and its effects in Tanzania

Tanzania needs increasing amounts of energy to sustain economic growth, raise living standards, and reduce poverty. The country's status and trend in energy use is not sustainable and adequate since its independence in 1961. The electricity crisis in Tanzania is high and has been a disaster to the country due to the increased population and demand in electricity for the emerging economic growth where on the other hand production and supply of electricity has been decreasing tremendously. Recently, the electricity supplied has been rationed on an hourly basis to extent that, there is no access to full day electricity supply.

Over five consecutive years Tanzania has faced electricity outages which affect economic growth and sustainable development. Small business and self-employed individuals reliant on electricity are mostly affected by power outages and these are clearly be a burden, with the hardest hit being the poor in the parts of the country.

Figure 4.1: Electricity demand (MW) and production (MW) in Tanzania



Source: Ministry of Energy and Minerals, Tanzania

From this figure we can see the electricity production has never matched the demand for the given period of data collected from 1995 to 2010. Moreover, the graph shows that the electricity demand is rapidly increasing while the production is sharply going down. Basically, this is a problem that needs to be addressed immediately because it is not productive for a country to have electricity shortage for such a long period of time.

Many sectors are affected by the existing power outages where services delivery is declining. The health sector is one of the affected areas; because of the continuous blackouts, operations are not conducted on time in hospitals, and "clinics cannot refrigerate vaccines."[22] The education sector is also a victim of the electricity crisis as students cannot study consistently, laboratories are out of use, and teachers cannot prepare the lessons for their students. Public and private institutions/offices are in the same track and they sometimes stop functioning due to electricity blackouts. It happened on 17 October, 2011 when the President of The United Republic of Tanzania (URT) Hon. Jakaya Mrisho Kikwete was conducting a fund-raising program for the expansion of the University of Dar es Salaam at the Mlimani City Conference. The electricity went off until the emergency generator was switched on.

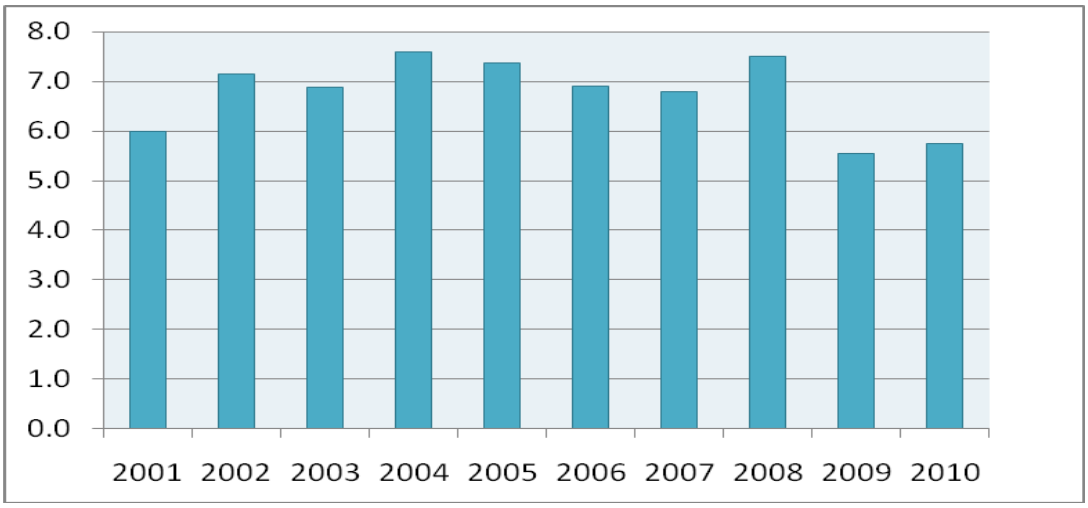
Sarah Collier in her article expresses, "Findings show that production in various industries and companies had dropped by about 30 percent because of the power problem."[23] The Tanzania Revenue Authority (TRA) has lost about $553 million, due to the failure in tax collection caused by power blackouts in the last quarter of financial year

[22] www.worldbank.org/Tanzania.

[23] Sarah Collier. "Lights Out in Tanzania."

2010/2011. The Confederation of Tanzania Industries (CTI) reported that the power shedding has caused about 50 factories to close, resulting in loss of jobs to many Tanzanians and the increase in the inflation rate and high living cost is also a result of power outages.

Figure 4.2: Tanzania Real GDP Growth Rates from 2001 – 2010



Source: *African Economic Outlook 2010-OECD©2010*

Based upon the data on GDP collected from the African Economic Outlook between 2001 and 2010, Tanzania's real GDP growth rate has not been stable from 2006 when the electricity crisis started to become intensive. This can be among the factors contributed to the decline on real GDP growth rate from 6.9% in 2006 to 5.7% in 2010.

4.3 Government strategies in addressing electricity crisis

The government, through Tanzania Electric National Supply Company (TANESCO), has been taking emergency actions to overcome the energy crisis by establishing short – term projects for thermal electricity generation. The initiatives have been in place from the beginning of the intense electricity problem in 2005/2006. Among the strategies pursed were to contract with private companies for electricity production such as Independent

Power Tanzania Limited (IPTL) and Agrreko in previous years and Symbion Company in 2011. The emergency plan for energy generation depends on oil, diesel or Jet A1 which is very expensive. The Africa Infrastructure Country Diagnostic Study (AICD) shows "estimates that load shedding and emergency generation cost Tanzania over 5 percent of GDP annually."[24]

In August 26, 2010 the World Bank's Board of Executive Directors approved $ 150 million to support a project on the implementation of electricity transmission. The project was expected to provide a reliable power supply to the northern regions of the country and later to the generating sources in southern regions. The first phase was the transmission line from Iringa to Shinyanga region linking the generating sources in southern Tanzania and centres in Northern Tanzania, particularly Mwanza and Arusha. The World Bank Country Director for Tanzania, Uganda, and Burundi, Mr. John Murray, stated that, "By increasing the availability and reliability of electricity in the northern part of the country, this investment will not only support the government's growth and poverty alleviation efforts that access to electricity brings in terms of social and economic benefits but also facilitate the conditions for private sector development in the country."[25] Nevertheless, the main focused regional centers face power outages where industries, small business, public offices and households are highly affected by the load shedding.

Generally, the efforts taken so far failed to stem the electricity shortfall in the year 2011, resulting in a shrinking economy of the country and its impacts to people's livelihood. In August 13, 2011 during the parliamentary session the Minister of Energy and

[24] www.worldbank.org/Tanzania.

[25] www.worldbank.org/Tanzania.

Minerals requested the authorization of Tsh 523 billion for the implementation of another emergency power generation project. Though the parliament authorized the immediate implementation of this project that was expected to start in August, 2011, implementation did not occur because the contractors have failed to deliver electricity. The National Social Security Fund (NSSF) being one of the contractors has not produced 150 MW as expected in August, 2011. Because of this situation, the government needs to take other reliable actions to deal with the problem of electricity shortage.

4.4 Issues to be addressed in order to have a reliable electricity supply

Political will and commitment are the fundamental driver of success and achievement of any project set by the government in the developed and developing country. Political will is a fundamental principal for setting developmental reforms for modernizing Tanzania in present and secure common goods and needs for the future generation. To enrich political will Tanzania need politicians and policy makers who are free from corruption and self centered interests and attitudes. Investment in political will is a vital aspect for Tanzania society to move from pre-modern to modern society with well established infrastructures in industrialization and urbanization. Change of mindset and attitudes to leaders, policy makers and society in general is important for Tanzania to develop energy mix projects that will bring benefits to all people instead of developing electricity projects in favor of groups, tribes, cultural, religious, and regions.

The Tanzanian government needs to commit itself through establishing a comprehensive energy generation project that will end the prevailing electricity crisis. A big energy project requires focused government decisions and huge capital investment, with well defined goals and objectives. Political leaders and policy makers in Tanzania have to take responsibility as key actors in developing and implementing energy reform

strategies to support effective exploitation of mixed sources of energy including coal, natural gas, hydropower, wind and uranium.

The government support to the agency will enhance the better results and comprehensive means of electricity generation and supply in Tanzania so as to reach its goal of connecting 75% of the citizens to the national power grid by 2025. The support must be accompanied by capacity building to all staff to make them productive, enough allocation of funds to energy projects, and improved technology for high capacity energy production to meet the increasing demand and prevention of energy loss during generation, transmission and distribution.

The government through Tanzania Investment Centre (TIC) has to encourage and promote the investment opportunities to attract Foreign Direct Investment in the energy sector for sustainable electricity generation. The present private companies investing in electricity generation do not focus on solving the problem as they are increasing the burden to the government; This is seen at those companies generating power by use of imported oil as a result the government pay a lot of money unnecessarily because power could be generated by use of domestic sources available including gas, coal, rivers and wind. It is one of initiatives of the government to use private companies to ensure sufficient and reliable power generation in Tanzania. However, the problem is observed on processes of selecting bidders. This can be seen in 2006 when Tanzania had a serious of power shortage where the government gave a contract to American company called Richmond Development Company which failed to work as required. The Select Committee Report revealed through their report “We would like to announce in this parliament that Richmond Development Company LLC, which won the tender and eventually signed a contract with TANESCO on June 23, 2006 lacked experience,

expertise and was financially incapacitated."[26] The consequences of the company failure led to the resignation of some top government leaders who were condemned of imposing the contract to Tanzania National Electric Supply Company (TANESCO) including the Prime Minister, Minister for Energy and Minerals, and Minister for East African Cooperation.

Moreover, based on the truth that Tanzania has huge deposits of natural resources, the government can apply for loans from international institutions like World Bank and IMF where the money can be invested on generating electricity by using the energy-mix method.

4.5 Challenges for generating electricity from fossil-fuel

World sources of electricity have been causing threats to the environment and other living things. Despite of all threats the generation of electricity from fossil-fuel and nuclear power are still important for human development. Coal is one of the most environmentally polluting sources of electricity in the world; however it is the major source of power generation globally, especially in the non-OECD countries. The IEA reports that, "Globally, coal remains the main fuel for power generation throughout the period to 2030. Its share in total generation increases from 41% to 44%."[27] Likewise, other electricity sources including nuclear power, hydro power and several fossil fuels sources are not environmentally friendly if not well treated in the process of plant establishment. These sources are constrained by government policies which discourage investment in power generation using nuclear energy and fossil fuels. Nonetheless, they all remain potential on the world sources and shares of electricity generation as shown below.

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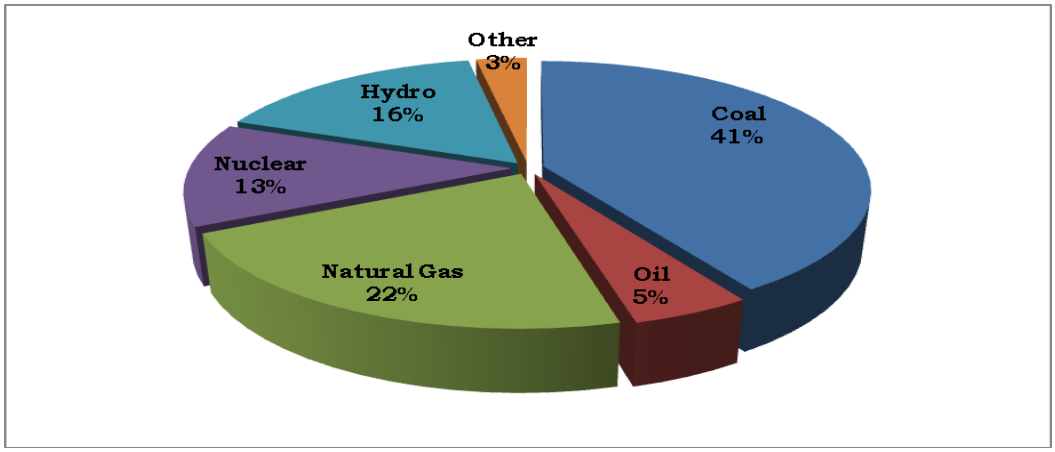
[26] The Select Committee Report on Richmond Scandal

[27] IEA, World Energy Outlook 2008. Global Energy Trend to 2030, 139.

Figure 4.3: The world energy sources of electricity



Source: IEA, Key World Energy Statistics 2011

Furthermore, the alternative suggested for renewable sources of energy like wind and solar power are not reliable and sufficient because the world cannot receive the sun and wind all the time as they are affected by climate change as well. In addition, the electricity generated from these sources is not powerful enough to run industries, big companies, and transportation system for example Trains. In comparison to the returns/output the cost of constructing wind, solar, and other renewable power generation are expensive. The share of renewable energy is 3.3% in the world electricity consumption as reported by the IEA, (Key World Energy Statistics 2011), hence the world cannot only depend on this source.

4.5.1 Budget constraints and lack of capital

Investing in power generation using the energy-mix system requires huge capital to finance the projects. Tanzania is facing budget constraints in establishing and implementing some of its projects. It is a challenge to the government in undertaking energy mix method of generating electricity. In reality the annual government budget alone is not sufficient for the investment in electricity production from fossil-fuel and other

sources. Dealing with budget constraints the government should set programs that will enable the implementation of the project in stages across a given period of time, raise funds from potential sources such as mining, tourism, and agricultural exports, secure funds from donor countries, and call for joint ventures with local and foreign investors who can invest in electricity generation using the energy-mix system.

Developing power plants raises many challenges that need to be settled in order to avoid bringing negative effects to other systems of human life. There are policies and world covenants that provide guidelines for the establishment and development of power plants especially by use of fossil-fuels and nuclear power. The most important thing is before establishing these kinds of power plants the government of Tanzania needs to find ways to develop the energy mix project without harming the environment. There are several techniques and methods that can be used to sustainably implement this project.

5.0 CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

This study explores the energy sources that can be mined and used alternative ways of electricity generation in Tanzania. The country's overdependence on hydropower has not been productive for many years due to different factors that cause low electricity production. Data and other useful information on energy deposits in Tanzania reveal the country's potentials and if strategically exploited, they can contribute to the availability of adequate and reliable electricity. Tanzania possesses enough potential energy sources to generate its own electricity domestically without importing from outside the country.

It is difficult to predict the future sources of electricity and this is the reason why this study concentrates on the present and available electricity sources in the country. The electricity demand in Tanzania has been rapidly growing due to factors such as population growth, increase in electricity requirements in industries, public and private institutions, mining sector, tourism sector, services, residential use, and other sectors. Electricity demand may keep on growing for many years to come; in addressing this challenge the government should change the method of generating electricity to the energy mix method because intensive investment in hydropower has proved that to be an unreliable and insufficient source of power.

The objective of this research was to find out what might be the cause of the long-persisting electricity shortage in Tanzania and investigate alternative ways of electricity generation by use of available energy sources including coal, natural gas, hydro, uranium, and other renewable. The study also intended to explore the benefits that Tanzania could get out of reliable and adequate supply of electricity, particularly in sectors development such as agriculture, mining, manufacturing industry, services, and other sectors.

More study was conducted to understand about electricity sources in other countries of the world. In fact that many countries especially in the developed world use the energy mix method for generating electricity. However, there are some variations in terms of energy sources, composition, and amount of energy from each source, while some of them are importing energy. This system has proved to be successful in many countries including Canada which have similar energy sources to what Tanzania has.

The study considered the challenges for developing and establishing power plants and its risks to the environment. Given this phenomenon, the research reveals some effects associated with generating electricity using fossil-fuel; however, they can be prevented

from causing harm to the environment. Attention was also drawn to how to acquire funds for investing on mining coal, uranium, iron, and developing coal burning plants, nuclear power plants, and iron and steel mills.

The study provides preliminary assumptions on the qualitative and quantitative data and information collected. The results of the study established the following:

a) The overdependence on hydroelectricity and failure to generate electricity from diversified sources of energy is the major cause of electricity shortage in Tanzania. This has lead to poor performance of other sectors particularly industries and financial institutions resulting in low level of Foreign Direct Investment.

b) The use of an energy mix model could be a better solution to address the problem of electricity in Tanzania. It would also provide an opportunity for effective utilization of the country's energy and other natural resources.

c) With sustainable and sufficient electricity supply, Tanzania can achieve fast economic development; however, other factors to be considered for this achievement are good leadership, skilled and diligent personnel, proper planning, better development strategies, and availability of fund to invest on different projects.

d) Adequate electricity supply would help to restore citizens' trust in the government. Due to the shortage of electricity, citizens' trust in the government has been declining because the government fails to fulfill some of its promises with regard to electricity.

e) The energy mix method of electricity generation would lead to fall of electricity prices and benefit more population with low income, giving them access to electricity.

Generally, electricity has proved to be a significant tool towards development of all sectors in Tanzania, capable of stimulating economic growth. The establishment and development of power plants for the energy mix might sound expensive but still Tanzania is endowed with abundant resources that can be turned into capital for electricity project investment. This study has revealed some issues that need to be dealt with the successful establishment of the energy mix project including political will of the leaders, improved infrastructure for electricity generation, research and development, human capital development, technology adaptation and innovation.

5.2 Policy implications

This research project examined how the energy mix method can be used for generating electricity in order to meet the rapidly growing demand for electricity in Tanzania. The findings of this study imply that the energy mix method is the best potential approach that Tanzania can adopt in addressing electricity shortages. Among other issues there are various policy matters to be addressed for the effectiveness of the energy sector to have better implementation of this big project. Policy issues to be addressed include:

a) Energy institutional responsibility and accountability should be promoted and strengthened by decentralized functions of sections in energy sector.

b) Enhance capacity building and training development for knowledge acquisition in all levels from top to bottom cadres and personnel positions in energy sector. This should also involve the adaption and use of new technology in electricity production, distribution, and transmission.

c) The government's acceptance and readiness to establish the energy mix projects is also important for successful implementation. This method of electricity generation

requires a lot of funds for investment. From this perspective the government should be ready to plan the ways through which capital can be accumulated to facilitate the projects' establishment. The government should develop policies that will help raise funds from domestic sources such as mining, agriculture, tourism, and tax and revenue collection reforms. The government can also apply for loans from international institutions like the World Bank and IMF. The obtained fund from the international institutions and other sources is a fundamental capital investment on infrastructures for alternative energy sources.

d) To ensure effective implementation of the energy mix projects, the government has to develop a national energy strategy that will set guidelines and frameworks for the construction of the projects in phases in a given period of time. This should be associated with regular monitoring and evaluation of the projects in order to identify areas of modifications.

5.3 Benefits expected from the study

This research project can help the policy makers with regard to the mentioned policy implications. It may as well help institutions, groups, and individuals who might be interested on energy mix system and electricity generation issues as investigated throughout the study.

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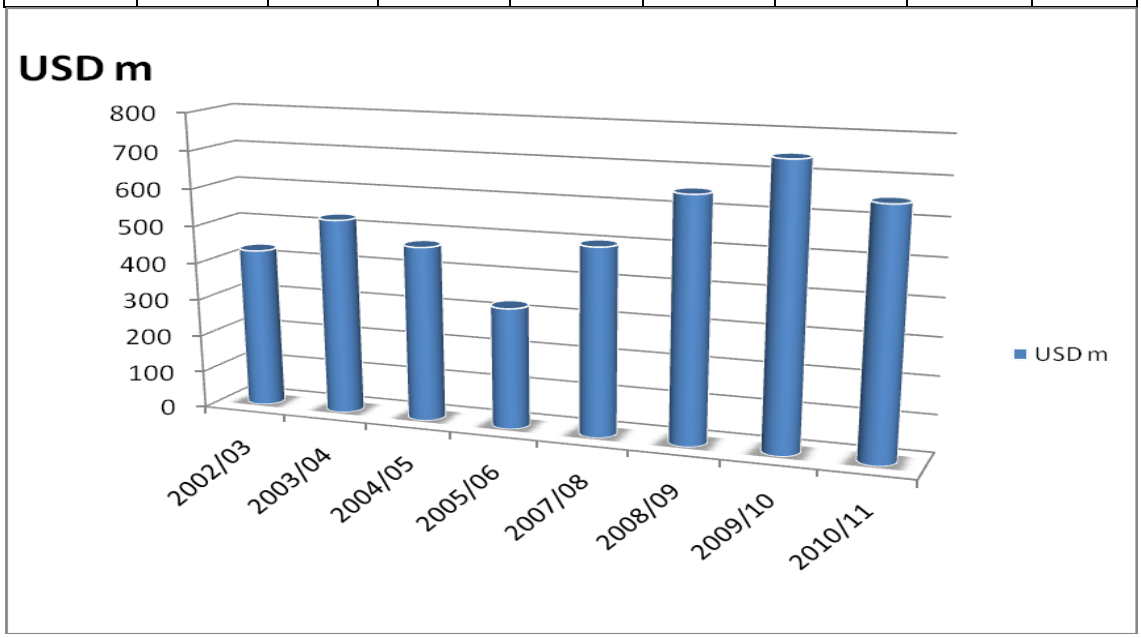
APPENDIX

Appendix 1

Data used to determine the level of FDI inflow in Tanzania (2002-2011)

Year	02/03	03/04	04/05	05/06	07/08	08/09	09/10	10/11
USD m	430	526.8	469.9	325	501.5	647	744	650



Source: BOT & TIC (Tanzania)

Statistics for Real GDP Growth Rates in Tanzania (2001-2010)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Real GDP Growth (%)	**6.0**	**7.2**	**6.9**	**7.6**	**7.4**	**6.9**	**6.8**	**7.5**	**5.5**	**5.7**

Source: African Economic Outlook 2010-OECD