Rwanda Energy Sector Brief Review and Research Intervention Required

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1. Energy, Water and Sanitation Authority (EWSA) Activities

EWSA (Energy, Water and Sanitation Authority) was created in 2010 and started operation in 2011 by merging the activities previously performed by RECO – Rwanda Electricity Company & RWASCO – Rwanda Water & Sanitation Company, and Energy, Water and Sanitation Projects of MININFRA – Rwanda Ministry of Infrastructure. The main purpose of merging these activities were to ensure adequate and quality energy, water and sanitation services in Rwanda at the least costs through effective planning, investment, contracting, supply, operations and maintenance.

EWSA has a vision of contributing effectively to the growth of the national economy and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner.

The EWSA mission is to create conditions for the provision of sufficient, safe, reliable, efficient, cost-effective and environmentally appropriate Energy, Water and Sanitation services to households and to all economic sectors on a sustainable basis.

2. EWSA and the Rwanda Energy Sector

For the energy sector, the mandate of EWSA is to contribute to the goals of national socio-economic development, including the progressive elimination of poverty as per the Vision 2020 and EDPRS II. This mandate is translated into three specific goals for the energy sector:

- Ensuring the availability of reliable and affordable energy supplies for all Rwandans;
- Encouraging the rational and efficient use of energy;
- Establishing environmentally sound and sustainable systems of energy production, procurement, transportation, distribution and end-use.

To achieve the above objectives the EWSA has decided to pursue the followings:

Development of Domestic Energy Resources.

It is clearly recognized that the only option for reducing the average cost of energy supply and the burden on foreign currency resources is to develop domestic resources. In 2010, the cost of imported petroleum products accounted for 40% of the country's foreign exchange expenditure. Imported petroleum is also a major source of power generation resulting in a very high cost of delivered electricity. Energy diversification therefore has a combination of economic, financial and environmental benefits. The main alternative sources of energy are hydropower, estimated at 300 MW, renewable methane gas in Lake Kivu, estimated at 60 billion cubic meters, peat deposits of about 155 million tons, and some potential for solar energy particularly in the rural areas where electricity may be only an off-grid option. Assessment of Geothermal prospects is also pursued.
Efficient Use of Energy.

Rwanda cannot afford wasteful consumption of energy and should make the best use of existing energy supplies as well as future additions to energy supplies, and in so doing minimize the adverse environmental consequences of energy use. Energy efficiency and energy conservation should be pursued through using efficient technologies and appropriate economic incentives. Energy efficiency in the household sector should be promoted through utilization of efficient appliances. Energy efficiency in the industrial sector should be supported through energy audits and providing financial incentives.

Energy pricing and subsidy.

Energy subsidies are known to result in inefficient use of energy resources, distortion in related technologies, and a heavy burden on the government budget that would jeopardize fiscal sustainability. Therefore appropriate pricing of energy is important in giving the right signals to consumers to encourage efficient and productive use of energy and to ensure that energy suppliers can operate on a sustainable basis.

Institutional Development of the Energy Sector.

EWESA has developed the roadmap for the institutional development of the power sector based on a vision that in the very long term, the consideration of the electricity sector unbundling into generation, transmission, and distribution components is being studied, with competition being stimulated in the generation and supply segments. However, it recognizes at the outset that this vision is achievable only after taking a number of intermediate steps. These steps include creation of a national electricity utility that would operate on a commercial basis; promoting private sector participation in generation of electricity and off-grid power supply; facilitating private (domestic and foreign) investment by putting in place transparent selection and contractual procedures; ensuring independence of the regulating agency that is mandated to promote competition and issue concessions and licenses; and a clear mechanism for sector coordination and strategy.

Capacity Building.

Considering the rapid and unprecedented forthcoming expansion of the energy sector, EWSA has developed the capacity enhancement plan spanning all segments and function of the energy sector. MININFRA and all other institutions involved in energy sector management are also included in this as the need to additional skills and institutional capacity to operate effective public-private machinery that would strategize, plan, develop and operate a sustainable energy sector is crucial for Energy sector development.

3. Energy Core Areas Being Developed

Rwanda's energy consumption is dominated by biomass that accounts for about 85% of primary energy use while petroleum accounts for 11% and electricity for the remaining 4%. Despite its low share in the present energy mix, the electricity sector is considered as a critical factor in enabling socio-economic development, and as the main vehicle for energy diversification. At the same time it is noted that Rwanda has by far one of the lowest per capita electricity consumptions in the world; Rwanda consumes about 42 kWh/year/capita compared with 478 kWh in sub-Saharan Africa and 1,200 kWh for developing countries as a whole. Although Rwanda's densely distributed population should facilitate network expansion and access to electricity, presently only 16% of Rwanda's households (350,000 customers) are connected to the grid.
The government has launched an aggressive program to increase the generation of electricity and the access to the electricity services by all sectors of the economy and all consumer categories. It has started from an extremely low base but the growth in electricity access has been an impressive 160% between 2008 and 2012. The target is to develop up to 610 MW and having the 70% of the Rwandan be connected to electricity by 2017/18. To achieve this, Energy diversification has been considered as it is seen to have a combination of economic, financial and environmental benefits. For the period 2017/18, the following projects are considered so as to achieve the above targets.

**Hydropower**
As a result of extremely low operational costs however, hydropower is one of the cheapest forms of generation in the long run. Hydropower has generated the bulk of electricity in Rwanda since 1960s. Its overall potential is estimated at slightly more than 300 MW but currently utilized hydro capacity is 60 MW. Rwanda’s potential hydropower resources are in the forms of small domestic hydropower, micro hydropower, and regional hydropower projects. As combinations of on-going and planned investment in Hydropower, we expect it to contribute around 113 MW by 2017/18.

**Geothermal**
Rwanda’s geothermal resource is yet to be fully proven, however, the exploration drilling of 3 wells started on 18th July 2013 and are expected to be completed in 6 months. Preliminary studies have indicated the total potential of 700 MW. We expect to degenerate about 60 MW from the geothermal resources by 2017/18.

**Peat**
Another vast resource Rwanda has for the electricity generation of Peat. Peat is of a proven technology and less complicated than methane or geothermal. The present plans include development of 260 MW of peat-fired power plants by 2017/18. The total potential capacity of peat-based power is estimated at 300 MW.

**Gas (Methane)**
Natural gas is internationally considered a very desirable fuel due to its technical, economic and environmental advantages. In particular, it has become the fuel of choice for power generation. Rwanda is fortunate to have an estimated 55 billion cubic meter (bcm) of usable methane gas found at the bottom of Lake Kivu, at a depth of around 250 meters. The total contribution of Methane gas to power electricity by 2017/18 is expected to be 83 MW from the current 4.2 MW.

**Solar**
Rwanda has a moderate source of solar energy with an average solar radiation of 4 – 6 kWh per square meter per day. Worldwide, development of solar energy in the form grid-connected electricity is considered to be very costly even for countries that have more intensive radiation. Rwanda has chosen a realistic track by focusing on the use of solar PV in two main areas: (i) electrification of clinics, schools and administrative offices in remote centers; and (ii) solar water heating, substituting biomass and electricity water heating, with significant environmental and recurrent cost savings. However, with increasing demand for the electricity and the energy diversification strategy taken by the Government, there is a planned additional of 10 MW to the National grid by 2017/18. Already 300 schools in remote areas are being installed with Solar Photovoltaic systems for lighting and running IT equipment in those schools. Also the is an on-going on project of Solar Water heaters expected to install 12,000 units by 2015 as an alternative way of
saving energy, which will be used for other purposes.

**Biomass**

Rwanda’s energy mix is dominated by biomass as highlighted earlier. Biomass is derived from wood fuel mostly used in rural areas in the form of firewood and charcoal that are used in the urban areas for cooking. Although the dependency on biomass has dropped from 95% to 85% in the last 20 years, the ratio is still considered too high and harmful to forest resources. Accordingly, the government strategy is to reduce the consumption of biomass energy from the current 85 percent to 50 percent of national energy consumption by 2020. The strategy articulates a combination of substitution and efficiency improvement measures to reduce biomass use and mitigate the risks of deforestation. These measures include:

- Promotion of other energy sources for cooking and heating such as biomass briquettes (peat, papyrus, waste), kerosene (using efficient and safe pressure stoves and lights), LPG, solar water heating and electricity (for users in the high end market);
- Expansion and improved management of plantations on a sustainable basis to support growing wood fuel and charcoal production;
- Promotion of improved technologies for charcoal production and improved stoves to make more efficient use of biomass fuels;
- Supporting the dissemination of biogas digesters to rural families where animal waste can be used and to schools, hospitals and other institutions where human waste can be transformed into biogas and slurry; and
- Encouraging the production of methane or other forms of energy from solid waste landfills or through gasification processes.

**Thermal Generation**

Approximately 45% of the existing generation capacity runs on expensive imported diesel. Diversifying away from diesel generation will enable EWSA maintain a regionally competitive tariff whilst eradicating subsidies to the energy tariff. Out of 47.8 MW being generated from thermal fuels (diesel and heavy fuel oil), by 2017/18, 20 MW of it will have been phased out due to operationalization of new projects under construction.

**Transmission & Distribution Lines**

It is inevitable that the power generated has to be evacuated from the power plants to the final consumers. Therefore in parallel with new power plants constructions for power generation, EWSA has developed a comprehensive transmission and distribution lines as well as new electricity substations construction roadmap. The roadmap includes an extension to the transmission and distribution lines (in total) for about 700 KM and the construction of around 10 new substations. Old substations are being rehabilitated and upgraded.

4. **Challenges and Intervention needed**

As highlighted above, the government has taken a number of initiatives to sustainable availability of energy to the population. A lot effort has to be done so as to achieve the mentioned targets. These have been formulated based on long term Government vision and plans to make Rwanda a middle income country by 2017 as highlighted in the EDRS II as well as the Vision 2020.

However, for the Energy Sector to deliver, there is a need for the collaboration with research institutions so as to address some of the research needs. Since academic institutions are the leading research institutions available, it is thought that, they can partner with EWSA and GoR to identify some of the bottlenecks to
deliver and hence find common solutions for this.

Some of the areas where research intervention is needed are:

- **Biomass**
  - Biogas digesters Construction Cost reduction

There is a wide perception among the beneficiaries that, the materials used for Biogas Digesters construction are expensive, especially for the rural community who are the major beneficiaries the National Domestic Biogas Program (NDBP). This has led to the slower pace of penetration despite of the effort by the EWSA with its promotion campaign and a 300,000 RwF subsidy for each Bio digester unit built.

  - Research on Bio-effluent as good fertiliser

The Digester bio-effluent has shown to be a good fertiliser. However there have never been any study/research indicating the nutrient contents in this fertiliser which will make it to be used more efficient and effective

  - Updating the existing biogas models in terms of gas production.

There is an indication of the biogas to be used as cooking gas. Research is needed to prove this.

- **Geothermal**

For Geothermal to be proved in certain areas, the earth studies need to have been carried out in different areas. The is a need for earth Surface Manifestation studies in:

  - Geology
  - Geochemistry
  - Geophysics
  - Hydrology

- **Hydropower**
  - Water resource management (Hydrological modelling of river behaviour and sediments analysis)
  - Feasibility studies of pico and micro hydro

So far, the studies which have been carried out focus only on large to micro-hydro sites. There is a belief that there is a high potential for the pico-hydro potentials which can be focused on especially for isolated and off grids.

  - Model for management of off grid micro hydro power plants

So far there is no any model for the management of the off grid power plants. Once developed, can help in faster generation and electrification for isolated and off grid areas.

  - Scientific guidance on manufacturing of pico turbines

There speculation about the capacity of local manufacturers capacity to manufacture the pico-hydro turbines. No assessment has ever been conducted on this. If this is done, it is going to provide a scientific proof for or against.

- **Methane Gas Extraction**
  - Mass Extraction of Gas

Previously, there has been a problem for the mass extraction of methane gas from the lake. Scientific advice (of course after research) may be used to solve this problem.

  - Lake Stability due to Gas Extraction

As we are talking of mass extraction of gas from the lake, there is a need to know, what will be the impact of this to the lake so that a decision to proceed or not we keeping in mind the effects.

- **Peat to Energy/Power**
  - Characteristics of peat bogs (moisture content, calorific value, ash content, etc.)
• Identification of sustainable substitution of wood by peat (especially in the institutions)

This may help to reduce the pressure on our precious forests and hence reduce the environmental impact on our country.

• Transmission & Distribution
  ◦ Loss reduction of distribution network
  ◦ Impact of introducing single phase distribution system on entire network
  ◦ Research on national grid frequency control system.

Acknowledgement

Many thanks INILAK for having invited and facilitated us to attend this informative and educative forum. We would like to confirm our commitment for collaboration with you in the future. The forum was inclusive and diverse which gave it a more international representation than many have thought before.