AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE DE DÉVELOPPEMENT

Opportunities for Mini-grids in Africa

Angola GMG market assessment

AfDB Green Mini-Grid Market (GMG) Development Programme

Carbon Trust

28/07/2020

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Green Mini-grid Market Development Programme

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The Green Mini-Grid (GMG) Market Development Programme (MDP) aims to foster access to electricity across Africa

- The GMG MDP is a pan-African programme launched in 2015 to develop green mini-grids across Africa and increase energy access.
- The GMG MDP has five business lines to address the main GMG market barriers through:
  - Establishing **comparable and actionable data** of the GMG market opportunity;
  - **Promoting the linkages** between communities, public institutions, developers, financiers, and technology providers;
  - **Strengthening** capacity of developers;
  - Promoting a **sound policy and regulatory environment;**
  - Supporting the development of **suitable financial solutions.**

Green Mini-Grids Market Development Programme	
Business line	*Barrier addressed*
Market Intelligence	*Lack of data and market linkages*
Business development support	*Lack of Proven Business Models, Unmade Linkages*
Policy and regulatory support	*Gaps in policy environment*
Access to finance	*Lack of viable business models and access to finance*
Quality assurance	*Standardization, Policy Environment*

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The GMG MDP is supported by a grant from the AfDB's Sustainable Energy Fund for Africa (SEFA)

- The Sustainable Energy Fund for Africa (SEFA) is a **multi-donor trust fund** administered by the African Development Bank.
- SEFA has the development objective to create employment opportunities and build strong African economies through providing **reliable, clean and affordable energy through**:
  - Supporting small- and medium-scale **Renewable Energy** (RE) and **Energy Efficiency** (EE) projects in Africa.
  - Supporting **sustainable private-sector led economic growth**.
- In total, **USD 95 million** has been committed by the Governments of Denmark, USA, UK and Norway.
  - Of this, **USD 4 million** was committed to the GMG MDP Phase 1 and 2
- SEFA has the ability to fund additional projects that result form the market intelligence work

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The *GMG helpdesk* was developed under the business development and policy support of the MDP to provide hands-on support

GMG Helpdesk focuses on two main areas

Hands on support

- To project developers across the continent
  - To date over 93 developers across 36 countries have been supported
- Policy makers
  - E.g. tariffs study for Nigeria and Sierra Leone

Online knowledge hub

- GMG Market Assessment reports
- Development of Quality Assurance Framework in Nigeria

Market assessment reports can be downloaded from the **Green Mini-Grid Help Desk**
https://greenminigrid.se4all-africa.org/

All public and private stakeholders are encouraged to view the site and contact the Help Desk for any technical assistance around GMGs

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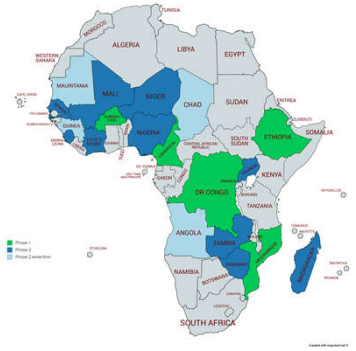
The *Market Intelligence* business line provides comparable, actionable data on the potential for GMGs across Sub-Saharan Africa

- Market Intelligence Business Line has the following components:
  - Analysis/identification of the mini-grid opportunity across 19 countries in SSA
  - Developing a standard market sizing methodology
  - Collate comparable data such as mini-grid market size, off-grid policies, regulations, key structure etc.
  - Development of a database of mini-grids across SSA.

Delivery Partners	**Main:** Carbon Trust **Phase 1:** UNEP, ECREEE **Phase 2:** Ecowas Centre of Renewable Energy and Energy Efficiency (ECREEE), SNV, ENCO



- Market intelligence generated will:
  - Foster the ability of project developers, investors and public entities to **identify market opportunities for GMGs**.
  - **Support linkages** between central authorities, local/national businesses, investors and communities with demand for power.

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The market assessments provide a detailed overview of the GMG market framework, opportunities, key players and challenges

The country reports includes the following sections:

- Country overview
- Energy and power sector analysis
- Off-grid sector analysis
- Mini-grid opportunity assessment and GIS analysis
- Renewable energy potential
- Recommendations
- Stakeholder and policy database

Energy and power sector analysis:	Off-grid sector analysis:	Renewable energy potential* for mini-grids:

• Actors, roles and responsibility
• Policy and regulatory analysis
• Installed capacity and electricity access rates
• Tariffs
• Transmission and distribution network
	• Energy access policy and planning
	• Licensing requirements
	• Mini-grid tariffs
	• Subsidies and Incentives
	• PPAs
	• Arrival of the grid
	• Technical Rules
	• Mobile services
		• High level overview of potential for
		  • Hydro
		  • Biomass
		  • Solar
		  • Wind
		*(*Desktop study only)*

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The main target audience for the market assessments are respectively the private sector, donors (e.g. DFIs) and policy makers

Local policy makers	• Status quo of GMG regulatory framework, roles and key players • Analysis and identification of gaps and weakness in policy and regulatory environment and how it affects other aspects of mini-grid development
Development Financial Institutions	• Identification of challenges and barriers and where assistance can be provided • Scan of existing initiatives, and potential additional gaps to be supported • Creation of new investment opportunities
Private sector/developers	• High level assessment of market opportunities (i.e. areas and size) and most lucrative market • Raw data for further own analysis

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Mini-grid market observations in Angola

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The Carbon Trust and ECREEE conducted the Angola country visit jointly and engaged key energy stakeholders

1. Desk research and preliminary draft
2. Country Visit (1 week, Sept 2019)
3. Report write up and market size GIS analysis
4. Review with AfDB and local experts

- **A special thanks to the following stakeholders:**
  - African Development Bank
  - Ministry of Energy and Water
  - World Bank
  - UNDP/GEF
  - Aggreko
  - IRSEA - Instituto Regulador dos Serviços de Electricidade e de Água
  - GreenTech
  - Associação Angolana de Energias Renováveis - ASAER
  - Prodel - Public Electricity Production Company
  - RNT - National Electricity Transport Network
  - ENDE - Electricity Distribution Company
  - Anglobal
  - Power Blox
  - GEP

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Angola has an installed capacity of 6.4 GW, mainly hydro and thermal and three independent grids.

- Population: **c. 31 million**
- Electricity access:
  - **National 40%**
  - **Urban 70%; and**
  - **Rural 16%**

  (World Bank, 2019)
- Installed capacity: **6.4 GW**
  - **Hydroelectric (3.7GW)** and **thermal (2.7GW)**
  - Generation market **liberalised;**

  (MINEA, 2018; USAID, 2019)
- **Three separate main grids:**
  - Northern – 400kV and 220 kV lines
  - Central – 400 kV; and
  - Southern – 220 kV

- Mini-grids comprise **6.8%** of total installed capacity Almost entirely publicly owned, no fully private operators
  - **Mostly diesel** and only **8 hybrid and solar PV** (only) mini-grids – all publicly owned
  - Estimated to amount to a total installed capacity of **139MW**

    (REN21, 2018)
- Private sector actors are involved in standalone solar home systems
  - Noteworthy is the **400 SHS** installed using a PAYG model by Green Tech

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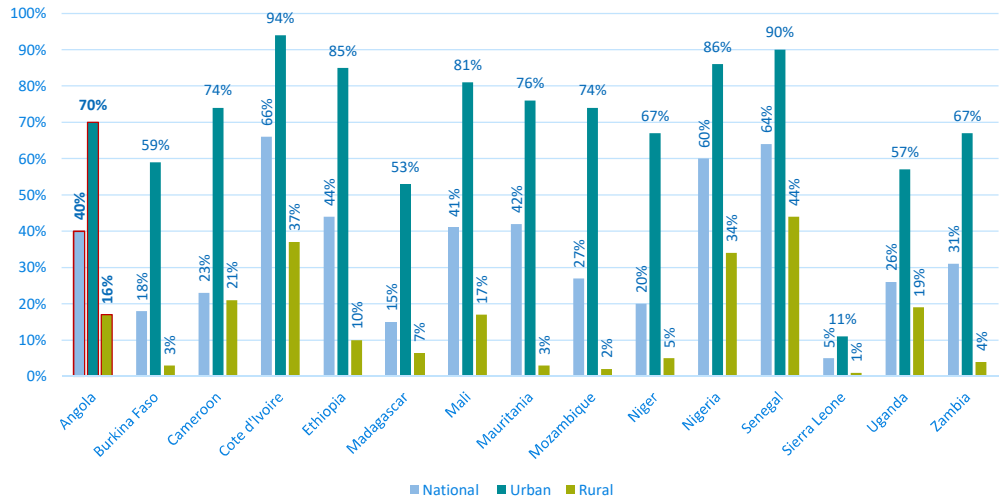
Angola's national electricity access rate (40%) ranks among the top 5 across the 19 countries assessed in the GMG MDP

National, rural and urban energy access rates

A major rural electricity access gap still exists



Source: Green Mini-grid Market Intelligence Country Reports (World Bank, SE4All, IEA)

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Successful mini-grids market deployment heavily depends on the establishment of a robust enabling environment

Policy and regulation

- Clarity of roles between different government departments
- National policies translated to action plans
- Specific policy for mini-grids in the country's national electrification plans – including procurement process, and clarity on balance between on and off-grid and clear targets
- Regulatory framework is clear, in favour of IPPs and private sector investments in mini-grids
- Clear and streamlined mini-grid regulation requirements: e.g. site selection, rules for future integration with the grid scenarios

Off-taker & Site development

- Availability of accurate geospatial and socio-economic information on sites to aid identification
- Productive uses and baseloads anchor clients
- Adequate demand for the amount of power produced

Tariffs

- Ability to charge cost reflective tariffs
- Provision of subsidies and incentives to reduce tariff
- Revenue collection (e.g. mobile payment)
- Community's ability and Willingness to Pay

Licensing

- Clear licence thresholds e.g. 1MW
- Streamlined licence approval process (including to receive exemption)
- Low cost of regulatory compliance (licensing and EIA)

Arrival of grid

- Predictable grid extension plans
- Clarity on what applicable rules upon arrival of the grid arrives
- Technical rules/requirement for integration of mini-grids into the grid

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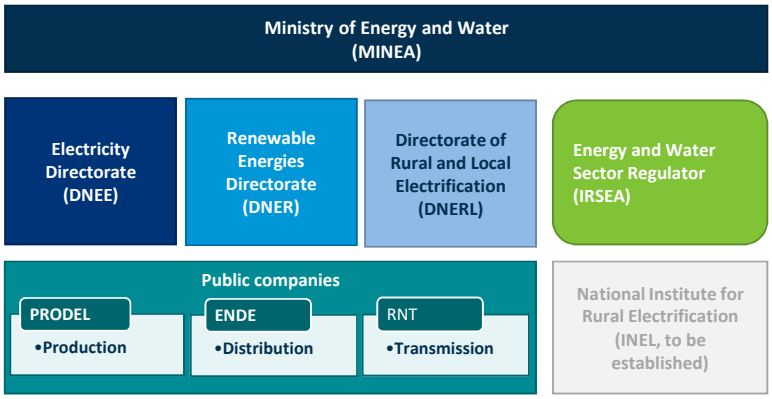
The Angolan power sector has been unbundled, but is lacking clarity on roles for different government departments

Policy & regulation



- ✓ Unbundling of the utility allowed private sector participation (since 2015)
  - × Lacks clarity in relation to relationships and responsibilities between e.g. PRODEL, ENDE and RNT
- × Capacity of the DNERL is limited and there is no Rural Electrification Agency equivalent
- ✓ Angola is in process of establishing National Institute for Rural Electrification (INEL) and an accompanying Rural Electrification Fund (REF)
  - × Progress slow to establish INEL and REF

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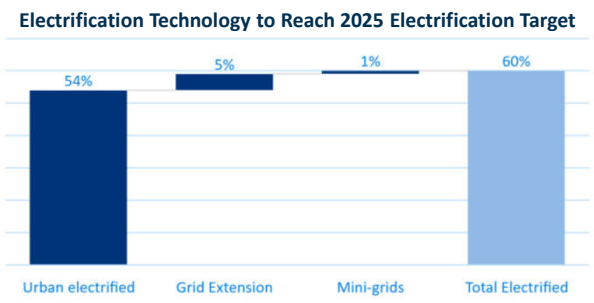
National policies such as Angola Energia 2025 has been translated to 5-year action plans with clear on vs. off-grid targets

Policy & regulation

Policy/strategy	Private sector/mini-grid related elements
Angola Energia 2025 *(targets being revised and extended to 2050)*	• 60% electrification by 2025 • Identified 31 locations for mini-grids 7 mini-hydro; 1 medium hydro; remainder diesel and solar PV • Mobilisation of private sector capital
2018-2022 Action Plan for the Energy and Water Sector	• 40 power distribution licenses for isolated systems • 1.5 GW of installed power from the private sector in 2022 (500 MW of which is will be renewables)
Atlas and National Strategy for New Renewable Energies	Improve access to energy services in rural areas through renewables, including: • 500 additional villages powered by solar/renewables; • 200 additional agricultural communities



- ✓ Policy and strategy framework in place which includes the recognition of the role of off-grid (mini-grids) in electrification
- ✓ Clear distinction between on- and off-grid targets
- × National electrification plan still under development

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Application of regulations to private mini-grids unclear, therefore limiting private sector participation

Policy & regulation

Private sector involvement is recognised as important. However, challenges remain:

- Unfavourable policies and business environment (Ease of doing business 177/190)
- Application of regulation to private mini-grids remains unclear – applied on-case by-case basis

Political will for reforms to crowd-in private sector participation and investment

GoA have been taken action to address gaps in regulatory framework e.g.:

- Creation of mini-grid (<5MW) and electrification framework with support from AfDB, UNDP and WorldBank

- ✓ Regulation allows private sector participation and MINEA strongly encouraging private sector participation in strategies
- × Application of licensing process and allowable tariffs to private mini-grids unclear
- × No examples of how regulation will be applied to privately owned mini-grids as all mini-grids are publicly owned
- ✓ GoA has political will for reform. Number of initiative seeking support towards taking first steps to improve the regulatory environment and creating a conducive environment for private sector participation and investment

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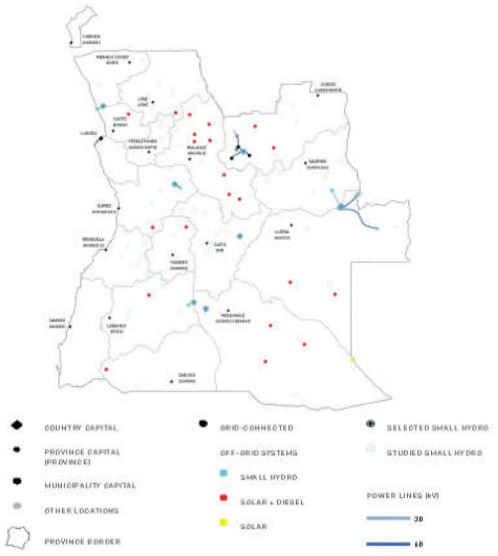
Potential sites for mini-grids have been identified and will be procured through an open procurement process in future

Site development

GoA to launch tenders for a combined capacity of 100 MW to develop small and medium hydro, solar PV and diesel plants at these identified sites

Angola Energia 2025 identified 31 areas most suitable for mini-grids, including a proposed technology

A National Electrification Plan is under development with support from WorldBank



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There is limited detailed information to identify sites in addition to the 31 sites listed in the 2025 strategy

Site development

Developers require sufficient information to develop in-country projects:

- Existence of **productive uses hotspots** and **baseload** clients
- **Quantity and patterns of consumption** to ensure adequate demand for the amount of power produced
- **Information on sites** e.g. GPS coordinates, socio-economic information, etc for site identification.

- ✓ Potential site identified in Angola Energia 2025 strategy
- ✓ Procurement through tenders to be launched in future
- ✓ Current distribution network to be re-mapped
- × However, no publicly available software or database
- × Impedes ability to analyse current and planned systems
- × No National Electrification Plan

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The allowed tariff and electricity system that would apply to privately owned mini-grids is unclear

Tariffs

It is currently unclear which system is applicable to private isolated systems

The allowable tariff is dependent on the applicable electricity system:

Public Electricity System - SEP

- Electricity producers connected to the Public Electricity System (SEP), that is, selling electricity primarily to the public - **national tariff applies**

Unliked electricity System - SENV

- Outside of the public electricity system, as part of the SENV - **cost reflective tariff may be charged through contractual agreement**

- **Tariffs**
  - × Uncertainty regarding applicable tariff regime for mini-grids
  - × Lack of an example and/or existing tariff structure for a private commercial mini-grid model
  - ✓ IRSEA mandated to develop new tariff regime for IPPs
    - × Unclear if this would apply to mini-grids
- **Ability to pay**
  - × Social tariff very low at c. $0.02/kWh
- **Subsidies**
  - × No subsidy mechanism in place
- **Incentives**
  - ✓ Exemption from import duties
  - ✓ Tax breaks
  - × Unclear whether these have been applied to off-grid systems

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How the regulations, including licensing requirements, would apply to privately owned mini-grids is currently unclear

Licensing

There is no regulation that clearly defines private mini-grids, nor sets out the framework allowing private entities to sell directly to end customers

>100kW

- The Regulation for the Licensing of Electricity Production, Transmission and Distribution Facilities

<100kW

- 2015 Electricity Law and Decree No. 31/04 of 2 July and the Draft Electricity Sector Regulation (released for public comment)

- × None of the regulations specifically refer to mini-grids
- × Process to follow unclear for privately owned mini-grids
- × No examples of how regulation will be applied to privately owned mini-grids
- ✓ Where the facilities are less than 100 kW, an exemption from obtaining generation licences may be sought

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There are currently no specific rules dealing with the arrival of the grid for mini-grids

Arrival of the grid

The National Electrification Plan is under development, but it is not clear when it will be finalized

PDMP elaborated with support from JICA

Grid extension plans

- Current strategic documents do not provide a firm roadmap and guidance for rural electrification

Rules upon arrival of the grid

- **SEP**
  - Dependent on type of user
  - Must be agreed with network operator and IRSEA
  - Network Access Regulation
- **SENV**
  - Generation concession or power generation license

Technical rules for integration into the grid

- No mini-grid specific
- Electricity Act
  - Safety rules

- × Limited information available on the process of integrating a mini-grid into the main grid
- × There are currently no mini-grids specific technical rules in Angola
- × No clear electrification plan specific to rural areas
- × No examples of how regulation will be applied to privately owned mini-grids

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The Angolan mini-grid sector is still nascent as several aspects of the required enabling environment for mini-grids are still lacking

Policy and regulation

- Clear institutional structure but unclear responsibilities for role-players, and no rural electrification agency (REA) or equivalent
- National policies are translated into electrification targets and action plans, including for clear targets for both on and off-grid
- Application of regulations to the off-grid sector unclear, limited incentives for private sector participation

Site development

- 31 potential sites for mini-grids identified in Angola Energia
- Information regarding energy demand and other socio-economic data should be made available

Tariffs

- Allowed tariff and electricity system that would apply to private sector mini-grids is unclear
- Low local ability to pay
- Currently no subsidies

Licensing

- Process to follow to secure licences unclear for privately owned mini-grids
- Licence threshold of 100kW

Arrival of the Grid

- Lack of clarity around grid extension plans as national electrification plan under development
- No rules for arrival of the grid arrives
- Unclear mini-grid technical standards

Key > > Most enabling to limiting areas

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Most donor programmes focus on creating an environment that facilitates RE deployment from IPPs

SEFA	• Electricity Sector Transformation Program Loan • Energy Sector Efficiency and Expansion Programme Phase I (ESEEP-1) • Angola Programme for Renewables (AREP) • Establishment of the National Institute for Rural Electrification • Mini-Grids Framework Development • The GoA submitted a request for financing to SEFA, for the development of a Mini-grid Program (pipeline)
THE WORLD BANK	• Preparation of Rural Electrification Strategy (ongoing) • Electricity Sector Improvement Project • Scaling Solar programme
	• Power Purchase Agreement (PPA) model for Renewable Energy Projects
gef	• Promoting Sustainable Energy Access for Rural Communities in South Eastern Angola • Africa Mini-grids Program (AMP):
POWER AFRICA	• Southern African Energy Programme (SAEP)
JICA	• Power Development Master Plan

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Angolan Mini-grid Market Size

The Carbon Trust analysis estimates the population size best served by mini-grids using geospatial data

Methodology

Country divided into three areas based on population density and proximity to grid:

Grid Extension areas:

- Areas within 15km of existing electricity transmission network.

Mini Grid

- Further than 15km away from existing electricity grid & density > 50 households per km^2. Scenario provided for both with current and future grid extension

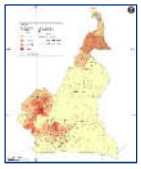
Future grid

- Repeat for planned transmission network

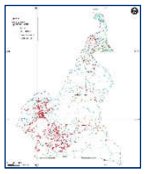
Solar Home System

- Further than 15km away from existing electricity grid & density < 50 households per km^2

Inputs

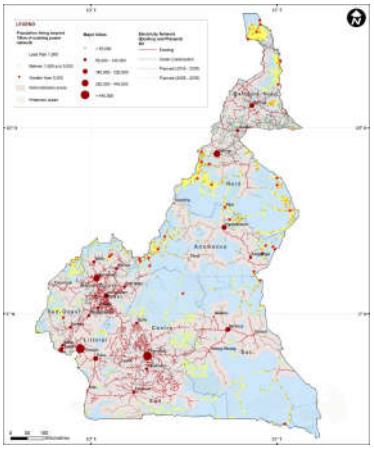


Population density



Grid: High voltage lines and night lights

Output



The methodology used is conservative as it excludes electrified areas, and potential sites within 15km from the grid

The Carbon Trust used a combination of night-lights and High Voltage (HV) line datasets as it provides a more comprehensive picture of current electrification vs. using HV lines alone.

Market size might be an underestimation as we have only considered GMG populations are those beyond 15km of the grid

It is worth noting that some developers may wish to consider regions already serviced by the grid, particularly where the grid is not reliable

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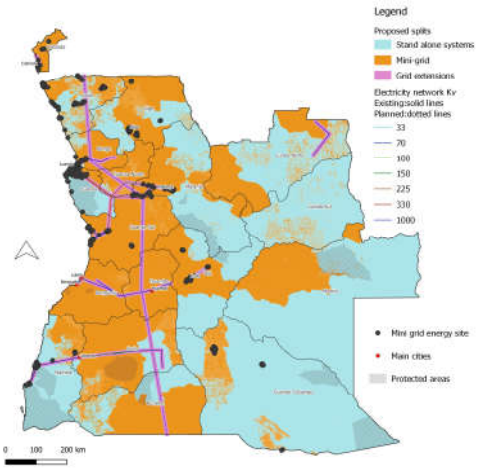
With the existing grid, 32% of the (or 47% of the unelectrified) population would be best served by mini-grids in Angola.

Current grid

- This corresponds to **9.9 million** best served by mini-grids.
- 1.2 million best served by solar home systems; and
- 10.1 million people living within 15km of the grid and best served through grid electrification

Planned grid extension by 2025

- Not calculated due to a lack of accurate GIS data on future grid expansion scenario



Source: Carbon Trust analysis

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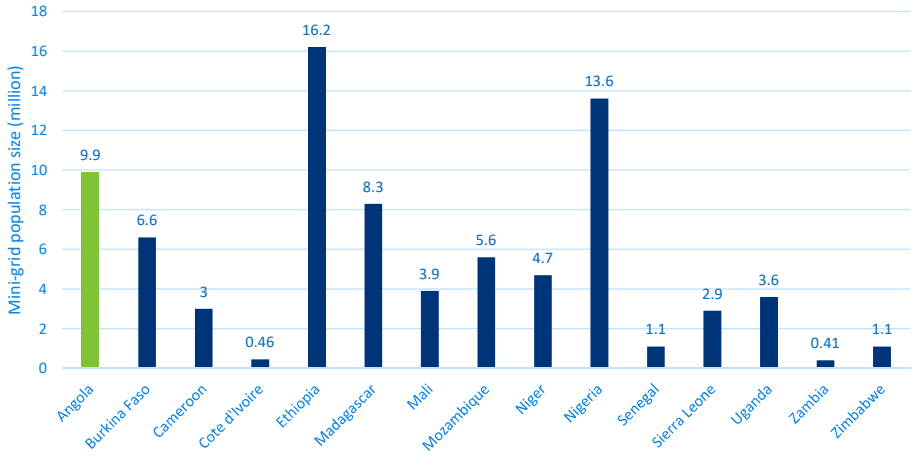
Angola has the third greatest number of people that will be best served by mini-grids compared to other countries in the MDP

Mini-grid market (population)



Source: Carbon Trust analysis

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The market size is then calculated by applying a likely electricity expenditure (either per capita or by household)

The Carbon Trust developed four different electricity expenditure scenarios.

However, only one was used for Angola based on availability of data

Methodologies	Details
Methodology 1	Existing rural household expenditure on electricity based on the World Bank Global Consumption Database
Methodology 2	**Existing rural household expenditure on electricity based on other literature and sources**
Methodology 3	Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL Tier 2/3 energy access nationwide, and an average allowable tariff currently used in-country.
Methodology 4	Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL Tier 2/3 energy access nationwide, and a flat tariff of $0.4/kWh

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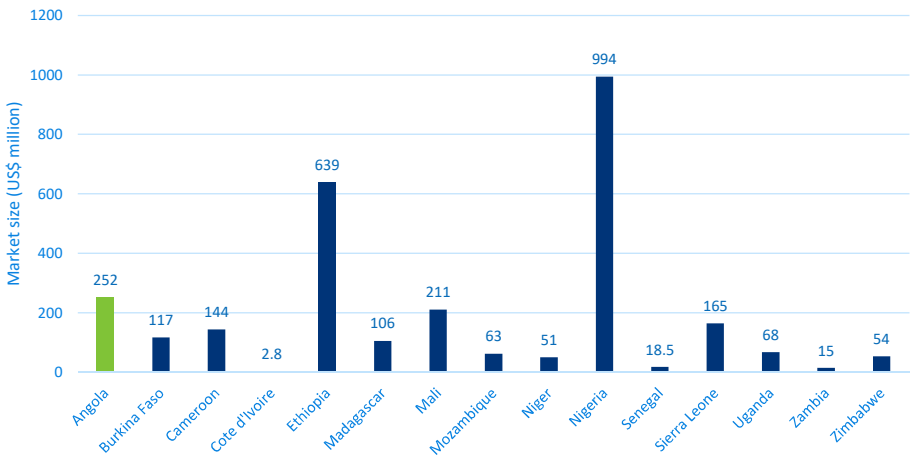
The analysis estimates a total annual revenue market size of $252 million for mini-grids under the present grid scenario

Mini-grid market (US$)

The methodology assumes an annual spend on electricity per capita was estimated to be **USD25.40**



Source: Carbon Trust analysis

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Huila, Cuanza Sul and Uige are the provinces with the largest mini-grid market potential

Population best served by electrification technology per province

Province	Current grid network		
	Population (thousands)		
	< 15km of grid	Mini-Grid	SHS
Bengo	78	264	0
Benguela	1,301	841	0
Bié	326	676	0
Cabinda	69	383	0
Cuando Cubango	-	148	257
Cuanza Norte	96	225	81
Cuanza Sul	345	1053	0
Cunene	-	545	120
Huambo	658	993	0
Huila	529	1565	0
Luanda	6,240	225	0
Lunda Norte	30	479	182
Lunda Sul	-	199	225
Malanje	232	455	0
Moxico	-	427	154
Namibe	196	71	0
Uige	-	1061	75
Zaire	-	330	76
Total	**10,100**	**9,939**	**1,170**

Source: Carbon Trust analysis

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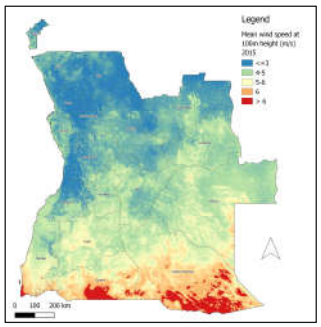
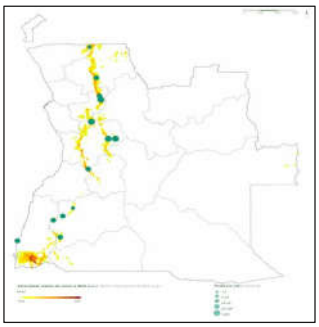
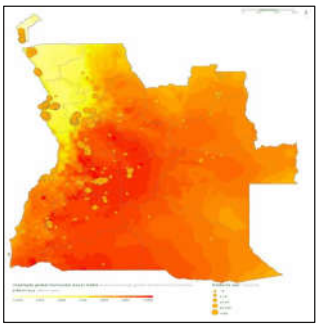
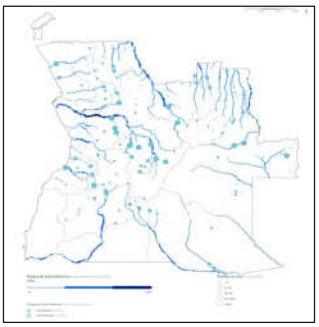
Angola has abundant renewable energy potential to reach the electrification targets

Mean wind speed at 100m height (m/s)	High potential identified sites for wind energy	Solar potential (kWh/m^2)	Hydropower potential
			
• Strongest potential in the south • Potential 3.9 GW	• 604 MW identified in 13 priority projects	• 17.3 GW on and off-grid potential • 704 sites identified	• Potential 18 GW • GoA prioritised development of large-scale hydro

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Concluding Remarks

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This market assessment provides added value to various stakeholders in different ways

Government & policy makers

- **Support linkages** between central authorities, local/national businesses, investors and communities with demand for power.

Development Financial Institutions

- Identification of challenges and barriers and where assistance can be provided
- Scan of existing initiatives, and potential additional gaps to be supported

Private sector/developers

- High level assessment of market opportunities (i.e. areas and size) and most lucrative market
- Raw data for further own analysis

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The large GMG opportunity can be unlocked by creating an enabling environment for private sector investment

- Market opportunity for GMG in Angola is **large**
- Some of the **largest barriers to GMG** development includes
  - **Application of policy and regulations** to the off-grid sector is unclear;
  - There are **limited incentives** for private sector participation
  - Grid extension GIS data
- Donors, such as the AfDB, is **actively providing support to create an enabling environment** for private sector participation in RE e.g.:
  - Technical assistance support for policy creation
  - Policy and regulatory reviews
  - Development of rural electrification strategies and dedicated rural electrification institutions

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Thank you

Questions?

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