Title: OPTIMAL ENERGY MIX FOR ELECTRICITY GENERATION IN NIGERIA

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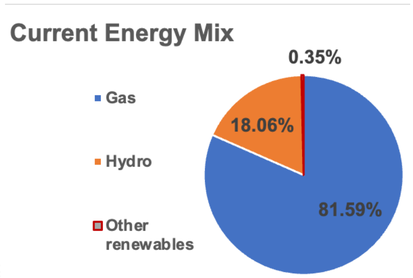
RESEARCH BACKGROUND

- Global warming has become an increasing concern in the 21st century as a result of rising CO_2 emissions.
- The energy sector is the highest contributor.
- The world now faces the trilemma of ensuring energy supply at an affordable rate while reducing CO_2 emissions.
- Investments into renewables and carbon capture and storage (CCS) have been proposed.
- However, developing countries like Nigeria also face severe energy crisis.
- Despite her vast energy resources, 45% of the general population and >75% of rural population lack access to electricity.
- Previous theoretical research suggest a lack of proper energy mix as a reason for the electricity crisis.



RESEARCH OBJECTIVES

- This research seeks to choose a feasible combination of energy resources to minimise the cost of electricity generation while meeting electricity demand, but also addressing the environmental and renewable targets set by the government.
- It also explores the possibility of integrating CCS in the energy mix for electric power generation in in Nigeria.

METHODOLOGY

- Least-cost optimisation was applied to 8 models.
- Objective function: Total generation cost (includes investment, O&M, fuel and CO_2 emissions costs.
- Constraints: i) Demand, ii) installable capacity for energy sources, iii) government plan for renewables (36% of electricity generated) & coal (2200 MW) by 2030, and iv) target for emissions reduction.

Table 1: Description of Models

Model Name	Scenario 1: Without CO_2 restrictions	Scenario 2: With CO_2 restrictions
Model 1	Base case model	
Model 2	Base case plus CO_2 cost	
Model 3	Base case plus CO_2 cost and government planning for RES	
Model 4	Base case plus CO_2 cost, government planning for RES and CCS	
Model 5		Base case model
Model 6		Base case plus CO_2 cost
Model 7		Base case plus CO_2 cost and government planning for RES
Model 8		Base case plus CO_2 cost, government planning for RES and CCS

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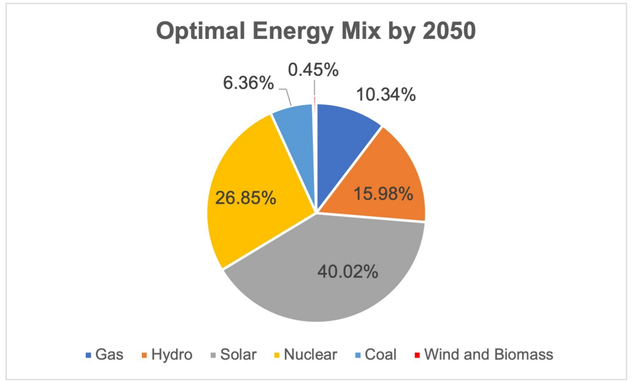
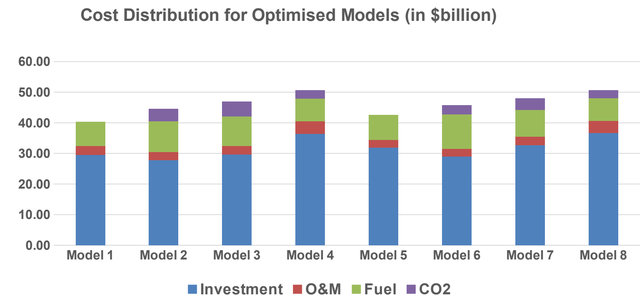
included CO_2 restrictions.

- Models with CCS had lower CO_2 emissions.
- From all 8 models, the best mix is Model 8 – Base case plus all restrictions and CCS:
  - With a total generating capacity of 90,593MW and
  - LCOE of $83.74/MWh

Table 2: Total Emissions Generated

Without CCS		With CCS	
Model 3	Model 7	Model 4	Model 8
3,714,324,600.44	2,282,030,615.57	1,770,075,572.39	1,604,684,540.26





CONCLUSION

- To achieve an electricity generation mix that meets demand at an affordable rate and achieves the emission goals and government requirements:
  - No new gas plants should be installed.
  - Hydro resources should be installed to their full potential capacity.
  - More investments should be made in solar.
  - The intended coal power plants should be fitted with CCS to reduce the CO_2 emission rate.
  - Nuclear energy should also be included to the mix.

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