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# Sierra Leone: National Electrification with Power Generation Resilience to Climate Change

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## 1. Introduction

The aim of this policy brief is to provide an insight into the amount of investment needed and the energy mix required for Sierra Leone to meet with its SDG 7.1. commitment of ensuring universal access to affordable, reliable and modern energy by 2030. Using OSeMOSYS modelling tool, results shows the following:

- That an **Extra 2.2 Billion USD** in Total Investment is needed to meet National Electrification Target.
- For power generation that is resilient to climate change an **extra 500 Million USD** is required over that for business as usual.
- That **Run-off Hydro** are more Economically Viable than Large Hydro Technology With **Dam**
- That any percentage decrease restriction on CO<sub>2</sub> Emissions would lead to approximately 2.7% increase in operational cost

## 2. Problem definition

Sierra Leone due to its climatic and topographical features, is endowed with abundant Renewable Energy Potential, but however it faces severe energy scarcity. The energy supply infrastructure is limited to mainly oil-fired Thermal plants and hydro power plants, with small share of Solar and Biomass. Thermal plants can be greatly affected by High fuel Price and hydro power by change in climatic conditions. The rate of Electrification of the country is at 14% and only 17.8% of Sierra Leone's population of 7million people has access to Electricity. The Mining companies and other heavy power industries are not connected to Grid, all of the above stalls the Socio Economic Development of the nation.

The context and challenges highlighted above pose the research question of "How can investment in a diversified energy supply mix ensure universal access to electricity and increase energy security and climate resilience?"

## 3. Methodology and Scenario Development

Scenarios were modeled in OSeMOSYS, which is a linear programming generator that selects suitable energy mix to provide least-cost optimal solutions. The modeled period spans from 2015 to 2050, with each year having two seasonal variations of 6 months dry season (November to April) and 6 months raining season (May to October).

The following scenarios were investigated:

**Base Case Scenario (BAU):** This scenario implements the business as usual i.e. the electrification rate of 14% and the energy supply mainly coming from Hydro and other variable renewable sources (VRES).

**National Electrification (NE):** This scenario is a modification of the base case wherein the domestic demand projections were increased such that the rate of electrification was targeted at 60% by 2025, 80% by 2030 and 100% by 2035.

**Delayed Hydro (DH):** In this scenario, the national electrification rate was maintained, but restrictions were made such that the installation of phase 2, 3 and 4 of Bumbuna was delayed to start in 2027.

**Climate Resilient (WS):** In this scenario, the national electrification rate was maintained, but with modifications made such that the model experiences

intermittent drought in several years of the modelling period. This increases the dry period of the dry season and reduce the capacity factor of the Hydro power plants.

**Emission Restriction (ER):** In this scenario, the allowable emission in the base case was restricted by 80%, 60% 40%, 20% etc. and the percentage increase in operational cost recorded.

#### 4. Results

Fig. 1 compares the percentage of population with access to electricity for the BAU and the NE scenario.

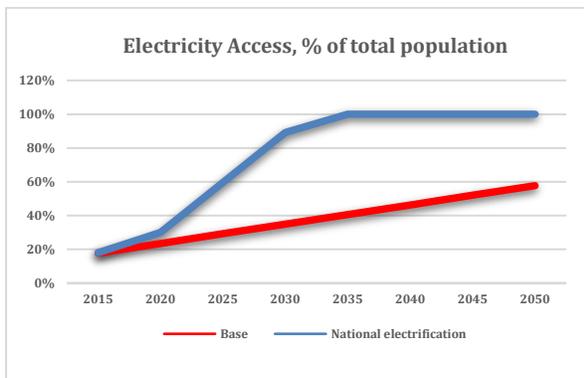


Figure.1: Comparison of Electricity access for Base Case and National Electrification scenario.

In BAU, at 2050 only 58% of the population will have access to Electricity, while in NE Universal Access is achieved in 2035.

Figure 2 compares the share of renewable energy (RES) in the mix for various scenarios.

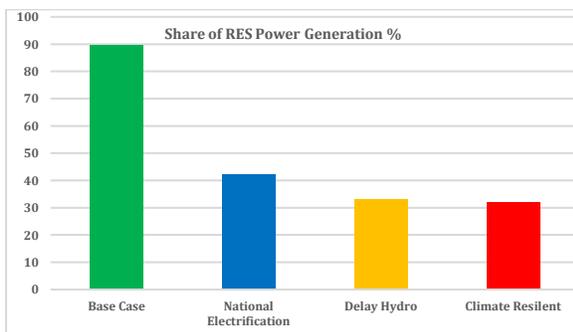


Figure.2: Compares the share of renewable energy (RES) in the mix for various scenario during the model period 2050.

For the BAU scenario, with its relatively low demand projections and electrification rate, close to 90% of RES

is used. For National Electrification, where considerably higher demand needs to be met, more fossil fuel and biogas comes into play, bringing the share of RES down to about 42%. If investments in hydro infrastructure are delayed, there is a further reduction in RES share down to about 32%.

Figure 3 compares the total investment for the various scenarios. NE was run over two base cases, one that implements Large Hydro with DAM and the other with only run-off river hydro.

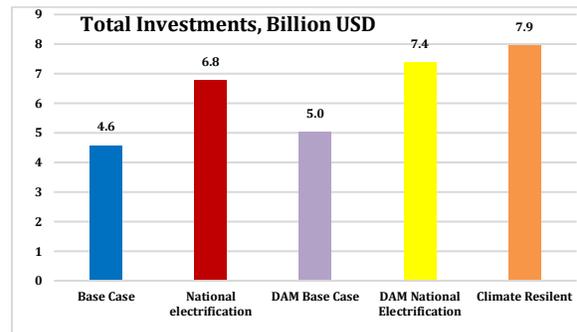


Figure.3: Comparison of total investment for the various scenarios.

Result shows Extra 2.2 Billion USD in Total Investment is needed to meet National Electrification Target, 2.4 billion USD with DAM, and another 500M USD to make power production resilient to climate change.

To analyze the effectiveness of the different scenarios, the Average Supply cost was chosen as indicator, which is the ratio of total annual cost to Total Annual Production (figure 4). The graphs of the various scenarios all follow each other throughout the modelling period with base case slightly higher.

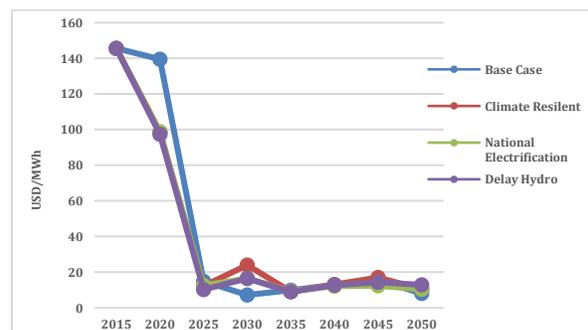


Figure.4: Compares the average supply cost for the various scenarios.

Figure 5 presents Emission Abatement curve that shows the effect restricting the allowable emission has on operational cost.

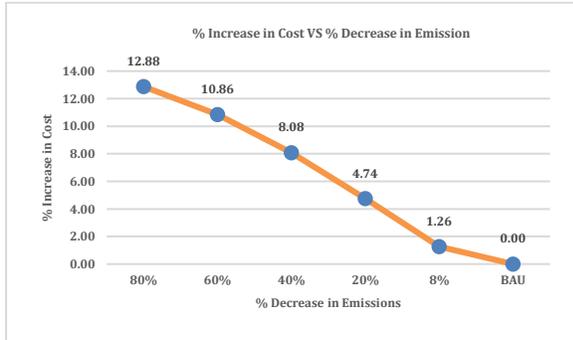


Figure 5: Compares the average supply cost for the various scenarios.

On average, any percentage decrease (restriction) in CO2 Emissions will result in 2.7% increase in operational cost.

### 5. Limitations

As National Electrification (universal access) is the central theme of this research, only the domestic demand projections were utilized, i.e mining, industrial and commercial demands were not considered. Secondly, the base case data utilized were informed by the current energy policy, which seems very ambitious and may need revision. Also other energy sources such as Gas, Coal and import of electricity that would be made possible by regional integration (WAPP) were not considered. Lastly, universal access was implemented on the assumption that the consumers are willing and capable for paying for the use of electric power.

### 6. Policy implications and recommendations.

Based on the modelling results and analysis, the following policy recommendations are proffered.

- In order to achieve universal access by 2035 as stated in the Government energy policy, huge investments must be made in the energy sector. The modelling results show that extra 2.2 billion dollars is needed over current rate of funding. The development of Hydro and Large Scale VRES should

be accelerated and new energy sources such as LNG, imported coal and electricity should be introduced in the energy mix. The funding plan should involve reaching out to donor community.

- The modelling results show that the energy supply in Sierra Leone is heavily reliant on VRES, with a share of about 90%. However, VRES supply varies with changes in climatic conditions. To ensure power generation resilience to climate change, extra 500M USD investment should be made on non VRES.
- To meet the increase in demand projection for national electrification, investing in VRES including run-off hydro provides an economical and effective approach.
- The modelling result shows that the CO2 emissions for Sierra Leone energy sector are relatively low, amounting to about 5% of the total emissions. Further results show that any percentage decrease (restriction) in CO2 Emissions will result in 2.7% increase in operational cost.

### 7. References

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