Uganda Solar Energy Utilization: Current Status and Future Trends

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Abstract- Solar energy is gaining attention worldwide as the most promising alternative and reliable source of energy. With increasing population and development, Solar energy in Uganda is receiving increased energy demand which can only be met through exploring other alternative sources of energy rather than heavily relying on traditional sources like charcoal, gasoline firewood and hydropower. The country lies along the equator and has a very high potential for solar energy production. The government has started various projects on solar energy production, though it's not able to meet the demand especially in the rural areas of the country that are mostly not connected to national electricity grids. At the same time there are no huge investments in this sector especially from the private sector since they are associated with minimal returns and high cost of investment. Most consumers rely on small scale photovoltaic plants for domestic application which are at times regarded insufficient sources of power especially if one is considering using it for industrial production, The rules and regulations in place are not being implemented adequately making the situation not any better since they cross cut in all energy power generation industries, with no subsidies to encourage higher investments in solar energy. To effect investment in solar energy, local financial institutions opt to partner with international financial institutions dedicated to fund renewable energy specifically solar. This will help to offset some of the interest rates currently hindering most people from accessing renewable energy loans and will increase access to solar energy.

Keywords: Solar energy, photovoltaic (PV), solar energy technologies, renewable energy, Solar Energy Investments

I. INTRODUCTION

The sun is a natural nuclear reactor that releases energy called photons, they travel 93 million miles from the sun to Earth in about 8.5 minutes[1]. Enough photons impact our planet to generate enough solar energy in about sixty minutes to theoretically satisfy global energy needs for an entire year[2]. A 2017 report from the International Energy Agency shows that solar has become the world's fastest growing source of power, marking the first time that solar energy's growth has surpassed that of all other fuels (Krishna Engineers & Consultants 2016). Solar power is arguably the cleanest, most reliable form of renewable energy available[3]. In Uganda the sun's rays are almost directly overhead due to its location along the equator and has average temperature of 21 °C and 23 °C (70 and 73 °F)[4][5][6].

Uganda is endowed with 5-6 kWh M^2 radiation 7 per day on flat surfaces [7]. The insolation is highest at the Equator. However, varies up to a maximum of 20% from place to place away from the Equator, the dryer areas (north-east) have highest temperatures and lowest in the mountainous areas (south-west) of the country[8][6]. Cloudy weather influences solar radiation. Temperature variations throughout the year are little making it easy to use solar power as an alternative source of renewable energy.

The country is endowed with renewable energy resources for energy production and the provision of energy services. The total estimated potential is about 5,300 MW[9]. These resources remain largely untapped, this is due to the perceived technical and financial risks. Hydro and biomass still dominates electricity generation[10]. In the recent past solar power has received increasing attention by investors as well as a promising potential for exploitation of geothermal energy.

Solar energy has being used with appropriate technology for cooking food, water heating, refrigeration, lighting, telecommunications, and many others.

However, Solar is becoming an important source of electricity , because of the escalating tariffs and the scarcity of electricity from the conventional hydro- and thermal- power generation in the country[11]. This is attributed to the high operational costs of the existing and planned thermal power plants and the failure to develop other alternative electricity sources such as co-generation, wind and geothermal sources which have been seen as promising potentials for energy generation in Uganda[12].

This is further made worse by the recent separation and privatization of the energy sector into many entities, namely; Electricity Regulatory Authority (ERA), Uganda Electricity Generation Company Limited (UEGCL), Uganda Electricity Distribution Company Limited (UEDCL), Uganda Electricity Transmission Company Limited (UETCL) and concessionaires ESKOM and UMEME which

all depend on a single tariff for their operations and maintenance, resulting into excessively high prices and unaffordable tariffs that are currently being charged on the electricity[13]

Solar energy has the potential of reducing the current demand exerted on the existing national grid-based power and consequently eradicating Uganda has launched a 19 million and 19.6 million U.S. dollars solar power plants in the remote eastern districts of Soroti and Tororo respectively[14]. The projects which are the largest in East Africa are the latest addition to Uganda's power generation plants, to feed its increasing demand for power as the east African country strives to fast track its development.

According to International Energy Agency (IEA), about 1.2 billion people worldwide lack access to electricity, with approximately over 620 million of these living in sub-Saharan Africa[15]. In terms of energy access, East Africa is greatly the affected region in the continent [16].These statistics explain extremely serious situation faced by many East Africans, mainly those in rural areas. Even those that are lucky enough to have access to electricity, they also experience sporadic service flows and yet costly, hence this means that there is need to exploit all the available sources to get energy to ensure uniformity of access.

Demand for electricity has also been growing which is influenced by the increasing population. Statistics from the energy regulatory agency in Uganda indicate that peak demand for power is growing by 15% every year. This is crucial in an economy that is expanding fast and aimed to give half of its 41 million people access to electricity by 2017[4].

In Uganda, 85% of the population does not have access to electricity and that number is rising with the increase in population and urbanization[17]. The government has long regarded solar energy as the only feasible option for renewable energy generation. According to the renewable energy policy of 2013, the country has a solar electricity potential of about 200MW, 1650MW from biomass, 800MW from peat, 2200MW from hydropower stations and 400MW from geothermal energy.

Recent survey on use of solar power shows that there are more solar energy consumers in the south-west and central regions than in the other regions in the country. This is due to the government's program that support use of solar energy called the Uganda Photovoltaic Pilot Project on Renewable Energy (UPPPRE) that was conducted in these regions and also due to the presence of Non-Governmental Organizations (NGOs) and churches in the regions that offered soft loans and credits to people interested in using solar technologies.

To increase the consumption of solar energy, the government has built two 10MW solar power plants, the largest in East Africa, in its eastern districts of Soroti and Tororo at a cost of USD 19 million and USD 19.6 million respectively that are estimated to connect electricity to around 75,838 (40,000 in Soroti and 35,838 in Tororo) residents[18]. It is Uganda's first grid-connected solar plants as the country looks to raise power generation capacity to 1,500MW by 2020, from the current 850MW. The power plants have the potential to increase their net output capacity by further 20MW of solar energy[18]. Rural Electrification Agency (REA) estimates that so far over 30,000 solar PV systems have already been installed to in rural areas in the country and still there are huge unexploited solar energy resources. The figure below shows the solar PV data in terms of area in kilometers per year.

Table: 1 Solar Photovoltaic data

	KM^2 OF CSP	PV
Total Area	241,278	241,278
Exclusion Area	30,828	30,828
1,800-2,000 kwh/m2/year	1,742	_
2000-2500 kwh/m2/year	203,108	210,450
2500-3000 kwh/m2/year	5,600	0

Source: *HERMANN ET AL. 2014*

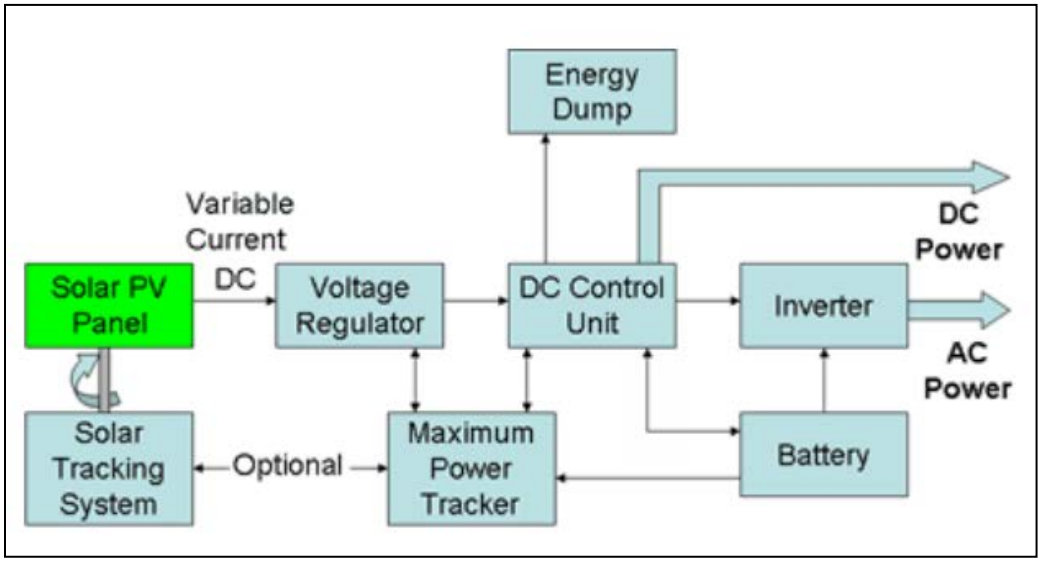
Solar energy can be converted to electricity on and off-grid through photovoltaic or concentrated solar power (CSP) technology. About 200,000 km^2 of Uganda's land area has solar radiation exceeding 2,000 kWh/m^2 /year (i.e.5.48 kWh/m^2/day) this is a high potential for solar power investment[12].

1.1. Generation and transmission of solar energy

Solar panels convert the sun's light into usable solar energy using N-type and P-type semiconductor materials. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity[19][20]. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect. Current technology solar panels convert most of the visible light spectrum and about half of the ultraviolet and infrared light spectrum to utilized solar energy.

Most of the solar energy users have installed solar panels in their homesteads hence no need for power transmission. However, with the increased projects in solar energy production by the government, transmission lines are necessary to ensure that the power is supplied to the end users. Electricity lines are therefore constructed from the power grid and those that pay the initial connection fee are connected to the grid. The below diagram shows the basic building blocks of a small stand-alone off-grid PV power generating system.

Figure 1: Small Scale Photovoltaic Plants and Domestic Application.

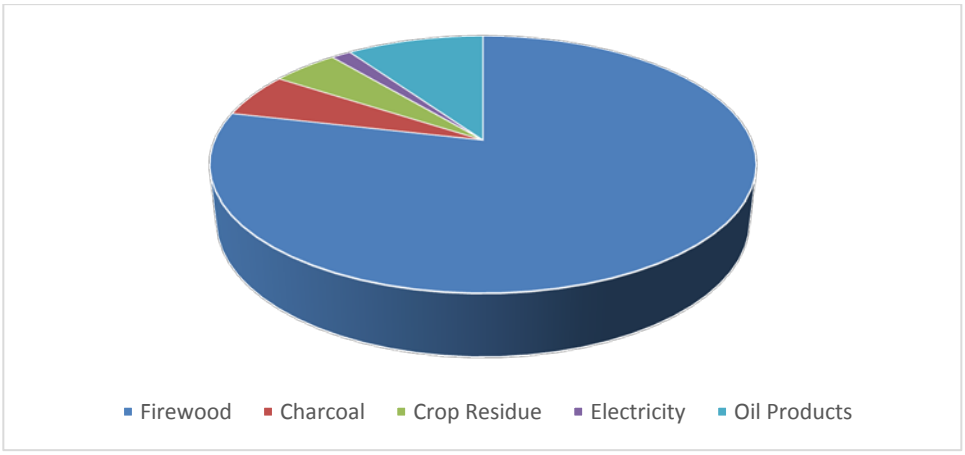


Source: *Performance evaluation of hybrid adaptive neuro-fuzzy inference system models for predicting monthly global solar radiation*

1.2 Total Energy demand in Uganda and contribution from each source

Uganda has a total primary energy usage of 0.0593 quadrillion Btu which equals to 14.94 million tons of oil equivalent[21]. Biomass is still the most viable source of energy for the majority of the Ugandan population especially in the rural areas. About 90 percent of the total primary energy consumption is generated through biomass, this includes firewood (78.6 percent), charcoal (5.6 percent) and crop residues (4.7 percent)[4]. This has accelerated to the high rates of deforestation to supply the ever increasing energy demand. Electricity contributes 1.4 percent to the national energy balance while oil products, which are mainly used for vehicles and thermal power plants, account for the remaining 9.7 percent.

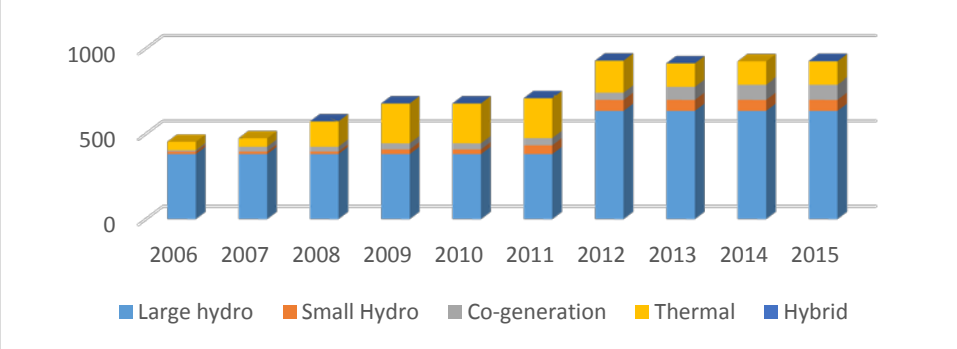
Figure 2: Uganda Energy Demand



Source: *A. M. Mueller, Energy Sources in Uganda and Solar Radiation*

The figure below shows the major sources of energy generation in Uganda, from 2006 to 2015, Hydro power generation still being used for industrial used, charcoal and firewood are highly consumed as a source of energy at household level both in rural and urban areas with very minimal utilization of the solar energy. The situation is however expected to be different by 2050[11].

Figure 2: Uganda's Energy Generation Capacity by types 2006-2015 in MW



Source: *MEMD 2015 Statistical Abstract.*

1.3 The Energy Cost and its Effects on Economic development

The cost of energy in Uganda is relatively higher than that of most of the east African countries like Kenya and Tanzania. Although the country has a surplus that it supplies to its neighboring countries the end user ends up paying a larger amount than the beneficiaries.

The tariff for domestic consumption is at 520.6 UGX which ranked the highest in East Africa. This is as a result of the enormous(52%) price increase in 2012, almost the cost-covering end-users prices[22]. Currently, the end consumer retail tariff is based on consumer category as illustrated in the following table. However, to cater for the poor, the lifeline tariff was not increased and remains at UGX.100 per unit up to 15 kWh per month. The table below shows all the Umeme tariffs in 2014

Table 2: Energy Cost in Uganda in Uganda's Shillings

Charge	Code 10.1 (domestic)	Code 10.2/3 (Commercial)	Code 20 (medium industrial)	Code 30 (large industrial)	Code 50 (street lights)
Average	520.6	474.4	458.9	310.4	488.8
Peak	-	569.7	542.3	373.7	-
Shoulder	-	475.0	452.2	311.6	-
Off-peak	-	354.0	371.0	232.5	-

Source: Energypedia 2018(https://energypedia.info/wiki/Uganda_Energy_Situation)

Maintaining the current economic growth and ultimately achieving sustainable development is a challenge that calls for proper and friendly energy pricing. Development is a key input in the overall strategic planning cycle and therefore energy policy and pricing makers should recognizes the linkages between the energy sector and the other sectors[3][23]. Considerations to address energy problems and prices have to be taken in specific policies such as economy, environment, water resources, agriculture, forestry, industry, health, transport, education, decentralization and land use.

1.4 Barriers to large scale development of solar energy

Despite the fact that a great percentage of the total required energy in Uganda can be generated from solar power this has not been the case mainly due to the various factors discussed below.

Table 3: barriers in developing large scale use of solar energy.

Category	Discussion	Source
Economic / financial barriers	High initial cost of installation, maintenance and repairs.as well as the risks related to the suitability and reliability of technologies and to the solvency degree of the project.	[24]
Legal / institution barriers	lack of stability of incentives for the adoption of photovoltaic like inconsistencies between policy measures and socio economic factors, or the sudden removal of existing subsidies	[25]
Political / policy issues	Lack of long term policies, lack of political will to diversify into clean energy, constantly changing of government and reshuffling institutions.	[24]
technology	The risks directly related to technology are high. Because the technology is at a development stage, the risks are not clearly known even if the same technology is working else where	[25]
Market	Competition from wealthier industries that benefit from subsidies and incentives and difficulties in market entry as most investors want large quantities of energy, ideally at times when solar aren't available.	[26]
Siting and transmission.	Locating solar farms in and transmission lines requires negotiations, permits contracts and community approval which increase the cost and duration of the projects.	[27]
Social/ behavioral	General information and awareness in relation to new technologies and understanding the practical Problems in implementing and maintaining projects is limited	[24]
Institutional barriers	Lack of coordination and cooperation within and between various ministries agencies, institutes and other stakeholders delays and restricts the progress in solar energy development.	[24]

II. SCALES OF SOLAR PV GENERATION IN UGANDA

Uganda government is committed to increasing the country's use of modern, renewable energy. Uganda has an electrification rate of 18%, with 8% recorded in rural areas, Uganda like most Sub-Saharan African countries rely most on traditional energy mostly hydro power generation, hence making the scale of photovoltaic solar generation minimal. However, in 2016, Uganda government through the Electricity Regulatory Agency (ERA) partnered with institutional donors such and private investors construct two large Solar PV plants in Soroti and Tororo in North-Eastern and Eastern Uganda respectively.

2.1 Soroti Solar PV Power Plant.

The rural Soroti region is heavily dependent upon subsistence farming and has high levels of unemployment. Gathered fuel wood is the main source of energy in the country. The Government of Uganda are commitment to increase the country's use of modern, renewable energy to 100% by 2040. Soroti solar power plant is a fixed tilt solar PV power plant. Solar power projects require long-tenor loans and can experience difficulty in attracting willing long-term capital investors Soroti Sola project cost USD 19 Million in total, a partnership between the government of Uganda through Electrification Regulatory Agency (ERA) and the Netherlands development bank, and the Emerging Africa Infrastructure Fund (EAIF), a facility of the Private Infrastructure Development Group (PIDG), which includes Australia, Germany, The Netherlands, Norway, Sweden, Switzerland and the United Kingdom, and the World Bank group. EAIF provided Access Soroti with a US$5.35m loan with a tenor of 17 years. The project mobilized an additional US$14.2m from commercial and development finance sources as well as GET FiT program. To ensure that the tariff for the electricity generated by Access Soroti can be competitive with other energy sources. Access Uganda Solar, will sell power to the Uganda Electricity Transmission Company Ltd (UETC Ltd) under a 20 year Power Purchase Agreement.

The plant will help Uganda to overcome its current energy shortfall. It is estimated that the project will cut Uganda's carbon emissions by 264,355 tons per annum. By adding 10MWp to Uganda's national grid, the plant is expected to benefit around 32,250 people. Electricity will be generated at a cost of USD 0.11/kWh, allowing energy prices in Uganda to remain low. By providing grid stability to Soroti, the plant will stimulate economic growth and increase productivity. As the largest privately owned solar plant in Uganda, Soroti will act as a catalyst for further solar projects in the country and other countries in the region.

2.2 Tororo Solar PV Power Plant.

Building Energy multinational company operating as a Globally Integrated IPP (Integrated Power Producer) in the Renewable Energy Industry, manages **Tororo Solar Plant**, its first photovoltaic system in Uganda, located at around 10 km from the border with Kenya. With a capacity of **10 MWp (16 GWh per year)**, the Tororo Solar Plant is among the largest in Eastern Africa. Uganda's 10MW solar power plant in Tororo will provide energy needs for 35,838 families a funding from the European Union and partners Consisting of **32,240 photovoltaic panels** distributed over a **14 hectare site**, the facility is designed to generate around 16 GWh of energy annually, catering to the energy needs of more than 35,838 people. In addition to covering the community's energy needs, the

Tororo Solar Plant is fostering clean industrial development in the town of Tororo and at the same time **save atmospheric emissions of more than 7,200 tons of CO2** per year, corresponding to the consumption of around 2,800 petrol-powered.

Like the Soroti Solar Plant, the Tororo Solar Plant was developed under the Global Energy Transfer Feed in Tariff ("GET FiT"), a dedicated support scheme for renewable energy projects managed by Germany's KfW Development Bank in partnership with Uganda's Electricity Regulatory Agency (ERA) and funded by the EU-Africa Infrastructure Trust Fund, the governments of Norway, Germany, and the United Kingdom. The GETFiT program helps renewable energy sources become more affordable and therefore more accessible in Eastern Africa.

The EU-Africa Infrastructure Trust Fund has provided funds through the GETFiT Solar Facility equivalent to 7,08 million euros in the form of a top-up payment per kWh of delivered electricity over 20 years. The financing aimed at filling the gap between the generation costs and the feed-in tariff set by Uganda Electricity Transmission Company Limited (UETCL) through a Power Purchase Agreement (PPA).

The project cost an overall **$19.6 million** investment at Tororo. Which was partially funded by **FMO**, the Dutch development bank which, as Mandated Lead Arranger, coordinated the provision of a **$14.7 million t**erm loan facility. Fifty percent of the funding was syndicated to the Emerging Africa Infrastructure Fund (EAIF), while the overall equity contribution of the shareholders was $4.9 million. EAIF is a member of the Private Infrastructure Development Group, which is funded by the UK, Switzerland, Australia, Norway, Sweden, Netherlands, Germany and the World Bank Group.

2.3 Green Technology Bank

The Green Technology Bank is a technological bank implementing the 2030 agenda for Sustainable Development in the green technology field. During the opening ceremony of the United Nations Climate Change Conference in Paris December, 2015, the Chinese President Xi Jinping stressed the need to establish a fair and effective mechanism to deal with climate change by focusing on the need to realize a high-level sustainable development of the world and constructing an international relationship of cooperation and mutual benefits. This later was conceived by the People's Republic. Again Li Keqiang during his chairing the 2030Agenda for Sustainable Development in New York's UN Headquarters issued Chinese National Plan on implementing the Agenda 2030, which made clear that China the need for China to establish and implement the Green Technology Bank hence in 2016 GTB was launched and the construction commenced which was completed in 2017 and officially opened.

2.3 Green Technology Bank Major Focus.

The Bank focuses on Information, Financial and Technology Transfer platforms, the information platform looks at technical demand, technology transfer mainly concentrate on enterprise, institution and intermediary whereas the financial looks at industrial fund, Bank and other capital markets.

2.5 Green Technology Bank Main Business.

The Green Technology envisioned five major business models each with its function, these includes the following;

Providing green technology transfer and transformation services, these encompass, testing, screening, evaluation, system integration, as well as package systematic solutions by centering

Providing financial support to the whole chain of green technology transfer and transformation. This business establishes green technology financial services platform by developing suitable financial products for the whole chain green technology transfer and transformation, setting up the green industry fund, facilitating the capitalization and securitization of green technology as well as promoting international cooperation on green finance.

Providing Comprehensive Solutions for Corporate Green Technology Development. By innovating new modes and new products combining green technology with finance and other elements, assisting enterprises in using and developing green technology, supporting the reforms and upgrading of corporate green technology, and sharing the emission reduction benefits or corporate public offerings.

Providing Systematic Regional Green Development Solutions to Local Government. Proving regional green development plan and projects design and integrated supply of the technology system, allocating financial solutions, exploring the local financial investments and social capital cooperation mode, and offering one-stop service including project evaluation, screening, consulting, think tank platforms.

Providing the Internationalized Transfer and Transformation of Green Technology. Replicating and promoting the successful application of mode of green technology industrialization in China, expanding the green development markets in developing countries,

facilitating the international green technology storage and re-innovation towards developed countries, and building the international network for green technology transfer and transformation.

III. FUTURE TRENDS IN SOLAR ENERGY CONSUMPTION IN UGANDA.

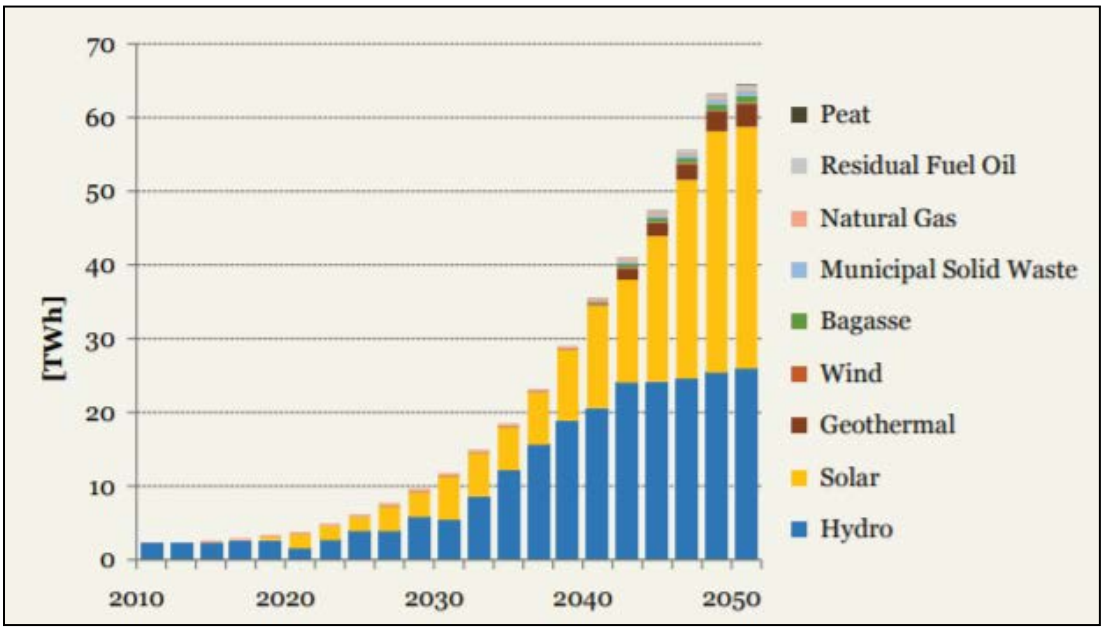
Uganda's economy and population is growing fast and so are its power needs, according to a report by ministry of energy it is expected that by 2050, electricity demand in the country will quadruple[28][8]. The need to use solar and other renewable sources of energy will be no longer an alternative but a must do thing.

The government has therefore started to partnership with the private sector energy providers that can build solar plants in Uganda learn them for agreed duration of time and later transfer them to the government[9]. Loans and grants to finance solar power projects is another undertaking that the government has come up with some of biggest multilateral lenders including the World Bank, the European Investment Bank, and the African Development Bank joined in with private financiers, such as South Africa's ABSA Capital and Standard Chartered Bank[28].

Ministry of energy has also come up with new Policies that are compatible with the global and regional energy policies. They acknowledge international and regional energy trends, especially in areas of energy investment, pricing and global impacts[29][30]. Since 2010, solar energy use has been gaining an upward trend[9][30].

Data available and projections indicate that by 2050 solar energy will surpass hydropower in terms of the most used renewable energy in the country[31]. Figure clearly shows the current situation and expected future trends.

Figure 4: Renewable Energy use Future Predictions.



Source: *organization for economic, energy the next fifty years.*

Solar energy is a global phenomenon on the upswing and Uganda is part of this, for a foreseeable future its growth is set to accelerate. However priorities and decisions that are made now will determine how future societies benefit therefore it's the responsibility of the government to ensure that progress is made in the right way.

3.1 Environmental impacts of solar power

Energy generation and transmission methods have significant effects to the environment. The conventional energy generation options have higher negative impacts that damage the air, water, climate, soils, wildlife, landscape as well as raise the levels of harmful radiation[32]. Renewable energy technologies are substantially safer hence offering a solution to many environmental and social problems associated with energy generation.

Solar energy does not pollute air, water or cause greenhouse gases. Solar energy can have a positive, indirect effect on the environment. Using solar energy replaces or reduces the use of other energy sources that have larger negative effects on the environment. Although, some toxic materials and chemicals are used to make the photovoltaic (PV) cells that convert sunlight into

electricity[33][34]. Some solar thermal systems use potentially hazardous fluids to transfer heat. Leaks of these materials which can harm the environment and cause health effects to human beings and animals.

However, environmental effects from solar energy technologies are usually minor which can be minimized by appropriate mitigation measures. The potential environmental burdens of solar energy are regularly site specific, depending on the size and nature of the project.

3.2 Recommendations

In Uganda the government should review the policies that are in place to favor investments in solar energy sector by changing the allocation of funds and proper control of revenues from the investments. The policies should outline and accommodate the role of investors in the energy sector; this will attract both international and local investors since the business environment will be accommodative.

Uganda government should also encourage partnership between local and international banks. As seen in the Green Technology Bank above, it can be an opportunity for Uganda local banks to benefit from the initiatives that the Green Technology Bank has put in place, the framework is so comprehensive in nature that it can address all problems related to technology diffusion in Uganda hence will lead to acceleration of investment as well as reducing the greenhouse gases (GHG).

The government should also consider reviewing laws and regulations and add articles/clauses that allow direct grants and investments in which funding can be transferred directly to recipients, especially at community revel, thus making projects wholly owned by community initiatives. Experts can help in Management but at the same time the communities will be in charge to ensure transparency, free competition and non-discrimination especially when it comes to power distribution.

Change in Perception by the Policy makers is a very important factor for full utilization of solar energy to be achieved; they are often preoccupied with electricity and liquid fuels. Solar energy is associated with low income populations and low revenue making businesses, with accompanying concerns over environmental degradation, and as such is given low political priority.

Tax incentives and subsidies on solar related products, though there are no taxes levied on solar panels, other products that complete the package of solar energy generation are still taxed for example, batteries, by subsidizing these, access to solar energy will be affordable that help improve the economics of either initial investment or operations in solar energy technologies. Investors can make profits and at the same time the end user will be charged reasonable prices that will help them put into consideration using solar energy instead of the other non-renewable energies available in the country hence will lead to reduction of greenhouse gases (GHG) that cause global warming.

Political commitment of the government and financial institutions solar energy sector is a necessity since this is one of the major barriers towards achieving the utilization of solar energy. Politicizing this makes it difficult for the results to be a achieved since each leader will argue on the basis of what is favoring their situation. It is therefore the responsibility of the government to ensure that decisions in the solar and other renewable energy sectors are not left in the hands of the politicians.

Ensure that the framework selected while implementing the solar energy projects has built-in provisions to allow for flexibility in the event of significant market changes or unintended consequences of incentive and tariffs schemes. This will ensure effectiveness for the long term and that the best interests of the country are met, some possibility for change is required. At the same time, any such change should be circumscribed within defined parameters that include mechanisms to measure progress toward solar energy goals, to allow for maximum predictability and minimal investment risk.

IV. CONCLUSION

Solar energy as one of the most promising renewable and environmentally friendly energy sources available in the world today. To meet the increasing energy demand there is need to diversify the energy sector through increased investment into other renewable energy sources, chief of which should be solar energy. Uganda inadequate access to modern energy services and safe supply of power is affecting the entire society. The Government and stakeholders in Uganda are working hard to tackle these challenges and one of the solutions towards achieving 100% renewable energy by 2040 is by increasing production and transmission of solar energy for off-grid citizens. On the other hand social and environmental benefits that derived from use of solar energy are already felt and are overwhelming.

APPENDIX

Abbreviation

i. ABSA- Amalgamated Bank of South Africa
ii. CO_2 – Carbon Dioxide
iii. CSP – Concentrated Solar Power
iv. EAIF—Emerging Africa Infrastructure Fund
v. ERA--Electricity Regulatory Agency
vi. EU- European Union
vii. FMO- Financierings-Maatschappij Voor Ontwikkelinglanden (Netherlands Development Finance Company)
viii. GET-FiT- Global Energy Transfer Feed in Tariffs
ix. GTB- Green Technology Bank
x. GWh- Giga watt hour
xi. KM^2 – Kilometers Square
xii. KFW-Kreditanstalt Fur Weideraufbau (German Development Bank)
xiii. KWh/M^2-Kilo watt hour per Meters Square
xiv. Mtoe-Million Ton of Oil Equivalent
xv. NGO- Non Governmental Organization
xvi. MW- Mega Watt
xvii. PIDG- Private Infrastructure Development Group
xviii. PPA- Power Purchase Agreement
xix. PV- Photovoltaic
xx. UETCL-Uganda Electricity Transmission Company Limited
xxi. UPPPRE-Uganda Photovoltaic Pilot Project on Renewable Energy
xxii. UGX- Uganda Shillings
xxiii. UN- United Nations
xxiv. UK- United Kingdom
xxv. USD- United States Dollars

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