

Sustainability assessment for West Africa's interconnected electricity network.

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OUTLINE

1. Context
2. Methodology
3. Results
4. Conclusions and policy recommendations



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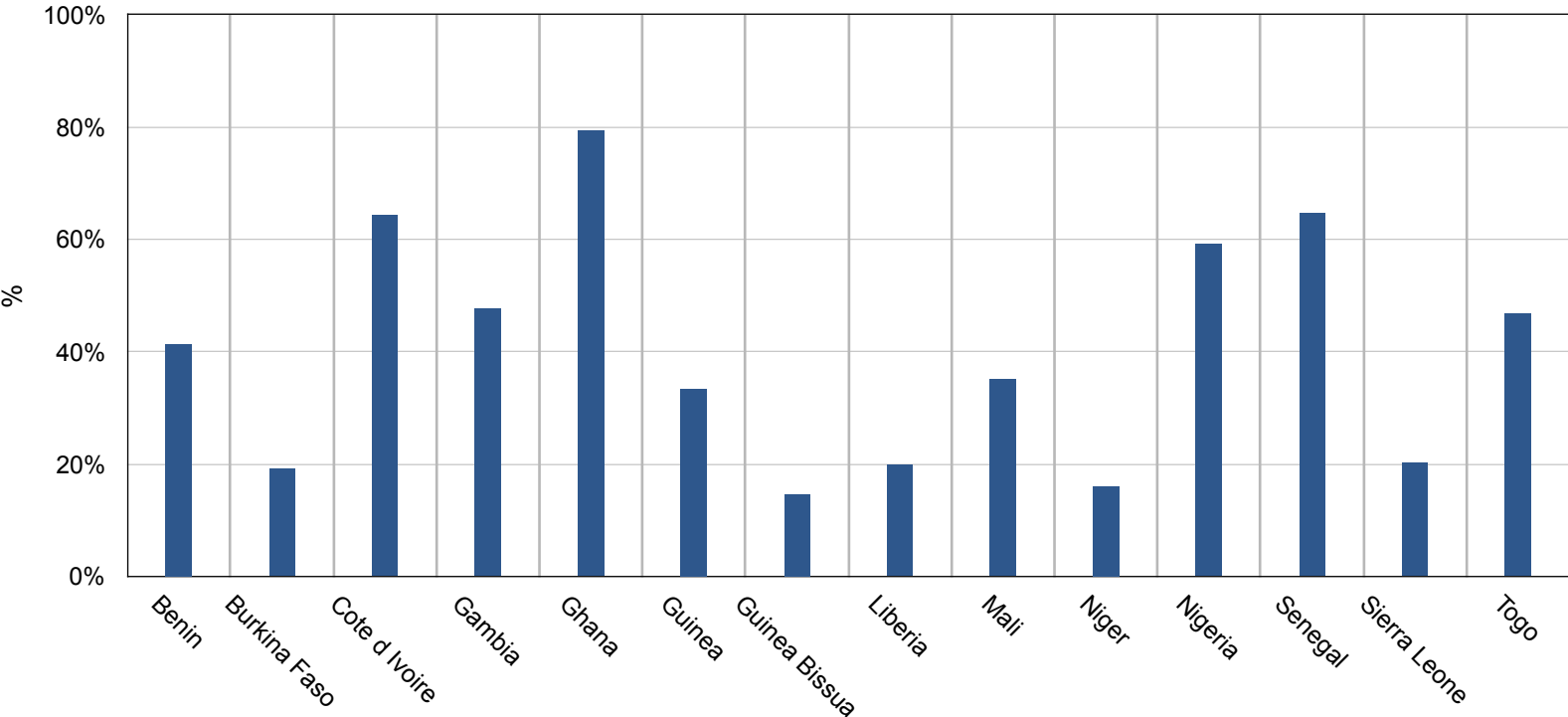
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Context: West Africa's Electricity sector

Low access to electricity

- Access to electricity is less than 50% in 10 countries
- 175 million people have no access to electricity



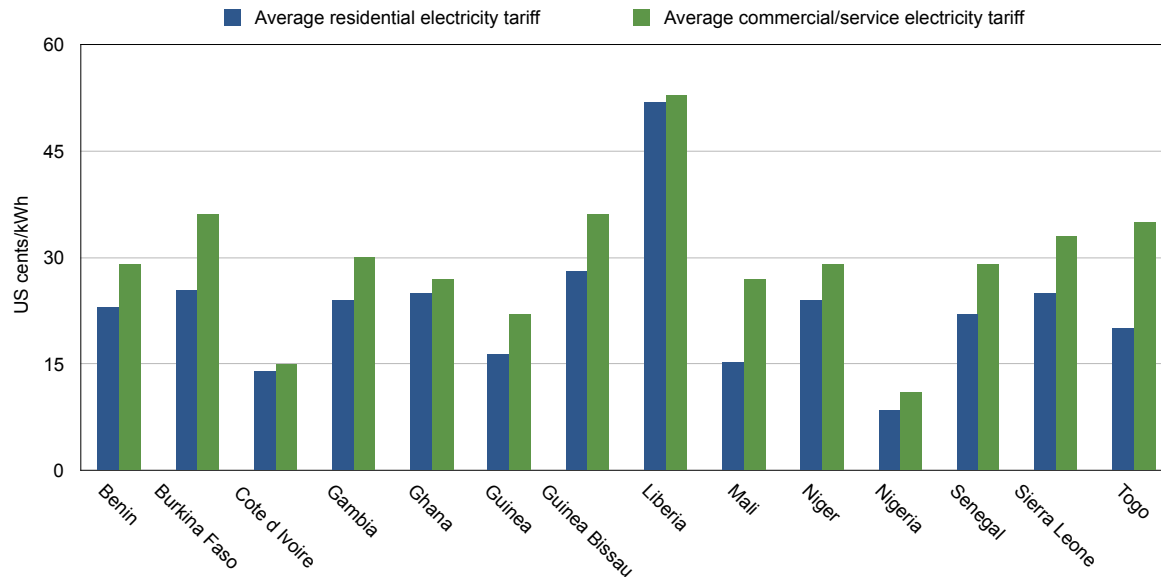
Context: West Africa's Electricity sector

Supply- demand gap

- Installed capacity:19GW, Estimated maximum demand : 24GW
- Daily power outages and load shedding.

High Tariffs

- 9 countries use oil generators to supply majority of its demand



Context: West Africa's Electricity sector

West African Power Pool

- Regional power plants
- Interconnect all 14 West African countries
- Single regional electricity market

2030 Regional renewable energy policy

- 100% access to electricity
- 48% RES integration
- Reduce GHG emission

Proposed power plants by 2030

- 10GW Solar
- 6.7GW Hydro
- 2.5GW Coal (plans for additional capacity)
- 1.7GW Gas



Objectives

1. Quantify the impact of increasing renewable energy sources and interconnections on electricity supply, rapidly growing demand, electricity generation cost and carbon emission.
2. What is the sustainability assessment of the proposed national and regional generation and interconnection plans for each West African country?

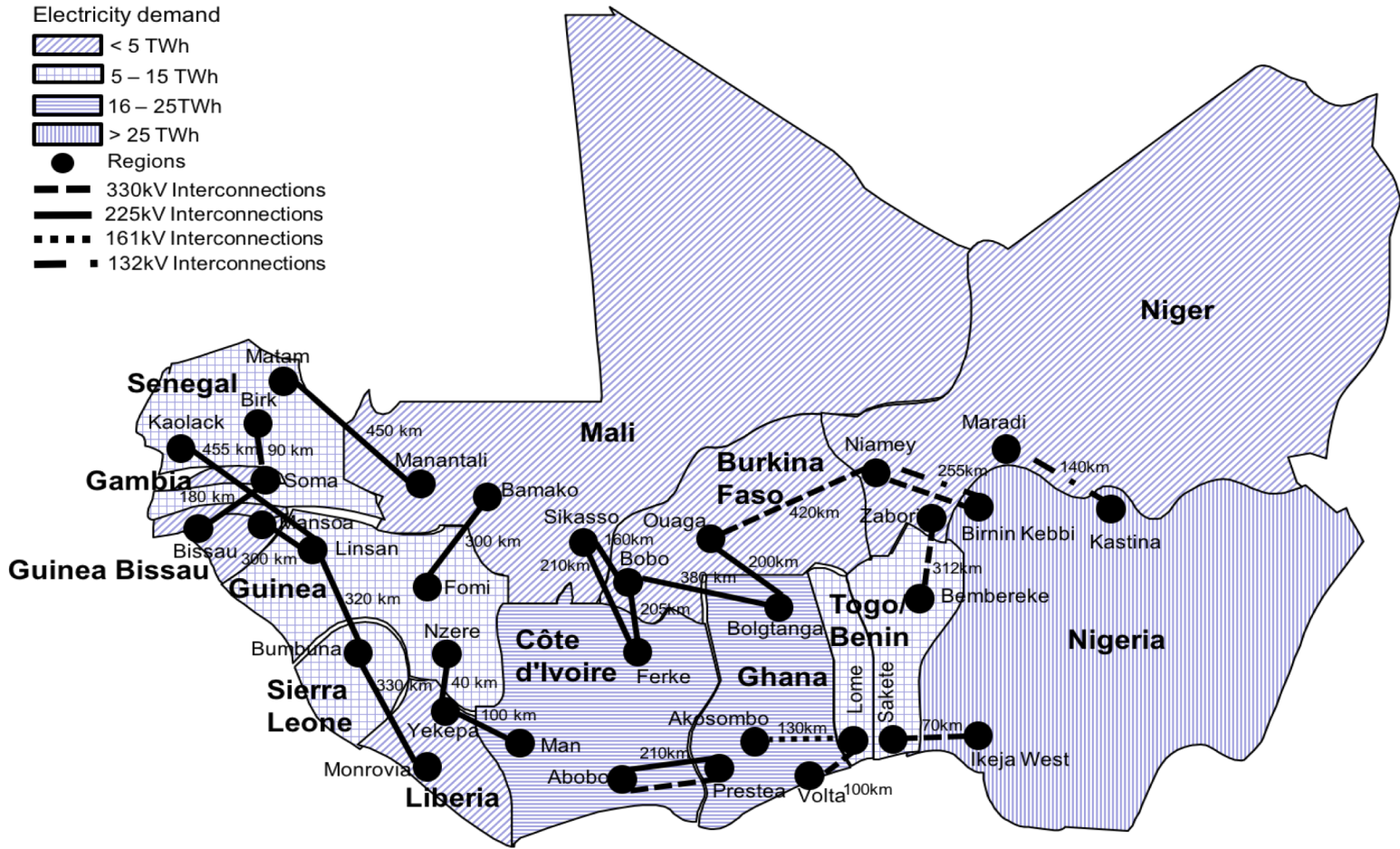


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Methodology

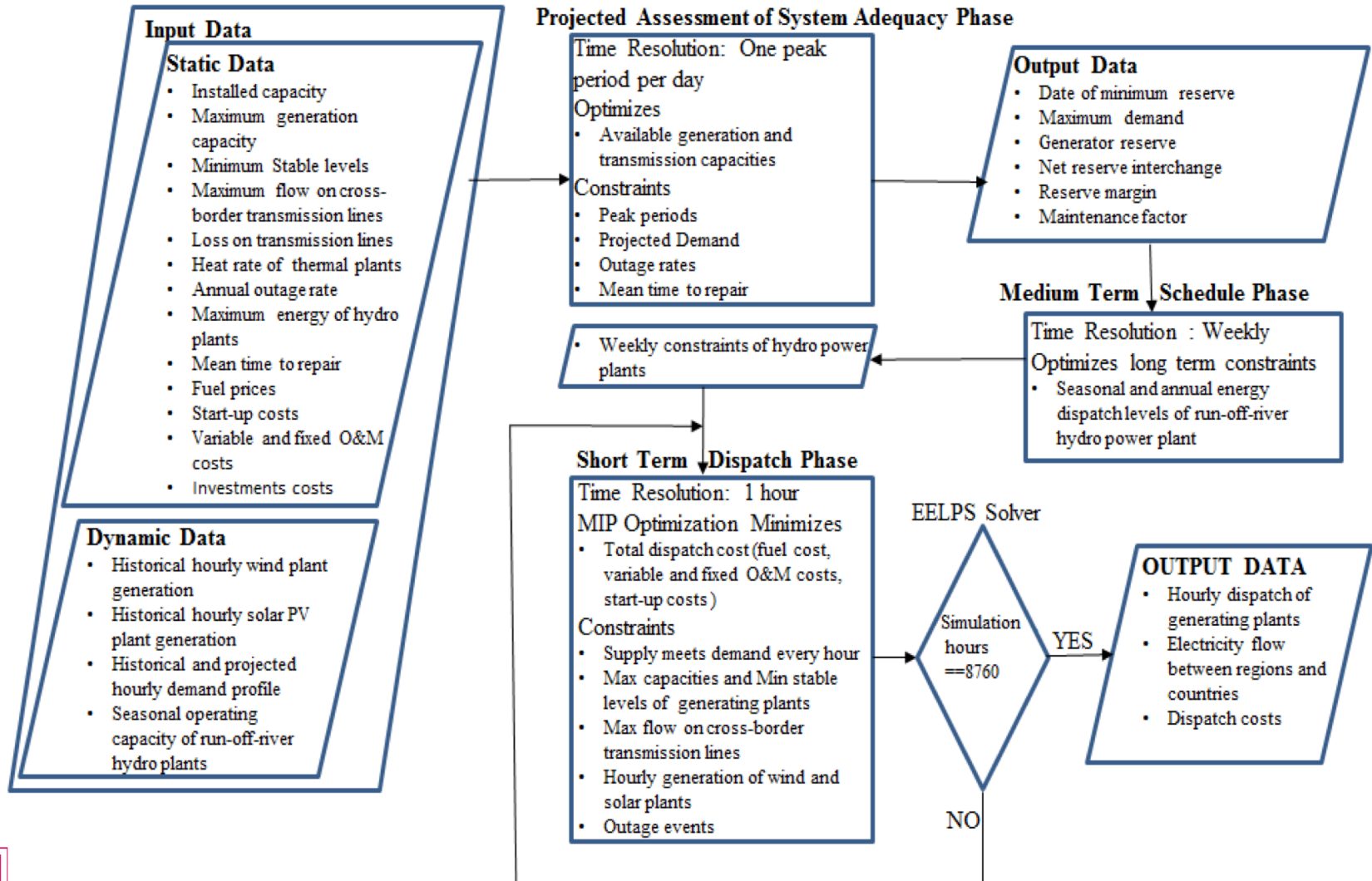


Existing and Proposed Interconnections in West Africa by 2030



- A multi-region economic dispatch model with spatial resolution of 33 regions and temporal resolution of 1 hour in the year 2030

Modelling Tool



Flow Chart of PLEXOS West Africa Interconnected electricity model.



Scenarios

1. Business as usual (BAU) scenario

- All planned national and regional generation infrastructures (45GW), and existing interconnections (2.5GW) are operational in 2030.

2. BAU Newlines scenario

- In addition to BAU scenario generation infrastructures (45GW), all existing and planned interconnections (9.6GW) are operational in 2030.

3. Renewable scenario

- In addition to BAU scenario generation (45GW) and interconnection infrastructures (2.5GW), unexploited hydro (6GW), solar resources (38GW) are operational in 2030.

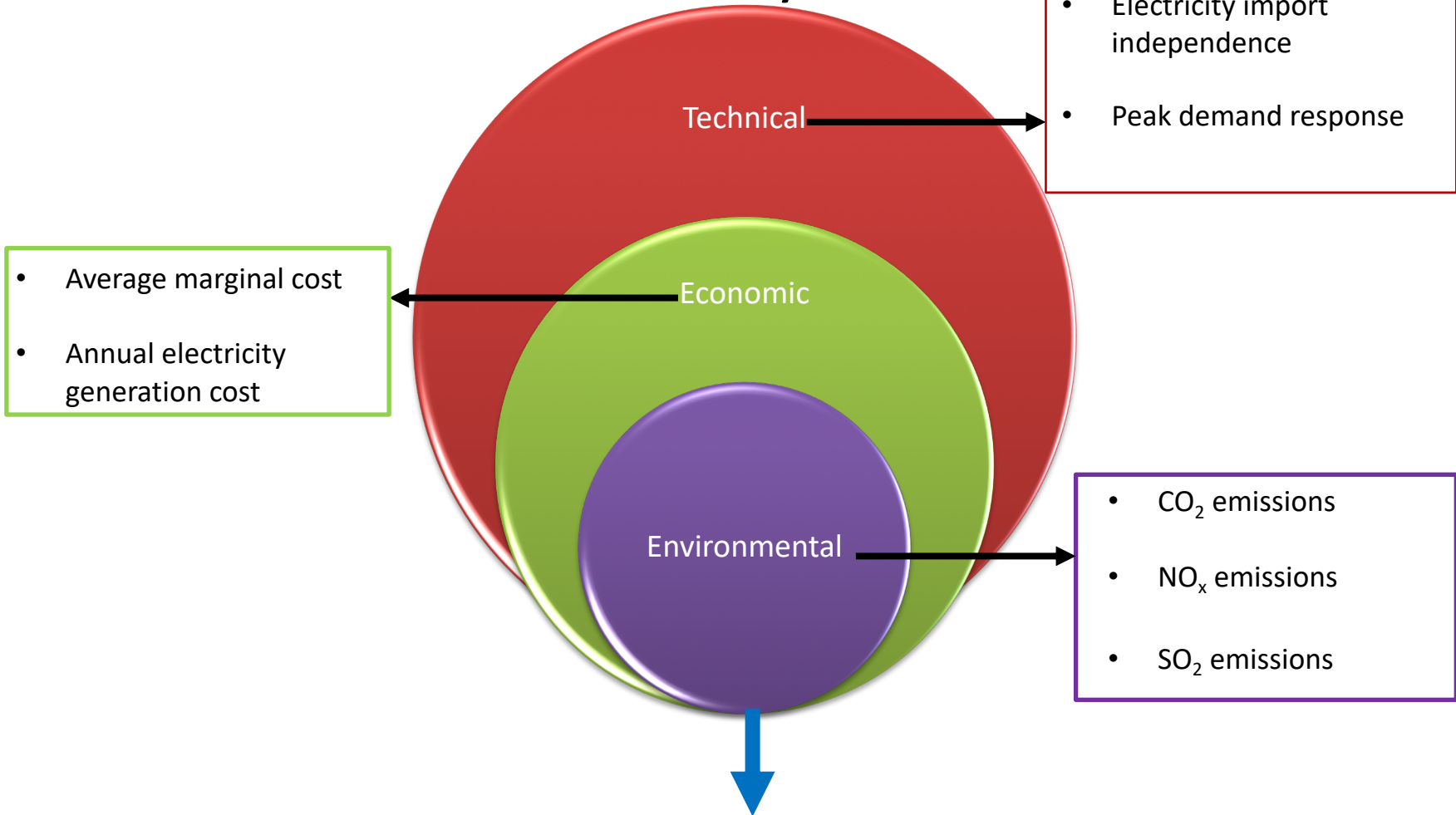
4. Renewable Newlines scenario

- In addition to renewable scenario generation infrastructures (89GW), all existing and planned interconnections (9.6GW) are operational in 2030.



Multi Criteria Decision Analysis (MCDA)

Sustainability Criteria

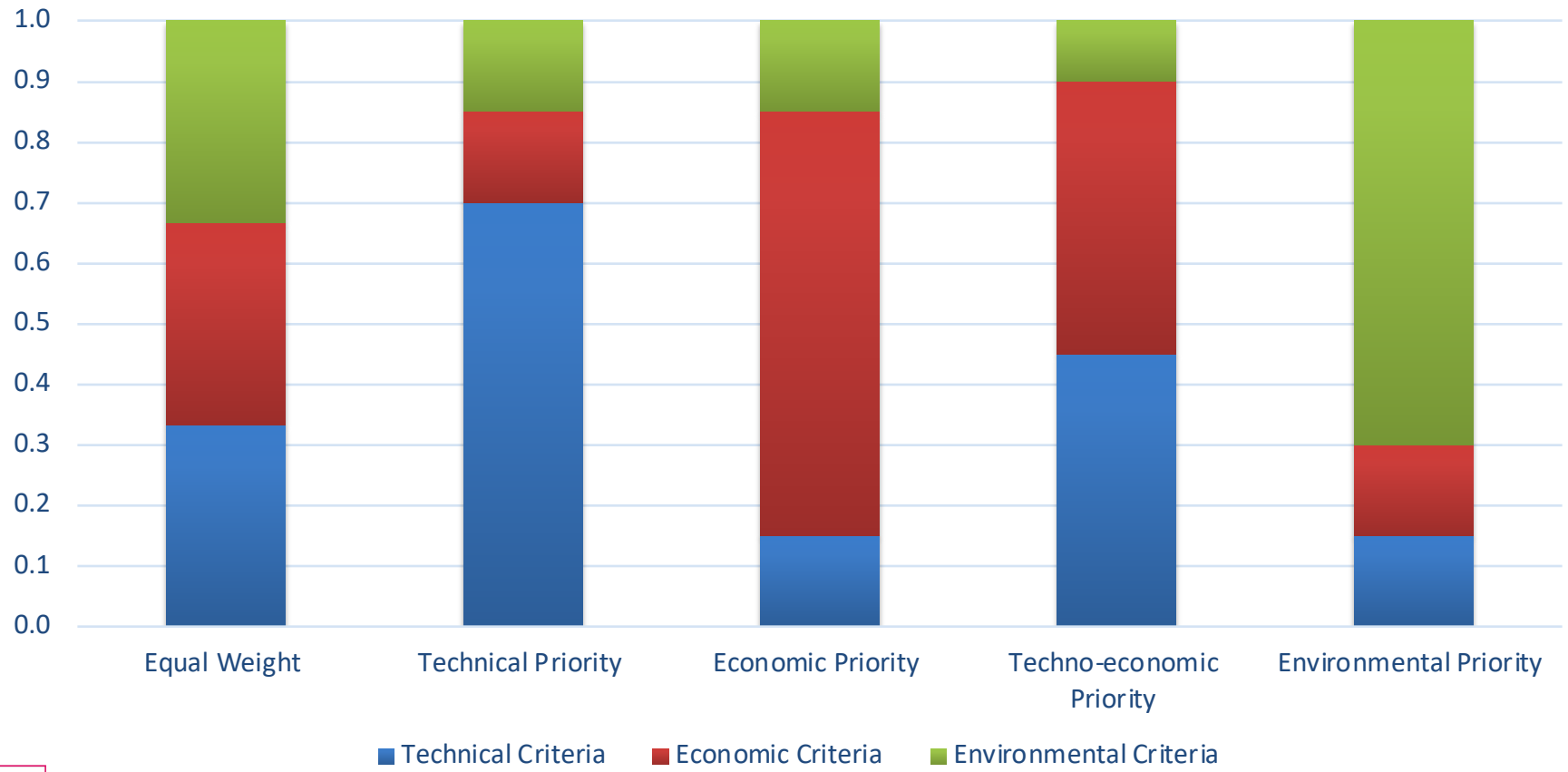


Application of outranking MCDA method (PROMETHEE II)



Multi Criteria Decision Analysis (MCDA)

Five Weighing Outlooks



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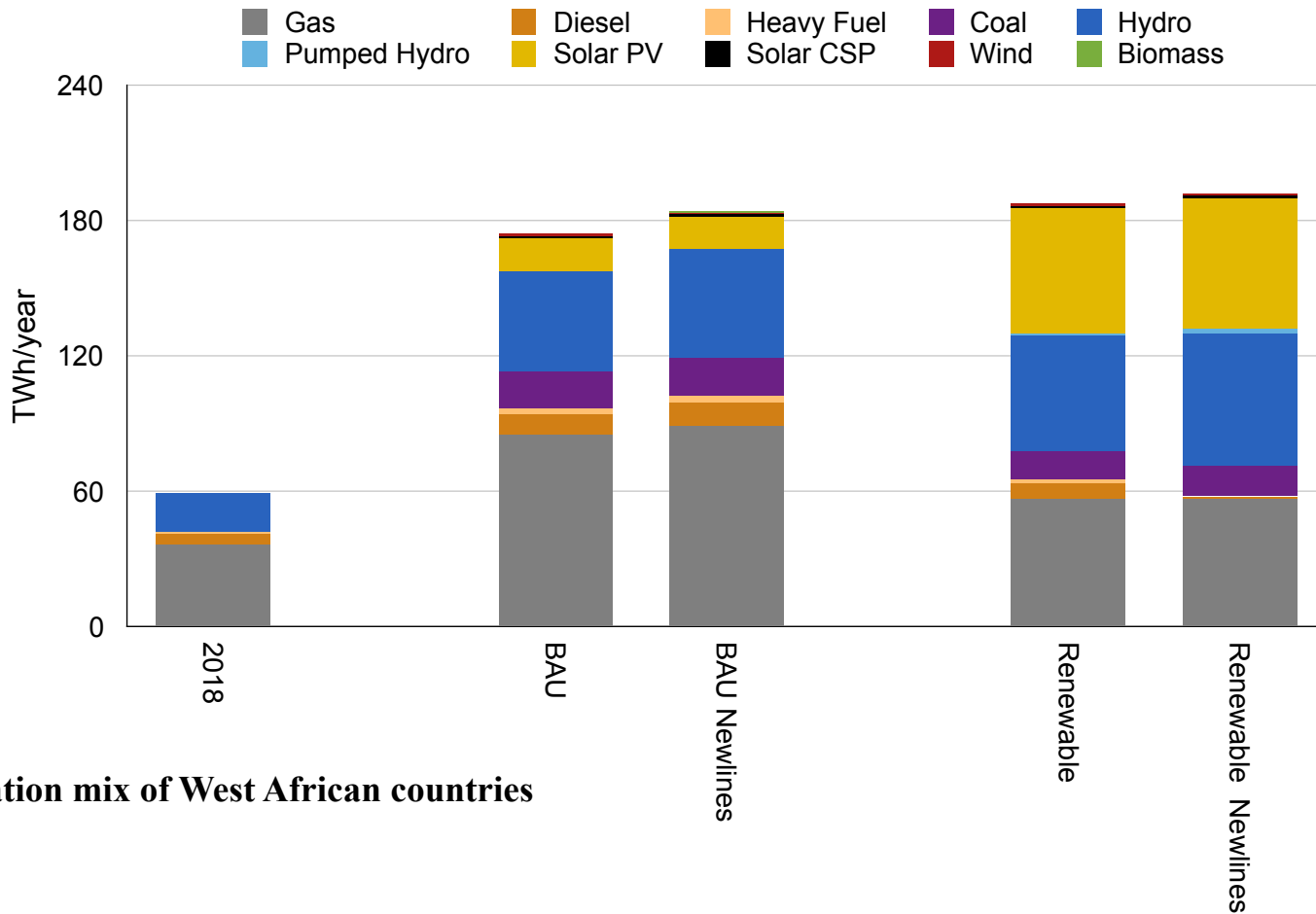
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Results

Power systems operations

- Additional RES in *Renewable* decreases the share of fossil fuel capacities by 31 %
- Additional RES and interconnections in *Renewable Newlines* decreases the share of fossil fuel capacities by 37 %



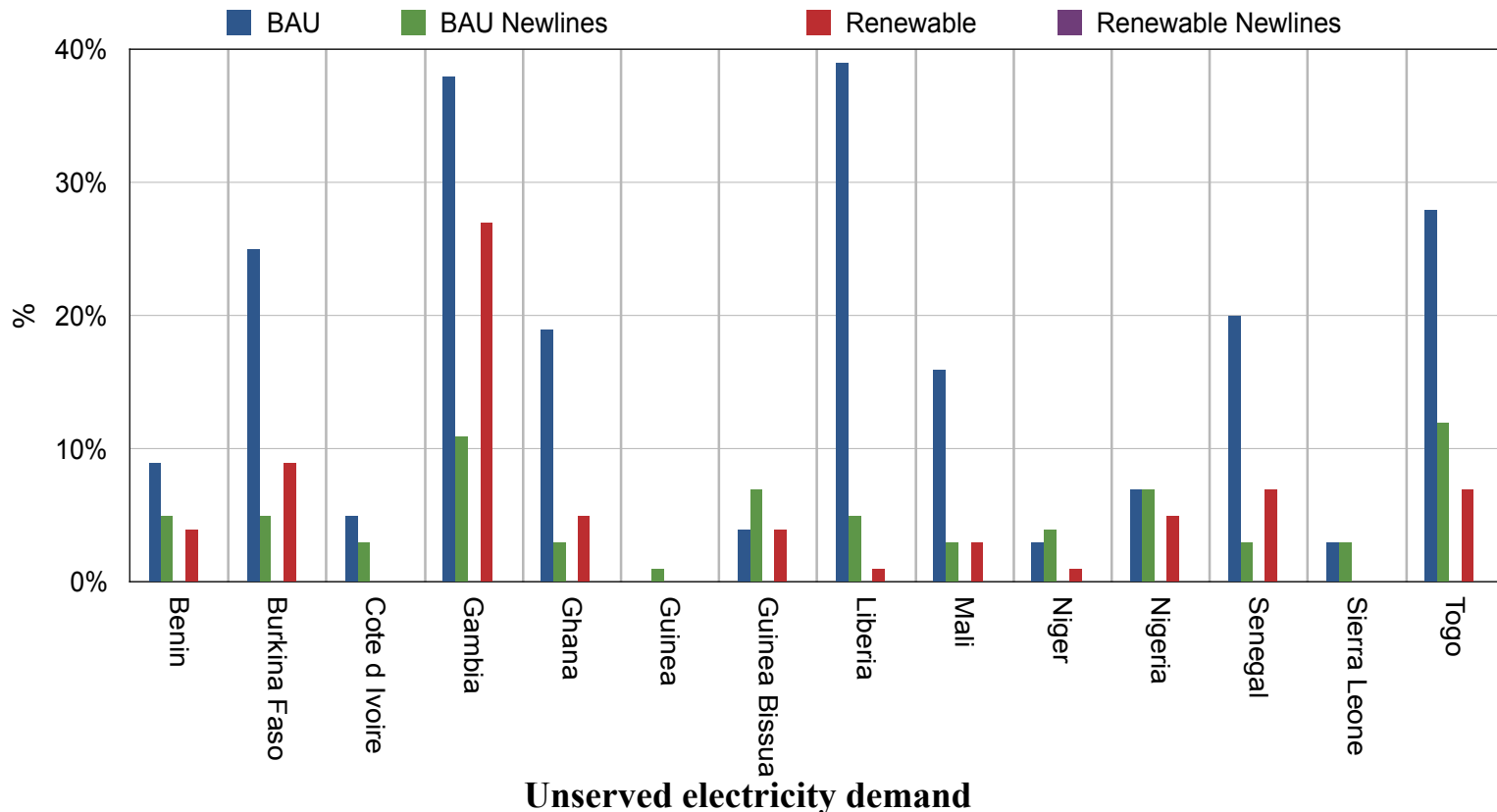
Electricity generation mix of West African countries



Results

• Demand

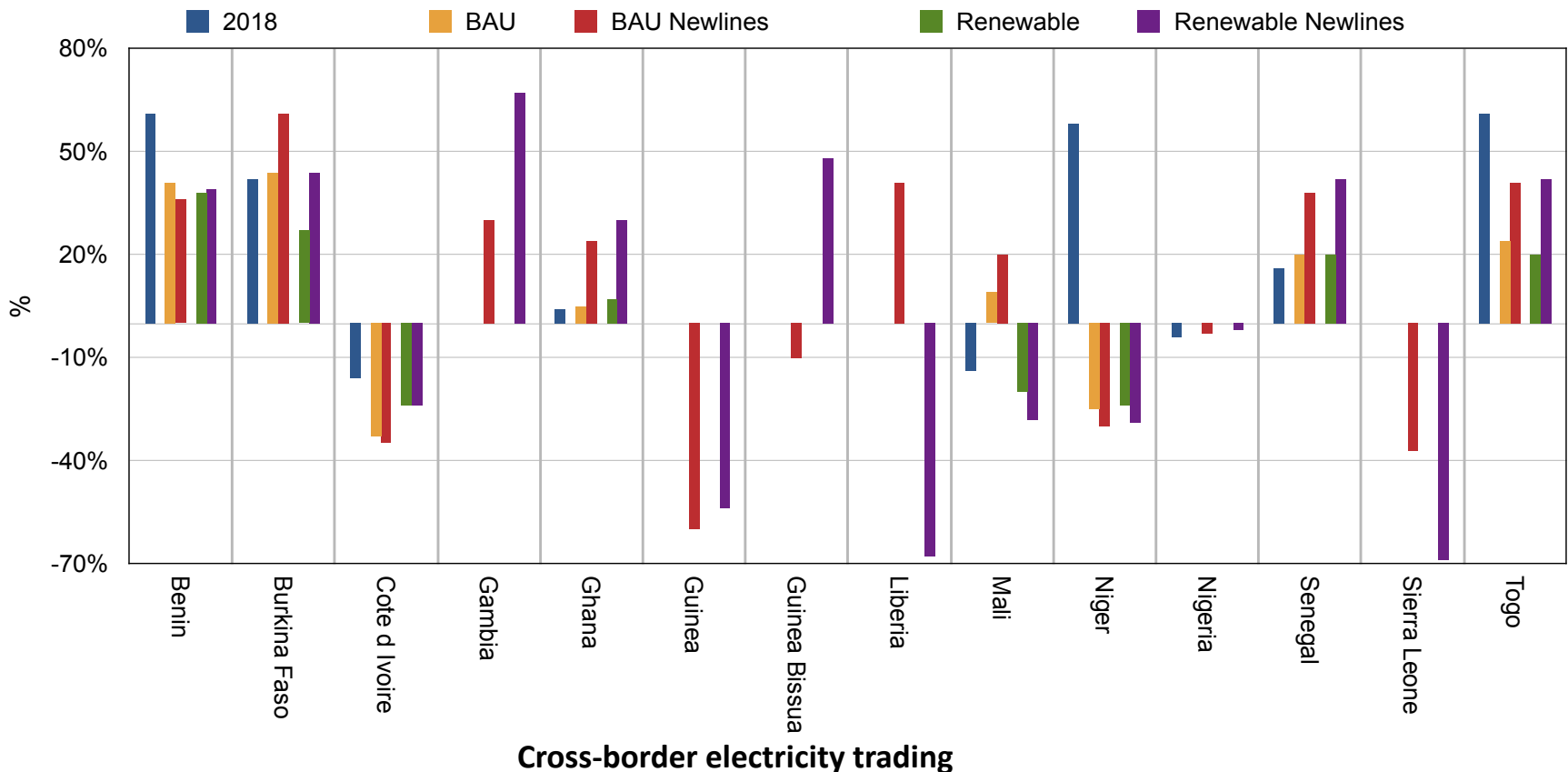
- This highlights the inadequacy of planned generation units in meeting the projected 2030 demand in the region.
- Interconnections provide countries with sufficient reserve margin an opportunity to export electricity to countries with unserved electricity demand



Results

Cross-border electricity trade

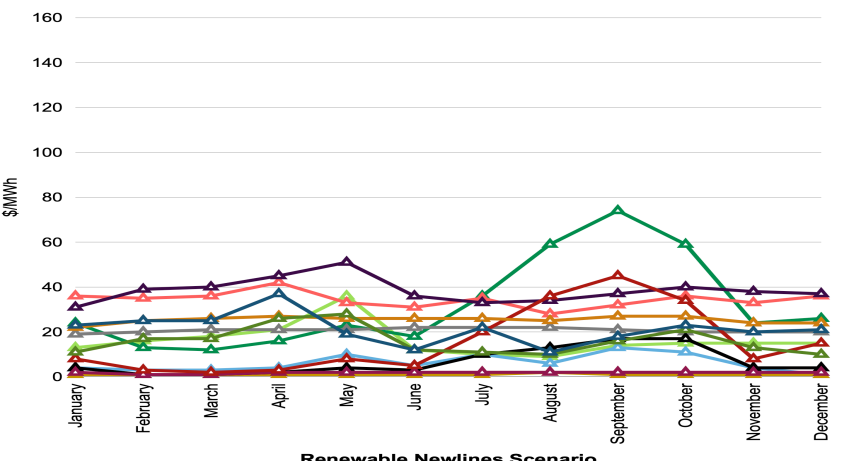
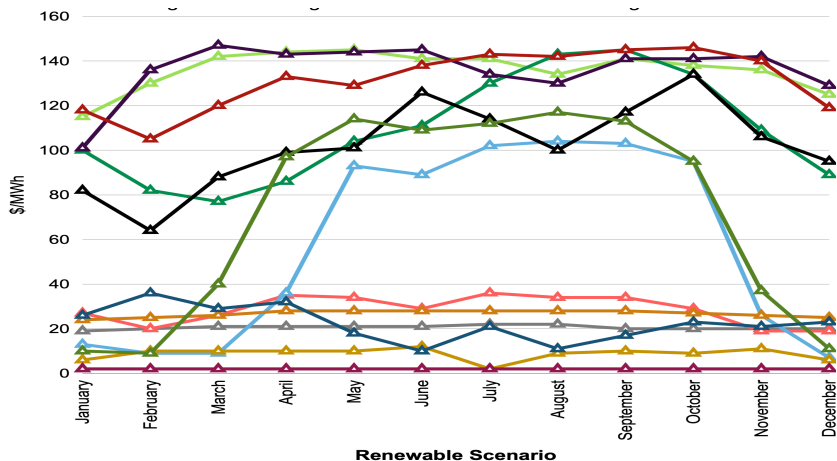
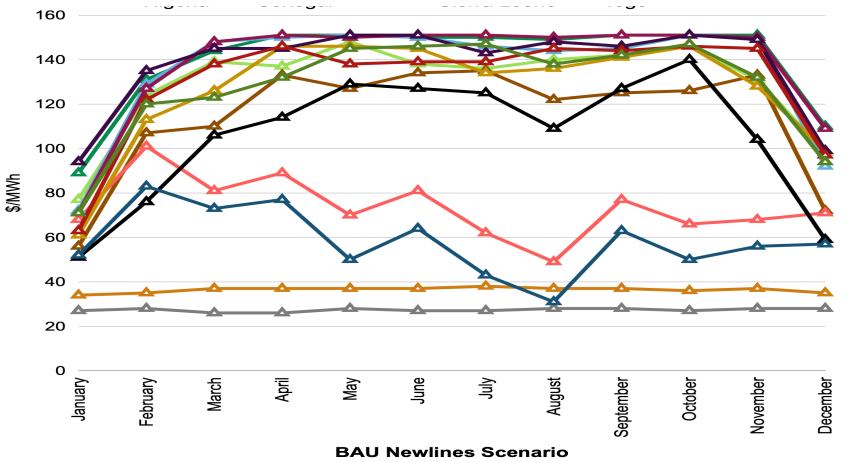
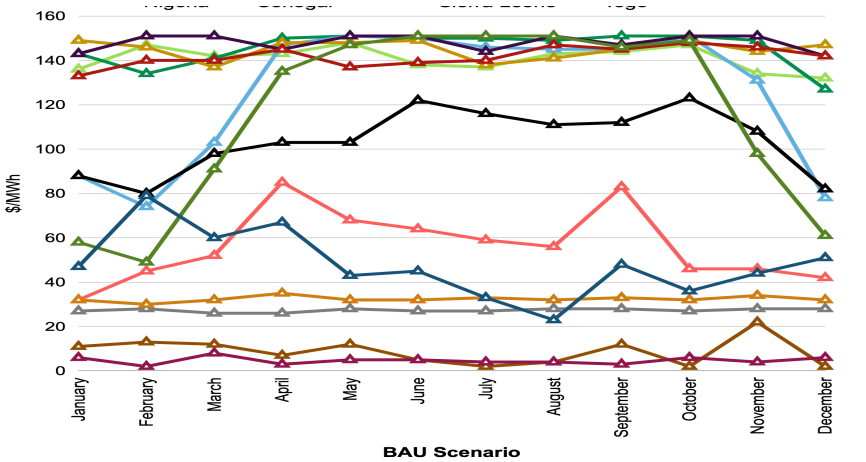
- With additional RES integration and interconnections , some countries switch from net importers to net exporters.
- In the *BAU Newlines* scenario, majority of the interconnection lines are under-utilized with only 11 out of the 25 lines utilized up to 50%



Results

Average Marginal costs

- With additional interconnections, average marginal costs converge, with most of the net importing and net exporting countries decreasing and increasing respectively



- Benin
- Burkina Faso
- Cote d'Ivoire
- Gambia
- Ghana
- Guinea
- Guinea Bissau
- Liberia
- Mali
- Niger
- Nigeria
- Senegal
- Sierra Leone
- Togo

Results

- Sustainability Assessment**

| Country | Equal Priority | Technical Priority | Economic Priority | Techno-Economic Priority | Environmental Priority |
|----------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Benin | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Burkina Faso | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Cote d Ivoire | Renewable | Renewable | Renewable Newlines | Renewable Newlines | Renewable |
| Gambia | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Ghana | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Guinea | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Guinea Bissua | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Liberia | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Mali | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Niger | Renewable | Renewable Newlines | Renewable | Renewable Newlines | Renewable |
| Nigeria | Renewable Newlines | Renewable Newlines | Renewable | Renewable Newlines | Renewable Newlines |
| Senegal | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Sierra Leone | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |
| Togo | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines | Renewable Newlines |



Top ranked sustainable scenarios for West African countries

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Conclusion and policy recommendation

Reliability

- . 100% reliability for all countries, thus no unmet demand.
- . However some countries could rely on imports to meet up to 40% of its demand.
- . Policies ensuring the implementation of cross-border electricity trading agreements and complete liberalization of the electricity sectors.



Conclusion and policy recommendation

Affordability

- . Average marginal cost in the region converges.
- . Diesel and heavy fuel maintained as reserves, and are susceptible to price fluctuations.
- . Future policies need to focus on increasing investments in RES and diversifying operating reserves in countries.



Conclusion and policy recommendation

GHG emissions

- . GHG emissions decrease by up to 44%.
- . No specific GHG emission reduction targets on a national or regional level.
- . The Paris agreement signed by all the 14 countries needs to be converted into GHG emission reduction targets to change the current investment direction of generation capacities .



Thank You for Listening

