Energy Transport and Storage: Kenya

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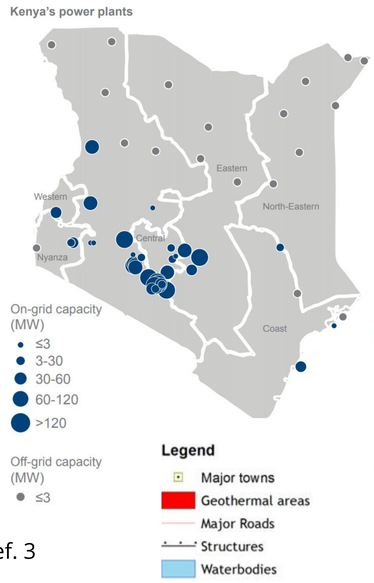
39-613 Energy Transport and Storage

Kenya's Energy

Ref. 1



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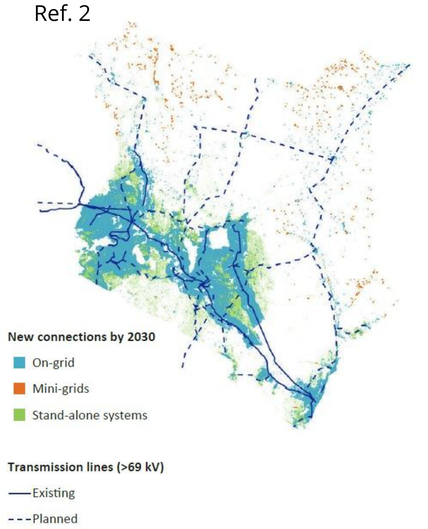

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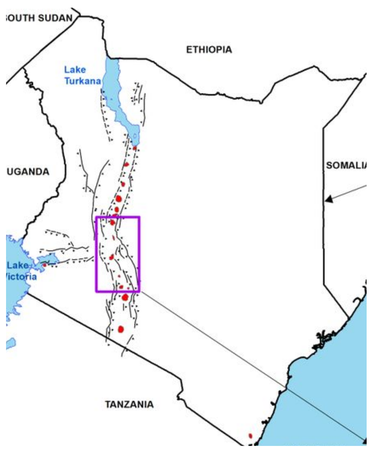
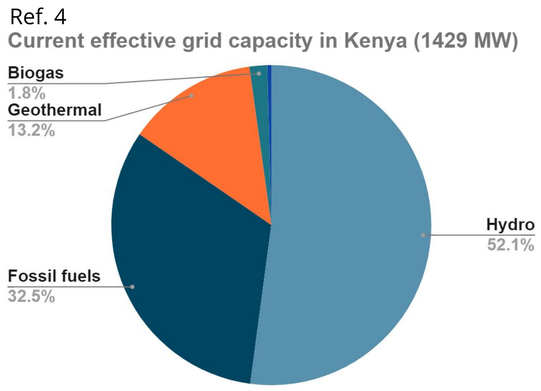


- Wood fuel and kerosene are the main fuel source for the majority of the population who live in rural areas.[4]
- Electricity usage is low in Kenya and electricity generation is low, effectively lowering demand and raising electricity prices.[5]
- Kenya has a high potential geothermal capacity of **10,000 MW** in the **Kenyan Rift Valley**.[4]
- Currently, installed geothermal capacity is 690 MW.[4]

Total Installed Capacity in Kenya: **2,351 MW**

Installed Capacity connected to the grid: **1,429 MW**

Ref. 4



Quantitative Analysis

Two Business Plans were analyzed:[7,8,9,10]

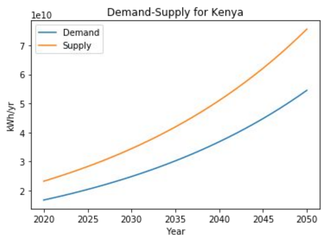
Plan A: Business as usual

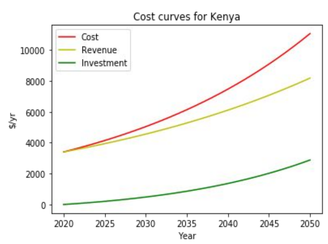
Plan B: Promotion of Decarbonization

Certain assumptions for Case A and B scenario:

- Constant rate of demand increase (4% YoY)
- Constant rate of supply increase (4% YoY)
- Electricity is at breakeven costs in 2020
- Supply cost remains constant till 2050
- Government aims at 1% decrease in electricity price per year to tackle high cost problem and increase demand
- Share of energy sources remains constant
- For decarbonization, fossil fuel plants are retired at a constant rate to achieve decarbonization till 2050
- Additional energy demand arising due to retiring fossil fuel plants is catered by a single renewable energy source

Case A: Business as Usual

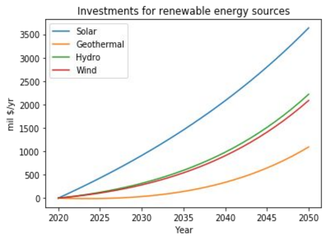


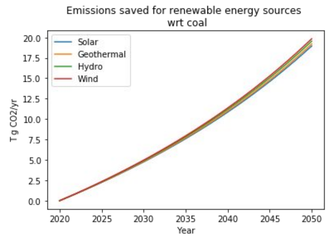


Highlights:

Investments need to be scaled up every year rapidly to ensure that demand increases steadily with a corresponding decrease in electricity price.

Case B: Decarbonization





Highlights:

Geothermal seems to be the most likely candidate to replace fossil fuel plants due to lower investment required as compared to other renewable sources.

Policy Recommendations

Major threats to energy infrastructure development:[6]

- Stagnating residential demand & rise of centralized power
  - Electrify rural areas by expanding the grid as well as incorporating microgrids by lowering the electricity prices through regular investment.
- Poor reliability
  - Ensure customer satisfaction by addressing grid stability issues and drive grid management and development which may adopt intermittent renewable energy projects in the future.
- Corruption & uncertainty in regulation
  - Ensuring a cooperative engagement in infrastrastructure development between public & private entities (government, private utilities, etc.)

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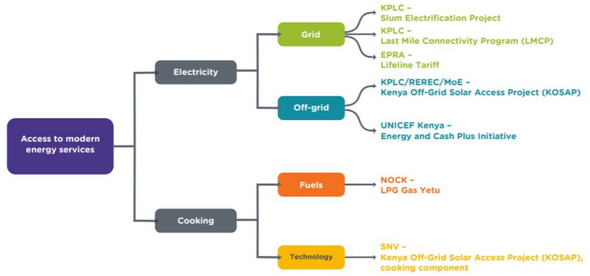

If Kenya decides to move forward with the **Plan A**, a significant amount of investment is necessary and with a constant increase to lower the electricity cost. Share of fossil fuels would be roughly at ⅓ of the total capacity, leading to significant carbon emissions.

If Kenya decides to move forward with the **Plan B**, geothermal emerges as the best candidate. Kenya can phase out its fossil fuel plants by 2050 with governmental support and investment.

References

1. Kenya power plants map https://www.usaid.gov/sites/default/files/documents/1860/Kenya_Power_Sector_report.pdf
2. IEA transmission lines https://www.iea.org/articles/kenya-energy-outlook
3. Geothermal map https://www.researchgate.net/publication/305659183_Stable_Isotopic_Composition_of_Geothermal_Fields_in_Kenya_The_Relationship_Between_Geothermal_Fields_and_Kenya_Rift_Lakes_Waters
4. https://energypedia.info/wiki/Kenya_Energy_Situation#Policy_Framework.2C_Laws_and_Regulations
5. IEA Kenya Energy Outlook https://www.iea.org/articles/kenya-energy-outlook
6. https://www.energyforgrowth.org/memo/the-seven-major-threats-to-kenyas-power-sector/
7. Wikipedia: Energy in Kenya
8. https://www.globalpetrolprices.com/Kenya/electricity_prices/
9. Master's Thesis: Keizer, D. (Utrecht University)
10. Wikipedia: Lifecycle greenhouse gas emissions of energy sources
11. https://www.seforall.org/system/files/2020-02/ESN_Kenya-SEforALL.pdf)