Electrification modelling for Nigeria

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Reiner Lemoine Institut (RLI)

Overview

- Not-for-profit research institute
- 100 % subsidiary of Reiner Lemoine-Foundation (RLS)
- Established 2010 in Berlin
- Three research groups:
  - Transformation of Energy Systems
  - Mobility with Renewable Energies
  - Off-Grid Systems
- Member of: ARE, eurosolar, BNE, dena, EEA
- Managing Director: Dr. Kathrin Goldammer

Reiner Lemoine
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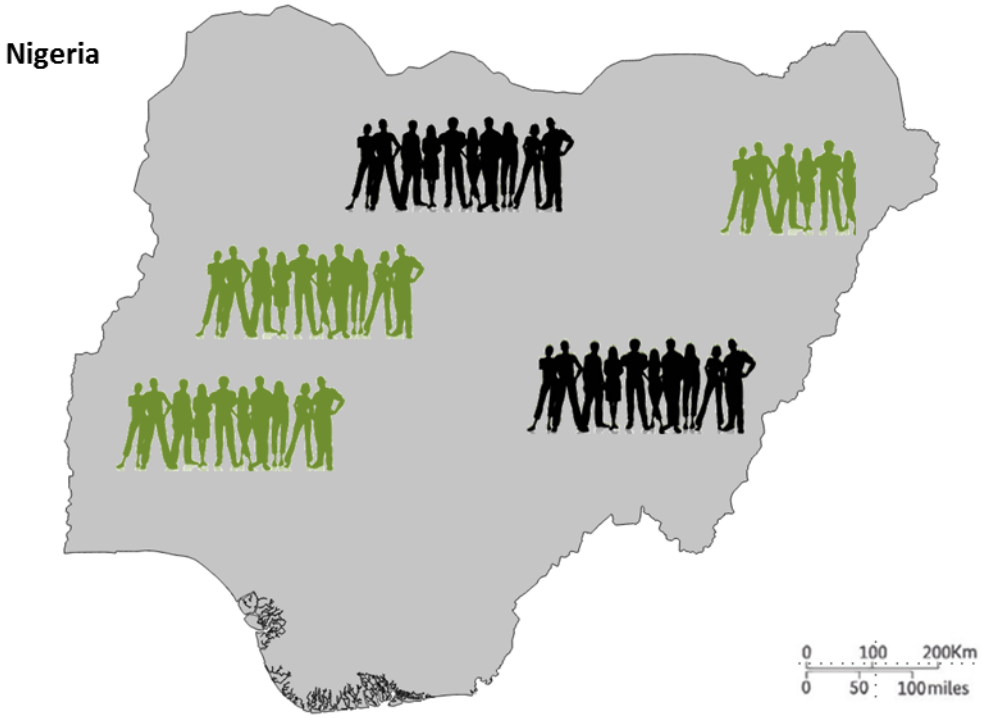
Agenda

- Introduction
- Research questions
- Methodology
- Results
- Conclusions

Introduction



- 181 million inhabitants
- 83 million people without power (46%)
- Centr. installed generation capacity: 6 GW
- Estimated decentral capacity: 6 GW

- 81 million inhabitants
- All electrified
- 180 GW (15x Nigeria)

Research questions

This project assists rural electrification planning by providing numbers on the potential of photovoltaic (PV) systems for rural electrification by Solar Home Systems (SHS) and hybrid Mini-Grids for entire Nigeria.

The attempt is complex because essential data on the current status of electricity supply and load demands in rural areas is lacking and profound work-arounds need to be established.

Research questions:

a) Where are rural consumers located?

b) Are they supplied with electricity?

c) What would be the most suitable electrification option?

d) What are the needed PV capacities for mini-grids and SHS?

Methodology - Overview

GIS analyses by QGIS to

- derive consumer cluster
- identify status of electrification
- define priority areas for electrification by grid extension, Mini-Grids, SHS

Literature analyses

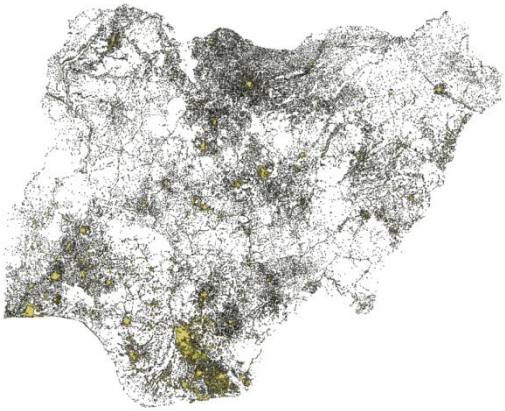
- define loads and electricity consumption for Mini-Grids
- define size of SHS for stand-alone electrification

Energy system modelling to

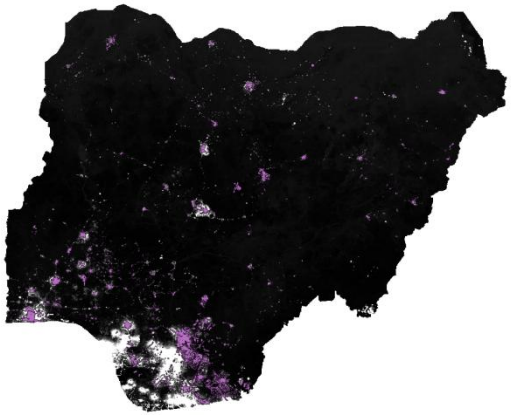
- derive shares of PV energy in one typical Mini-Grid as baseline for extrapolation of PV Mini-Grid potential

Methodology - Parameters

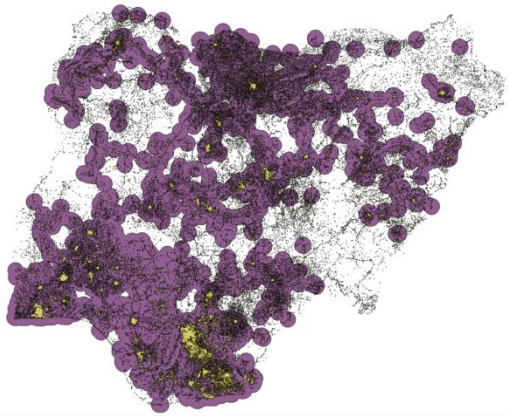
Consumer cluster



Status of Electrification

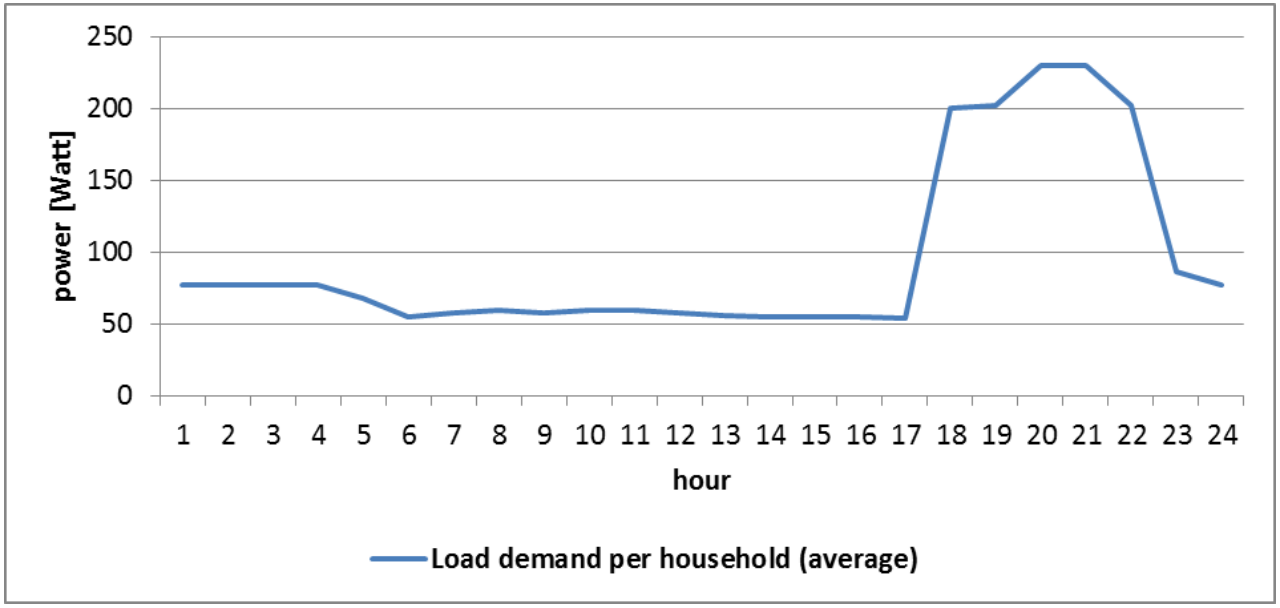


Electricity supply options



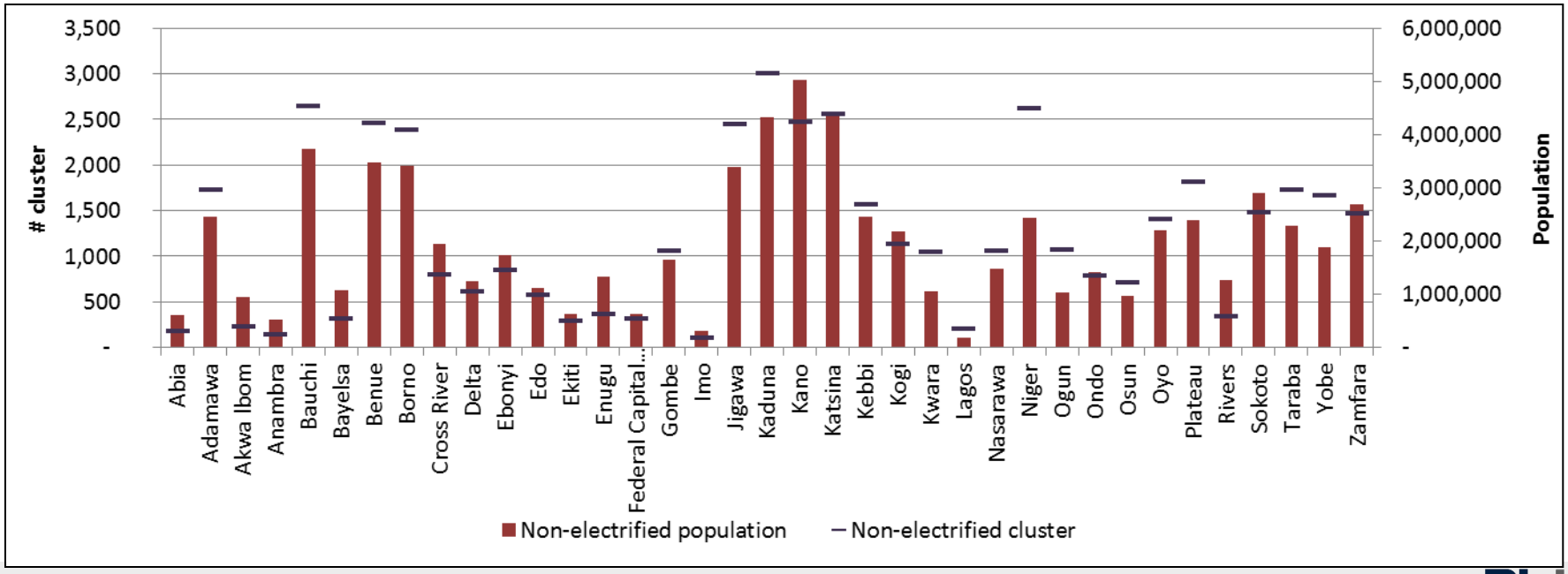
Methodology - Load Demand for Mini-Grids

- On average 5 persons per rural household are assumed
- Per household a combined electricity consumption of 2.3 kWh/day (840 kWh/year) is assumed on average, annual peak load is appr. 350 W
- Suggested PV capacities for further analysis
  - Low share system: 0.75 times peak load
  - High share system: 2 times peak load



Results - Status of Electrification and population

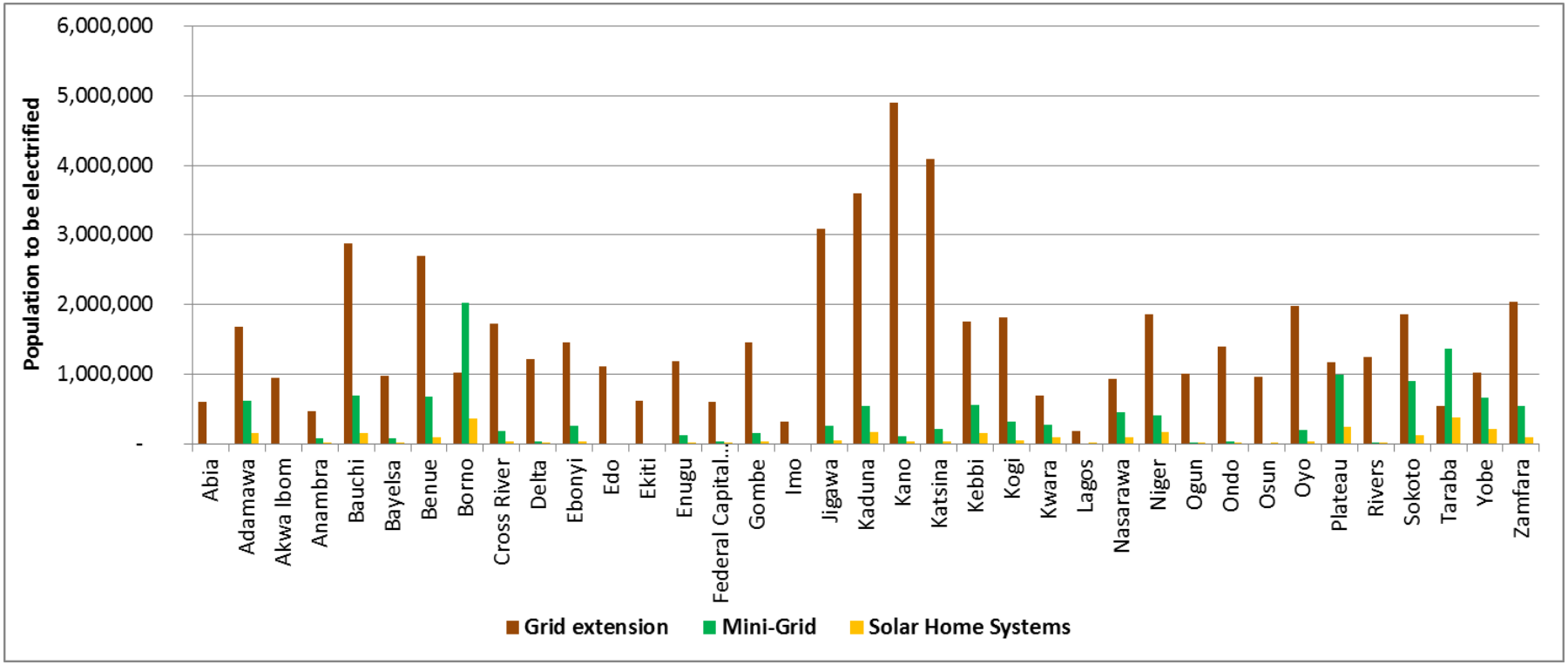
- In total: 47,489 clusters including 171 of 181 million people of Nigeria are identified
- In total 45,456 clusters are non-electrified (95 %)
- But only 83 out 181 million people are non-electrified (46 %)
- Analysis allows to determine not only number but also location of non-electrified people



Results - Electricity supply options

Total results

- Grid electrification: 34,446 cluster 57.1 million ppl
- Mini-Grid electrification: 3,800 cluster 12.8 million ppl
- SHS electrification: 7,210 cluster 2.8 million ppl



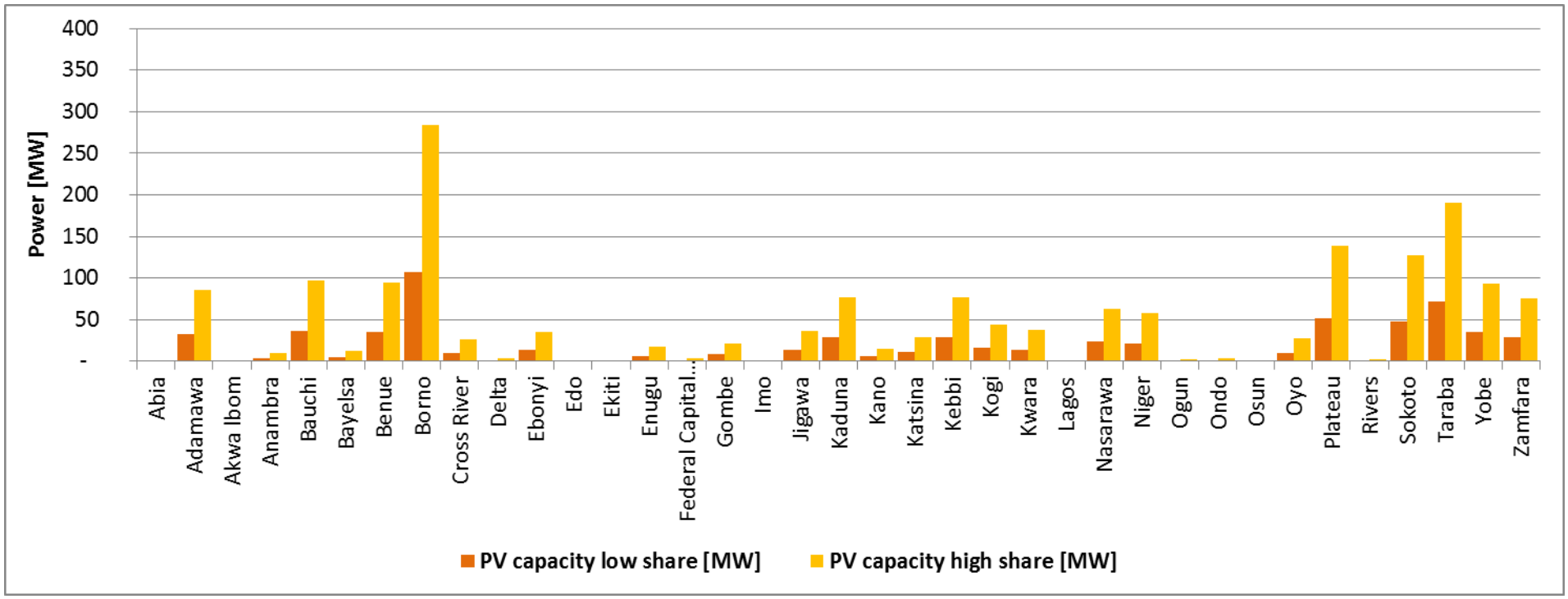
PV potential Mini-Grids – Results

Per Mini-Grid priority cluster 263 Wp PV (low share RE) and 700 Wp (high share RE) capacities are assumed for each household

Total capacity: 671 MW (low share); 1,790 MW (high share)

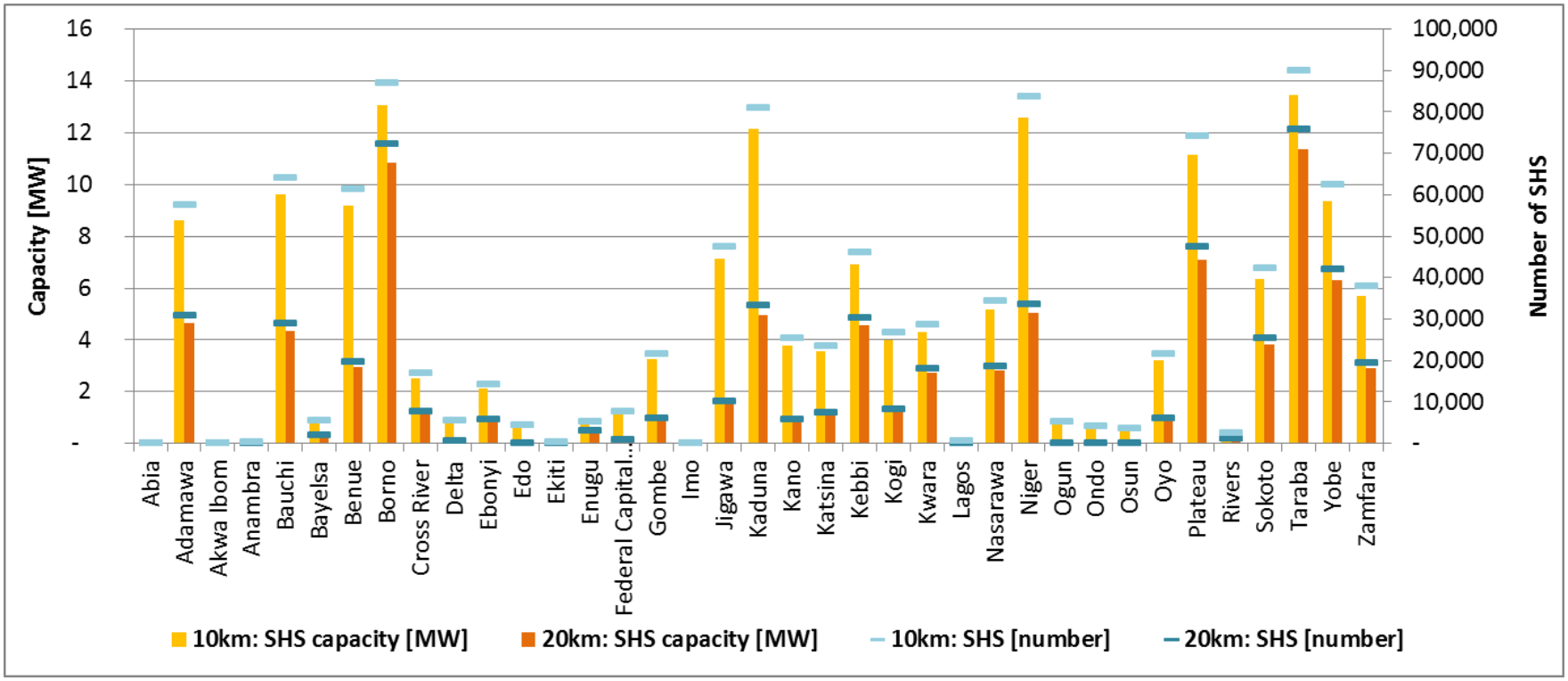
Per Mini-Grid cluster only one PV hybrid Mini-Grid is assumed

- Total number: appr. 3,800



Solar Home Systems – Methodology / Results

- Per SHS priority cluster 150 Wp SHS capacities are assumed for each household
- Total capacity: 84 MW
- Total number 0.6 m



Conclusion & Limitations

Conclusion:

PV potential for hybrid Mini-Grid electrification ranges from **671 to 1,790 MW**

- Two scenarios for low and high share RE systems
- Low share RE: 671 MW
- High share RE: 1,790 MW

SHS PV potential for stand alone electrification roughly **84 MW**

Limitations:

- No detailed simulation for grid extension costs was performed
- No detailed energy system modelling for each cluster was performed
- No specific regional input parameter could be applied

Results show a preliminary possible range of PV potential for Mini-Grid and SHS electrification

Related aspects / potential of Africa-EU research cooperation

- This study is of high relevance for African-European partnerships as enhancing rural electrification remains a major task in many African countries besides Nigeria
- With our methodologies we address the lack of planning capacities which are regarded as one of the main obstacles for rural electrification
- The developed methodologies are transferred to Nigerian authorities through training which will increase capacities and potential for African-EU cooperation
- The overall approach is applicable for other African countries and needs to be further developed in upcoming research projects

Contact

Thank your for your attention!

Get in touch with us for:

- Research collaboration
- Collaborative project applications
- Industry partnerships

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