AIMS | African Institute for Mathematical Sciences RWANDA

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Forecasts for Energy Demand and Production

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1 Introduction

The rapid growth of population in African continent has had huge impact on climate change and the energy sector. This has led to adoption of new technologies and innovations in order to meet the increasing energy demand[1].

Energy demand simply refers to how much energy is needed by the various sectors in order to carry out their operational activities. For many Governments, this has been done through energy forecasting in order to have credible statistics that are mostly used for planning.

Energy is the capacity to do work and it can be broken down into renewable and non-renewable sources.

1.1 Renewable Source of Energy

This is the source of energy that is unlimited, continuous and can't be easily depleted. They include: Solar energy, wind, hydro power and tidal. Generally renewable sources provide clean (environment friendly) energy.

1.2 Non-Renewable Source of Energy

This is the limited source of energy and they include: oil, coal, and peak.

2 Forms of Energy in Rwanda

Historically, many African households depended on biomass as a form of energy for domestic use. This has had adverse effects on climate change. Energy from biomass involved cutting down of trees in large numbers and many of the Africans weren't willing to grow more trees in order to meet the energy demands. Several governments took it upon themselves to promote other forms of energy in order to tackle the effects created by wide use of biomass.

In Rwanda there are so many forms of energy. However, the most commonly used forms of energy include:

- Biomass
- Solar Energy
- Hydro Power
- Gas
- Biogas

2.1 Biomass

In the olden days, firewood was widely used in Rwanda. This was because trees were readily available and many of the people didn't know the long term effects of deforestation on their environment.

With the increasing concerns and adverse effects of deforestation, many people have been encouraged to adopt other forms of energy that are environment friendly. This has been adopted by many average earners and it has since promoted the climate change campaign in Africa.

2.2 Solar Energy

Solar energy is one of the clean forms of energy. This energy is obtained by concentrating light rays on a solar panel and it has been adopted mainly for domestic use and for small scale businesses.

2.3 Hydro Power

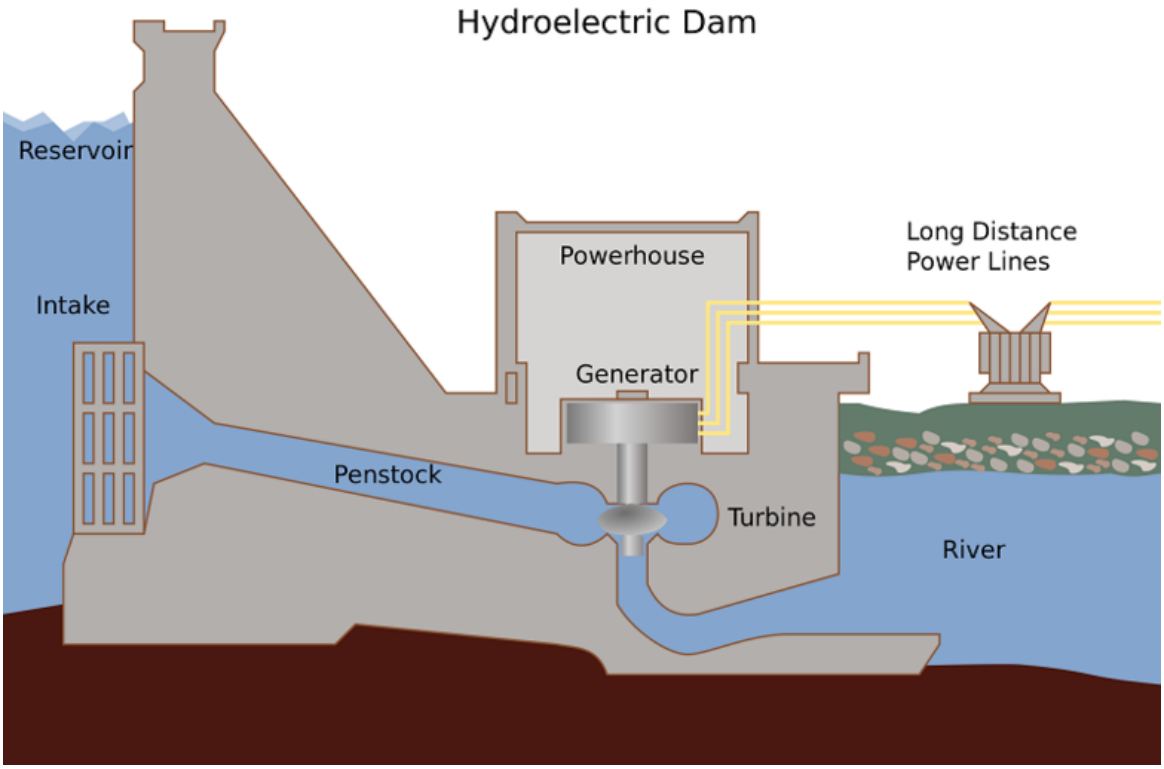

Figure 1: hydroelectricity (Source: **University of Calgary, Energy Education**)

Generation of hydroelectricity

Hydroelectricity is generated by moving water.
Water of density, ρ accumulated in a reservoir of volume,V is at a height, h above the turbine. This water has got mechanical energy(ME).

$$ME_{Water} = \rho V g h$$

Then water of mass, m then flows and falls on the turbine with velocity, v. At this point the mechanical energy of the running water is:

$$ME_{Running\_Water} = \frac{mv^2}{2}$$

The mechanical energy of the running water is therefore used to run the turbines by principle of conservation of energy. This principle states that energy is neither created nor destroyed but can be transformed from one form to another.
The rotation effect of the turbine then powers the generator connected to it which eventually produces the electrical energy[4].
Electrical Energy is given by:

$$E_{Energy} = VIt$$

Where V is the voltage, I is the current and t is the time taken. This electrical enery is stepped up using a step up transformer such that it can be transported using high voltage line to distant places. This is done to minimise energy losses. At the site of consumption, the voltage is stepped down using step down transformer to avoid destruction of appliances by the high voltage.

This energy has been adopted in Rwanda to meet the increasing energy demands for large scale use.

2.4 Energy Demand in Rwanda

There are various factors influencing energy demand in any developing country. In Rwanda these factors include but not limited to:

2.5 Population Growth

Primarily, an increase in population increases the demand for energy for domestic use. Africa's population is among the fastest growing and this has huge impact on the daily demand for energy. One would argue that apart from the major basic needs such as food, clothing, energy has become a need that shouldn't be left out. This has been the reason why many governments have considered investing heavily in clean energy in order to meet the increasing energy demands in their respective countries.

2.6 Industrialisation

An increase in the number of industries in a country means more energy is needed for large scale use. With many African countries such as Uganda promoting campaigns such as *Buy Uganda, Build Uganda (BUBU)*, this means that more room is given to local production. This has increased energy demands for industrial use[2].

2.7 Civilisation

Civilisation in common terms refers to any development in a given place. In Rwanda, the establishment of African Institute for Mathematical Sciences (AIMS) significantly increased the energy demand in the area.

Civilisation also include creation of many businesses and these businesses need energy in order to carry out their day to day operations.

3 Energy Forecasts in Rwanda

Five years after the World Energy Outlook's first special report on Africa, the International Energy Agency has updated and expanded its outlook for the continent based on in-depth, data-rich and country-specific analysis[3].

However, there is still more research needed to gather data about Africa's energy demand. This has created a big gap in forecasting energy demand in Africa.

Our research therefore limited itself to the analysis and forecasts done by the Global Economy about electricity production and consumption in Rwanda.

3.1 Electricity Production in Rwanda

The Global Economy provided data for Rwanda from 1980 to 2017. The average value for Rwanda during that period was 0.21 billion kilowatthours with a minimum of 0.09 billion kilowatthours in 2001 and a maximum of 0.68 billion kilowatthours in 2017.

Total electricity net generation (Net generation excludes the energy consumed by the generating units).

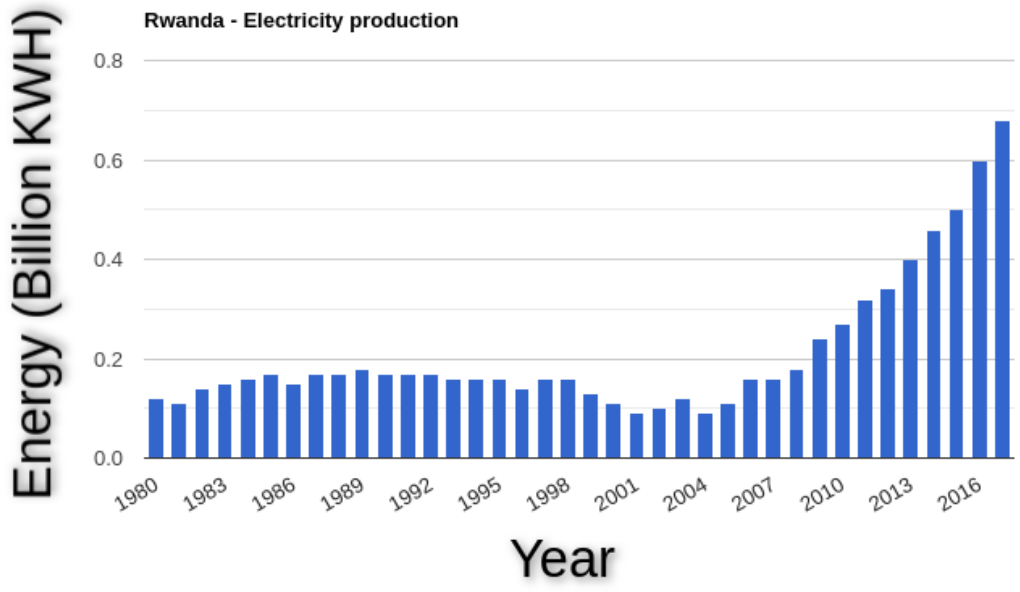

Figure 2: electricity production (Source: **The Global Economy**)

3.2 Electricity Consumption in Rwanda

The Global Economy provided the average electricity consumption value for Rwanda from 1980 to 2017. During that period, it was 0.26 billion kilowatthours with a minimum of 0.15 billion kilowatthours in 1981 and a maximum of 0.81 billion kilowatthours in 2017. The latest value from 2017 was 0.81 billion kilowatthours.

Total Electricity Net Consumption = total net electricity generation + electricity imports − electricity exports − electricity transmission and distribution losses.
Net consumption excludes the energy consumed by the generating units.

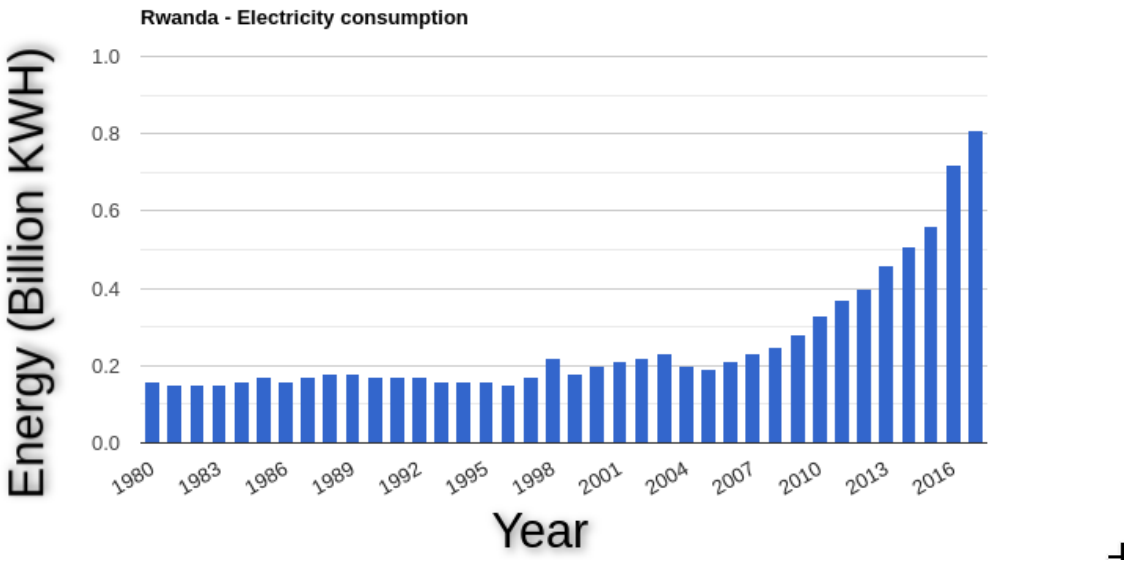

Figure 3: electricity consumption (Source: **The Global Economy**)

3.3 Electricity Forecast in Rwanda

The board then provided a forecast up to 2024 for electricity in Rwanda as shown below.

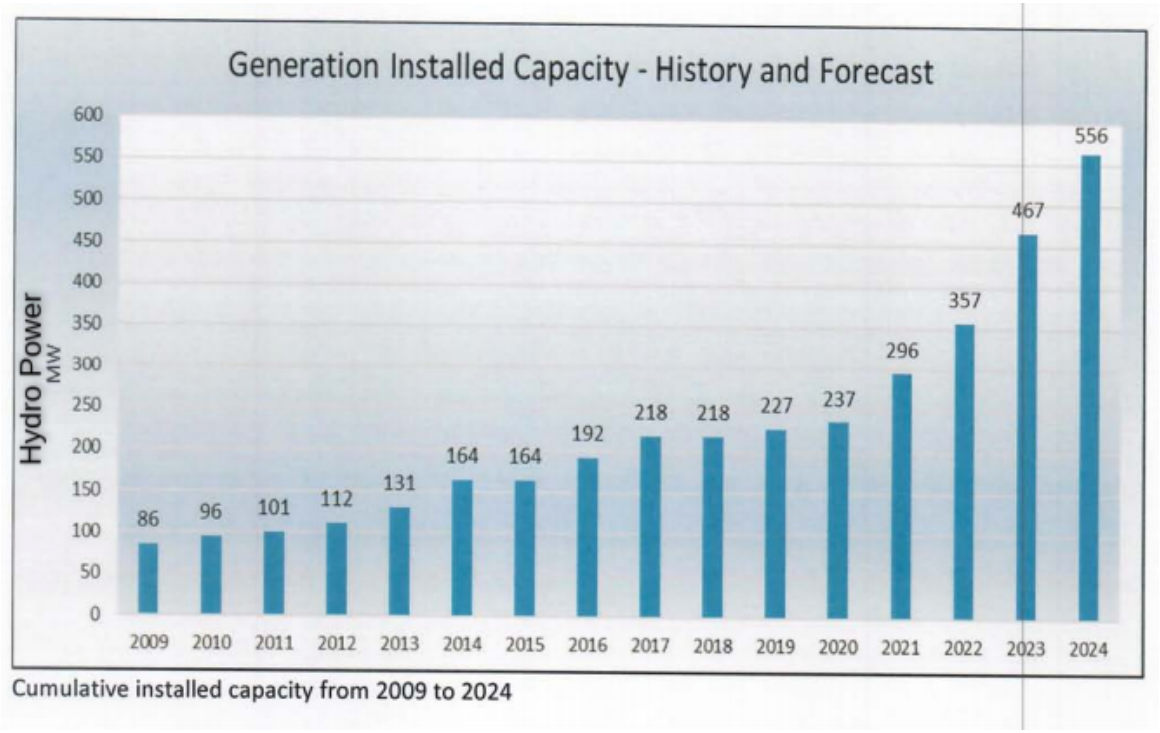

Figure 4: electricity forecast (Source: **The Global Economy**)

3.4 Overall Energy Forecast in Rwanda

The Global Economy also provided forecasts for the various forms of energy in Rwanda.

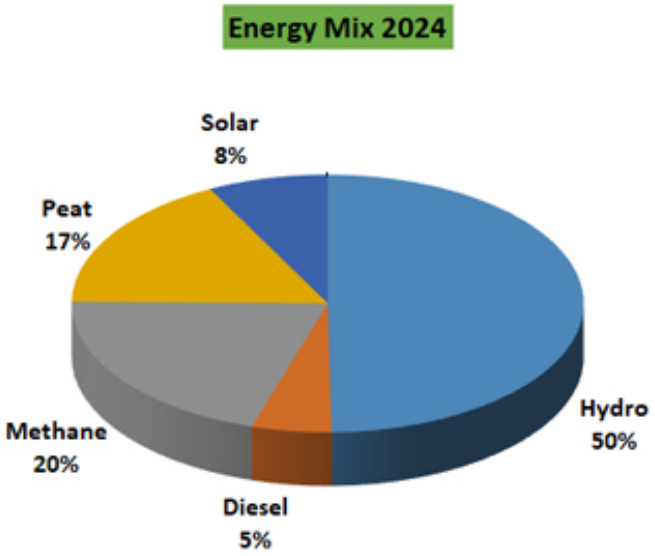

Figure 5: overall forecast for energy (Source: **The Global Economy**)

4 Conclusion

This research can be used by Governments to plan and budget for clean energy. The projections can help the African continent minimises wastage and provide evidence for the business community to make decisions.

With such data on energy demand, many regional governments can launch constructive campaigns on climate change and see themselves achieve their targets.

References

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[4] Mohammad Taleghani, Hamid Reza Ansari, and Philip Jennings. Renewable energy education for architects: lessons from developed and developing countries. *International Journal of Sustainable Development & World Ecology*, 17(5):444–450, 2010.