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Nigeria: Energy needs assessment and value chain analysis

Version 2.0 (2017)

Together with

Contents

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Research conducted jointly by All On and Dalberg.

Dalberg

Key learnings from energy needs assessment

1. There are **14.2m households and 4.0m SMEs that have no access to electricity** (currently off-grid) in Nigeria.

2. Those in **'bad-grid' areas suffer from chronic under supply of energy. When you combine those off-grid and those in bad-grid areas, it leads to a total of 27.9 million households and 10.6m SMEs with critical A2E needs in Nigeria**; 1.8m of these households and 0.9m of these SMEs are in our three focus states.

3. **The addressable market is large**: off-grid and bad-grid households and SMEs **consume 4.4 TWh and spend US$420m per annum on energy sources (excluding the national grid) in our three focus states alone**, and 8.7 TWh and $823m, respectively, in the six South-South states.

   The six South-South states are Akwa Ibom State, Bayelsa State, Cross River State, Delta State, Edo State and Rivers State. The three focus states are Bayelsa, Delta and Rivers States.

4. Total energy demand in the three focus states, the six South-South states and Nigeria are **expected to nearly double in the next 10 years.**

5. There is currently a high dependence on petrol generators in the Niger Delta as grid electricity is unlikely to increase significantly in the medium-term with DISCOs* focused on the existing grid. The alternative **technologies and solutions that are needed to address A2E challenges – though proven and cost-effective – are largely unavailable.**

6. But given growing demand for reliable energy, there is also a **high willingness-to-pay that is in line with the prices we expect will prevail in the market for the key A2E solutions** (and often less than current spend for grid and generator usage).

* *DISCO means electricity distribution company. These are private sector companies that succeeded the Power Holding Company of Nigeria (PHCN), a public utility company which was privatised in 2012.*

We have developed a view on current and forecast energy use, by volume and spend, based on leveraging our primary research dataset

Research objectives		– Assess household and SME energy use and usage patterns – Assess responsiveness to price and willingness-to-pay – Current size and likely evolution of energy use over a five and ten year horizon
Primary field research	**Field research partner**	Local survey research firm with extensive experience in the Niger Delta, local enumerators, [good] survey methodology, and relevant project experience successfully conducted primary research without any security or safety incidences
	Sample size	**Residential: household surveys** – Sample size: c.300-305 per each of three LGAs in Bayelsa, Delta, and Rivers for a total of 910 household surveys **Non-residential: survey of SMEs** – Sample size: 50-65 per each of three LGAs in Bayelsa, Delta, and Rivers for a total of 165 SMEs surveys **Focus group discussions and interviews** – 22 focus group discussions; 17 interviews with community leaders, business owners, participants in local petroleum value chain
Secondary research		– Census 2006 – National Bureau of Statistics (NBS) – Nigeria Demographic and Health Survey 2013 – Other desk research (IEA, EIA, WEti, World Bank, UN, PIND, etc.)

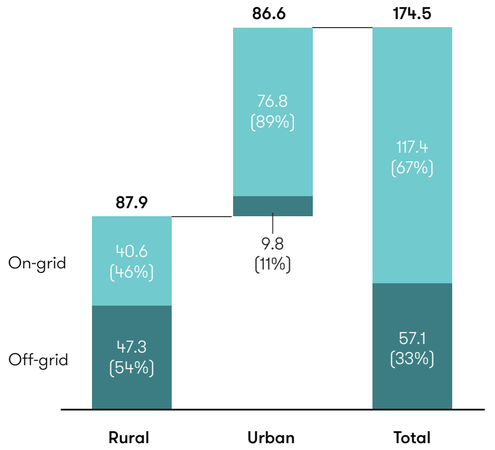
1 Level of analysis	– **Regionally in three focus states** of Bayelsa, Delta, Rivers; South-South, and total Nigeria – **Sectorally, households and SMEs**; and sub-sectorally, the on-grid electrified (>4 hours of electricity supply), bad-grid (<4 hours), and off-grid – **Primary energy source** (i.e., national grid, diesel/petrol generator, kerosene, gas, etc.) **and use** (i.e., lighting, cooking, and appliances) – Biomass for cooking and heating is not included in this analysis as its relatively large energy content (and limited usage in the Niger Delta) biases the opportunity analysis in the whole of Nigeria to a segment that is expected to decline in terms of demand volume
2 Assumptions and scaling methodology	– Household and SME survey data from three focus states is representative and scaled up to the whole of Nigeria. Households are scaled by number of households in each region; SMEs are scaled by employees – Household energy consumption volumes are estimated by reported lighting, cooking and appliance usage multiplied by benchmark kWh for those appliances; SME usage is as reported
3 Forecasting scenarios	– We are presenting a base case today based on population and GDP per capita growth through 2025 – Conservative demand forecast assumes static supply-side dynamics (i.e., no grid network expansion or additional supply of additional generation sources) – Forecast 'what-if' scenario that includes supply-side changes (i.e., grid expansion, increased power generation, improved energy efficiency)

Source: Dalberg analysis

c.30-40% of the Nigerian household population is off-grid, with substantial regional disparities

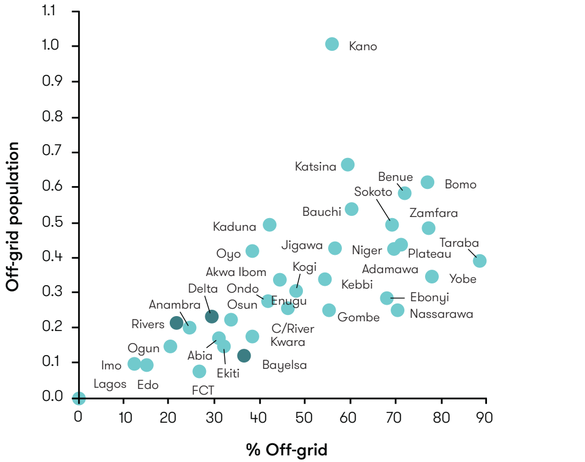
c.33% of Nigeria's population is off-grid

Nigeria population, 2013
millions, %



There are substantial regional disparities

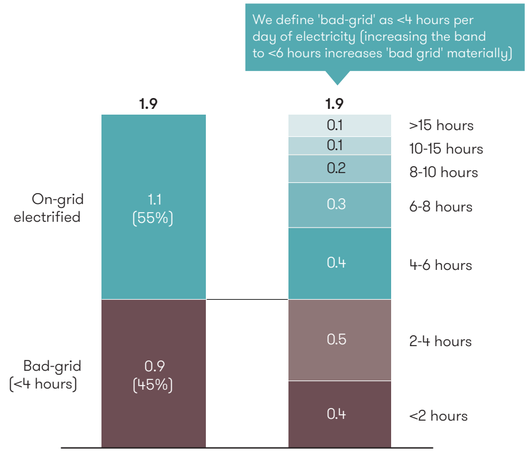
Off-grid population by state, 2011
millions, %



Source: Census 2006; Indexmundi; Lighting Africa; NBS; UNDP; World Bank; Dalberg analysis

c.43-45% of on-grid households get <4 hrs electricity per day or run generators >4 hrs / day; we term these 'bad grid'

Number of households in three focus states, by connectivity
millions, %; n=910

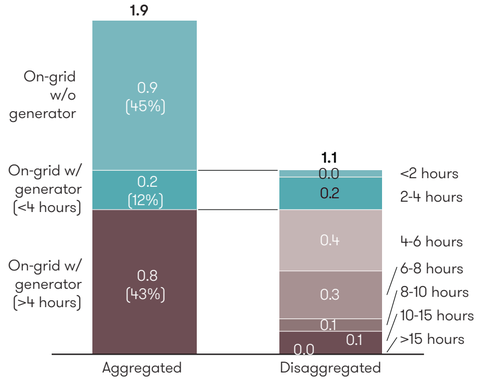


Bad grids, by hours of electricity

Aggregated refers to lump sum number of people by hours of electricity supply that they receive.
Disaggregated refers to proportion of households by number of hours of electricity supply that they receive.

Source: Household and SME surveys; Dalberg analysis

Number of households in three focus states generator hours
millions, %; n=910



Bad grids, by hours of generator usage

Aggregated refers to lump sum number of people by hours of generator usage.
Disaggregated refers to proportion of households by number of hours of generator usage.

Even with grid connectivity, the majority of Niger Delta households and SMEs receives limited or no service from the local grid network

Quantity of power delivered is inconsistent

"I can remember it has been five months or more since we last saw light in this community.
Bomadi household focus group discussion (HH FGD)

"The light comes and goes anytime – when they [NEPA] want to bring electricity, they bring it.
Ahoada East HH FGD

Voltage fluctuations damage appliances

"In my area, they bring the light with usually too high voltage that damages our appliances such as the TV, DVD and refrigerator.
Nembe HH FGD

"The problem in Warri is the current is too low – for example if you plug your water in the morning it will take a long time to become warm.
Warri SE HH FGD

Grid power has not improved in years

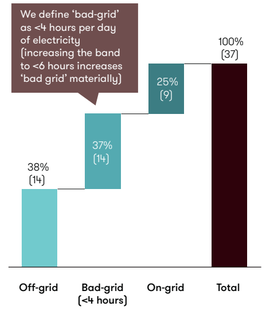
"We thought that when it is privatised, the electricity system will be boosted. But what we are seeing now cannot even be compared to the best of electricity we had before now.
Uvwie HH FGD

"We are using this opportunity to plead for assistance, let them give us the light and let Brass be as it was seven, eight years back.
Brass HH FGD

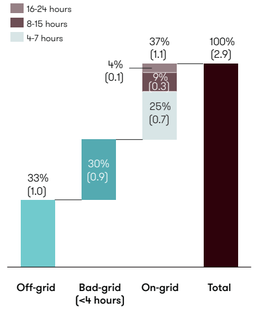
Source: Household and SME surveys; Dalberg analysis

Off-grid and bad-grid are both addressable for A2E solutions; they account for c.60-75% of the total population…

Number of HH in Nigeria, by connectivity (2015)
millions, %; n=910



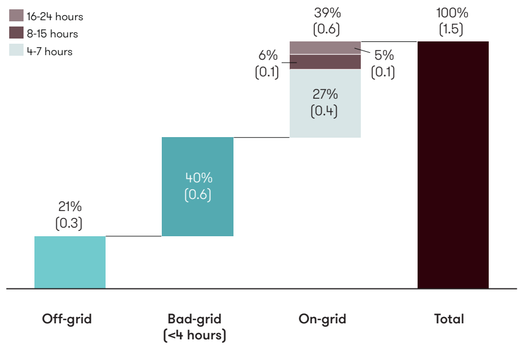
Households in focus states, by connectivity (2015)
millions, %; n=910



Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

For SMEs, off-grid and bad-grid – like in the household sector – are sizeable populations, accounting for c.61% of SMEs in the focus states

Number of SMEs in three focus states, by connectivity
millions, %; n=165



Source: SMEDAN; Household and SME surveys; Desk research; Dalberg analysis

The majority of the population is far from satisfied with the status quo: the undesirable, but necessary use of generators

Grid alternatives come with undesirable side effects

> If I have to keep my generator between my house and my neighbour, imagine the noise; they should not be happy, causing problems between people, generating all kinds of chemical substances dangerous to the health.
> *Nembe HH FGD*

> We have this kind of kerosene that is mixed with (petrol) and my grandmother nearly got burnt.
> *Warri HH FGD*

Inhabitants feel taken advantage of / abandoned

> [NEPA] are like small gods that anything they bring for you, you just pay.
> *Warri SE HH FGD*

> The big men we have here abandon us to go to Warri and Asaba where there is light.
> *Bomadi HH FGD*

State of energy provision exacerbates existing social challenges

> We don't have many resources because there is no job. No companies and nobody is doing a good business that will employ our youths because there is no light.
> *Bomadi HH FGD*

> We have trouble sleeping because with the noise of the generator, you cannot hear if someone comes to steal from you or if there is violence from youth groups.
> *Yenagoa key informational interview (KII) with community activist*

Source: Household and SME surveys; Dalberg analysis

End-users are typically already paying significant costs for access to energy…

There is little consistency in grid billing

> NEPA bills in Ughelli sometimes is two thousand naira while some other times, it is five thousand naira, they don't have a fixed amount they pay. It is pay as you go, but they don't want to do that for us here in Warri.
> *Warri HH FGD*

> Even if you pay, sometimes you are disconnected, they will tell you to pay reconnection fee of 5,000 and you will still pay those boys to come and connect the light.
> *Brass HH FGD*

Upfront and running costs of generators are quite significant

> When there was no light in Bayelsa, I bought my generator for 52 thousand naira, and I had to beg the guy to sell to me at 50 thousand. But if there was light I would have bought it at 38 thousand.
> *Uvwie SME FGD*

> In my house, I use more than 100 litres monthly because whenever I have to put on the generator, I buy up to 10 litres.
> *Bomadi HH FGD*

Gas, kerosene, and traditional energy (biomass) are expensive

> The lowest kerosene consumer here, those that are handicapped financially, still use 20 litres, like 1000N, in addition to firewood, per month.
> *Bomadi HH FGD*

> We don't buy kerosene from filling station, we buy off the black market. It is a difficult task as you must pay the boat to cross [the river] – we spend a lot of money buying that kerosene.
> *Bonny HH FGD*

…and are willing to pay for better quality and value for money

Despite high cost, households pay for poor service

> We are willing to pay as long that we will get proportionate services in return for what we paid for.
> *Nembe KII with community activist*

> In my community, we have estimated bills that they use to pay; we pay above five thousand a month whether there is light or not, we pay the money constantly.
> *Uvwie HH FGD*

SMEs express willingness to pay more for quality

> If we pay even 15 thousand naira at the end of the month and they will give us that light constantly, nobody will complain.
> *Yenagoa SME FGD*

> This hotel business is competitive, so I always make sure that I buy fuel even if the price is high because if there is no NEPA light our customers will go to another hotel.
> *Uvwie SME FGD*

Both groups are desperate for better value for money

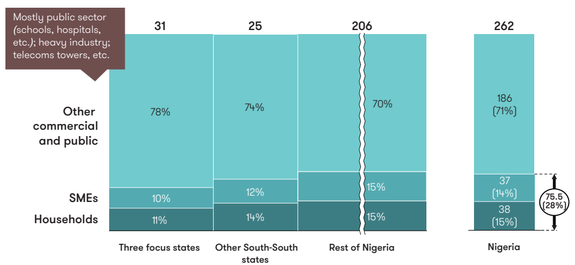
> We don't want to continue to be slaves to [NEPA]. If we can get a better option we will prefer other people to manage it so that we can compare them and make our choice.
> *Warri SE HH FGD*

> Now that its festive season, people tend to be desperate because they want the light and when the community now comes together we collect money to pay NEPA to chill our food.
> *Ahoada SME FGD*

Source: Household and SME surveys; Dalberg analysis

Although total energy use in Nigeria is c.262 TWh per annum, we focus on household and SMEs, representing c. 20-30% of use

Total current energy consumption (2015), by sector
TWh, %

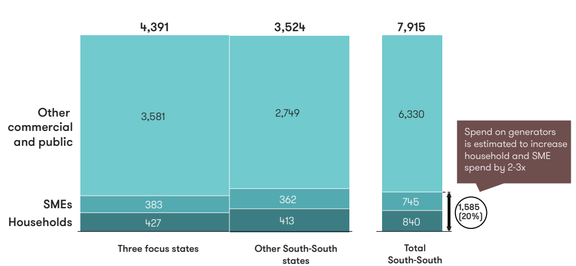


1 Estimate assumes consumption data from household and SME surveys are representative of the broader population
2 Biomass for cooking and heating is excluded from this analysis

Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

We estimate that these sectors currently spend c.US$1.6b per annum on energy in our focus states

Total current energy spend (2015), by sector
millions US$ per annum, %

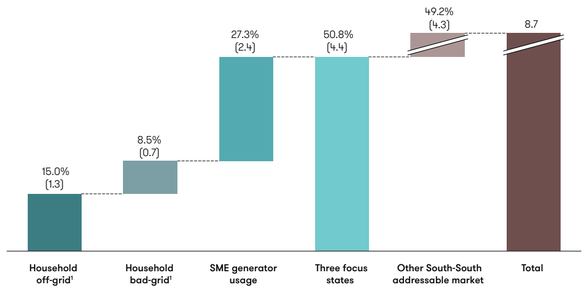


1 Estimate assumes consumption data from household and SME surveys are representative of the broader population
2 Biomass for cooking and heating is excluded from this analysis
3 Top-line spend figure does not include equipment cost, including kerosene lamps, diesel/petrol generators, gas cook stoves, etc., but includes fixed monthly connection charges for the grid; generator spend assumes c.NGN 30k per unit replaced twice per annum per household and SME

Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

The specific addressable household and SME energy market is c.4.4 TWh per year in the focus states in terms of use...

Total current energy consumption of addressable market (2015)
TWh per annum, %

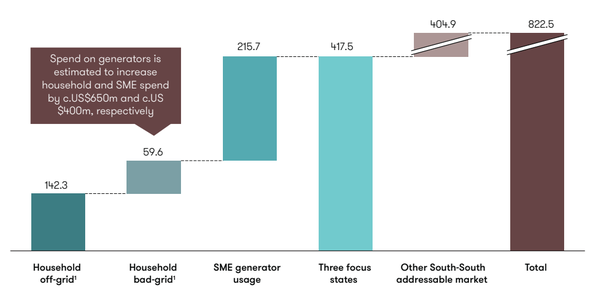


1 Excludes energy consumption from the national grid in each of the addressable segments
2 Estimate assumes consumption data from household and SME surveys are representative of the broader population
3 Biomass for cooking and heating is excluded from this analysis

Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

...this addressable market is worth an estimated c.US$0.4-1.5b per annum (c.US$823m in the six South-South states)...

Total current energy spend of addressable market (2015)
millions US$ per annum, %



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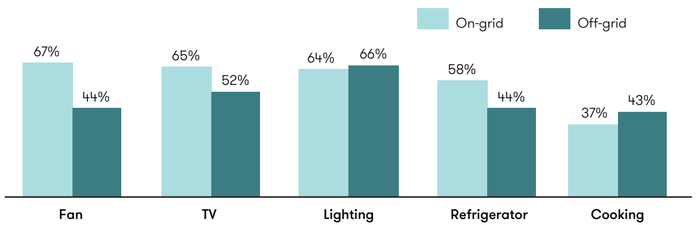
4 Top-line spend figure does not include equipment cost, including kerosene lamps, diesel/petrol generators, gas cook stoves, etc., but includes fixed monthly connection charges for the grid; generator spend assumes c.NGN 30k per unit replaced twice per annum per household and SME

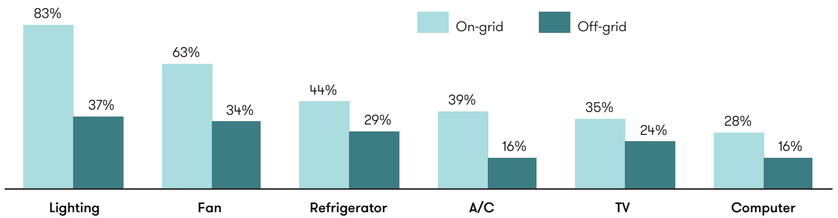
Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

…but addressable demand volume and value are expected to be much higher than actual use and spend as end-users are supply constrained

Share of households requiring additional energy for select uses
%; n=910



Share of SMEs requiring additional energy for select uses
%; n=165



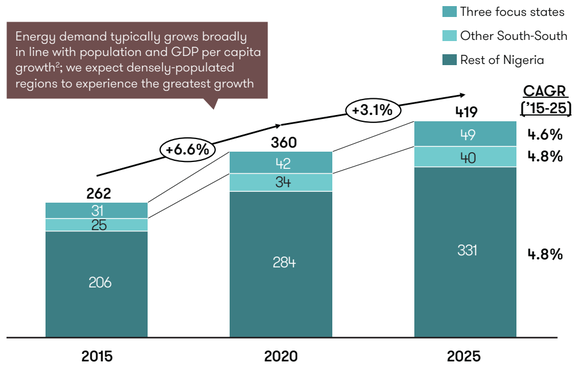
Actual demand may be up to 67% higher than actual use by households, and 83% for SMEs, but they are supply constrained

On-grid unmet demand is higher than off-grid in both households and SMEs, as electricity supply creates demand for more energy

Source: Household and SME surveys; Dalberg analysis

Energy demand is expected to grow by c.4-5% per annum, to c.419 TWh by 2025, assuming a conservative static demand model

Estimated total future energy demand (2015-2025), by region[1]
TWh per annum, %



1 Estimate assumes consumption data from household and SME surveys are representative of the broader population

2 Population and GDP per capita growth rates through 2020 use 10-year historical averages; GDP per capita growth through 2025 are conservatively assumed to be zero, though population growth remains fixed

Source: Household and SME surveys; Desk research; Dalberg analysis

In order to identify customer segments, we divided the population along three key parameters

1 **Grid connectivity**	**No grid:** – Households that have no connectivity to the grid – These consumers typically have low consumption levels and are often satisfied with basic lighting and other value add features. They demonstrate a greater willingness to pay	**Bad grid:** – Households that receive electricity for <4 hours per day – Consumers typically have higher consumption levels and while low-income might need basic lighting services, most middle-high income need energy for lighting, heating/cooling, entertainment, etc.
2 **Demand density**	**Sparsely populated villages/towns:** – Villages, towns or communities with a density <250-500 inhabitants per km^2 – Though they have significant need, sparsely populated regions create difficulty in last mile sales and often do not make for a significant critical mass to install infrastructure	**High density clusters:** – Villages, towns or communities with a density of >500-600 inhabitants per km^2 – Densely populated areas are easier to penetrate in terms of distribution/retail and can see faster adoption by way of demonstration effects
3 **Terrain**	**Coastal:** – These are marshy areas where it is difficult to set up or maintain large infrastructure and are difficult to penetrate	**Uplands:** – These are relatively homogeneous regions where setting up infrastructure or penetration is relatively simple

Source: Dalberg analysis

A large market opportunity exists also in catering to commercial enterprises and institutions

Description	
Large network medium-large enterprises (>10KW)	– **These are enterprises with significant demand, that can be catered as standalone or as an anchor load** – They can be dispersed or close by, but have significant establishment within a macro-region. Include both enterprises (e.g., mobile towers, petrol stations, commercial farming operations, light industry) and institutions (e.g. universities, hospitals)
Small-medium enterprise clusters (1KW-10KW)	– **Enterprises that have small individual demand, but can be catered to as anchor loads or in clusters** – These are typically aggregated in a small region (e.g., a rural retail market with multiple establishments, public banks and ATMs, clinics, small schools)
Remote enterprises (<1KW)	– These are standalone enterprises that have small-sized demand (e.g., a store in a sparsely populated village, artisanal workshop, small farms with irrigation energy need) – **Their energy requirement is slightly larger than average household requirement, but not by much – so for segmenting purposes can be treated the same**

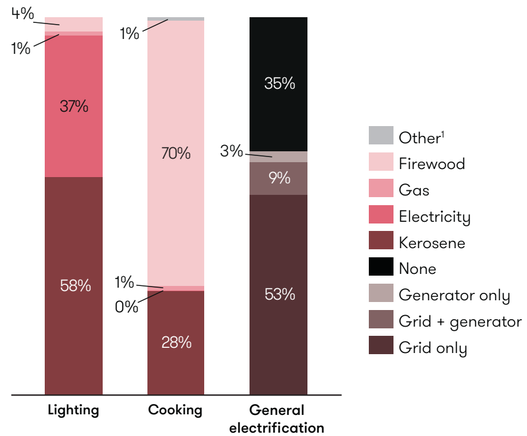
Within these, we identify key commercial and institutional customers which present opportunities for captive generation and anchor load

Commercial / institutional segment	Size of market in Nigeria / Delta	Energy requirements
Mobile towers	Approx. 24,000 mobile towers – c. 52% of mobile towers in Nigeria are situated in off-grid regions; an additional c.40% see outages of more than 12 hours/day	– Mobile towers need power to run 24/7, requiring on average c.5.4k units/ month[2] – An average off-grid tower uses c.1.7k L/ month of diesel, while an on-grid tower uses c.1.5k L/month
Banks / ATMs	Approx. 5,800 bank branches and 10,000 ATMs, with number of ATMs projected to increase at 25% CAGR up to 2012	– Power efficient ATMs may need as little as 1.8 kWh/day – Integrated ATM and bank solutions likely to require upwards of 10 kW
Public institutions	Approx. 35,000 hospitals and clinics in Nigeria (3,800 in 6 Delta states) Approx. 9,000 schools and 21 public and private universities in South-South	– Smaller hospitals require between 0.5-15 kWh/day, while larger ones typically need 15-60kWh/day
Factories / Agri-business	N/A	– Factory needs are for running heavy machinery / maintaining temperature control – Main agribusiness needs are for (i) pumps (ii) post-farm processing (iii) chilling and cold chain (iv) farm office and administration

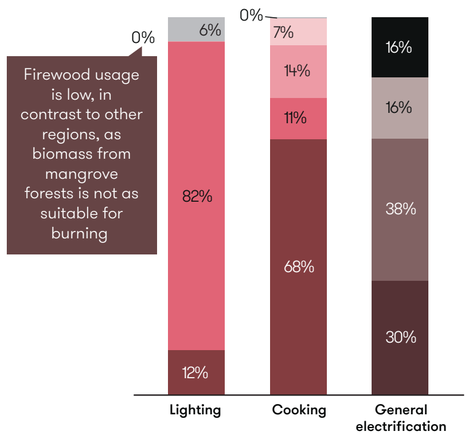
Source: GSMA West Africa Market Analysis, Journal of Emerging Trends in Engineering and Applied Sciences, 2014; National Bureau of Statistics 2006, 2012, eHealth Nigeria, Dalberg research; African Journal of Science, Technology, Innovation and Development, 2011.

Electricity is the dominant primary source of lighting energy; kerosene for cooking; and generators for general electrification in the Niger Delta

Nigeria primary source of household energy, by use (2006)
%



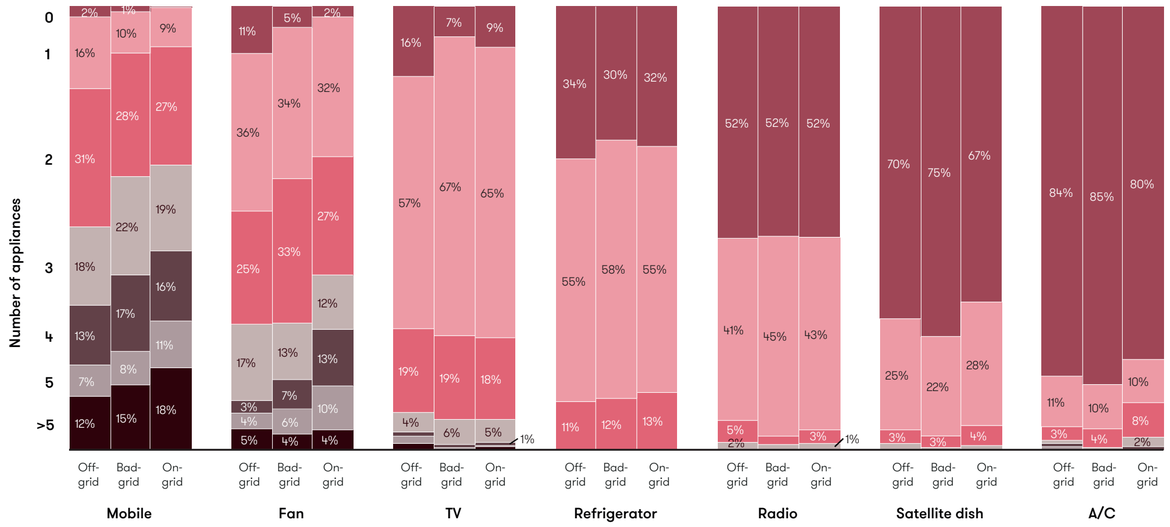
Niger Delta primary source of household energy, by use (2015)
%; n=910



1 Other includes candles, solar or no lighting energy source; coal for cooking
Source: Census 2006; NBS; SDN; Household and SME surveys; Dalberg analysis

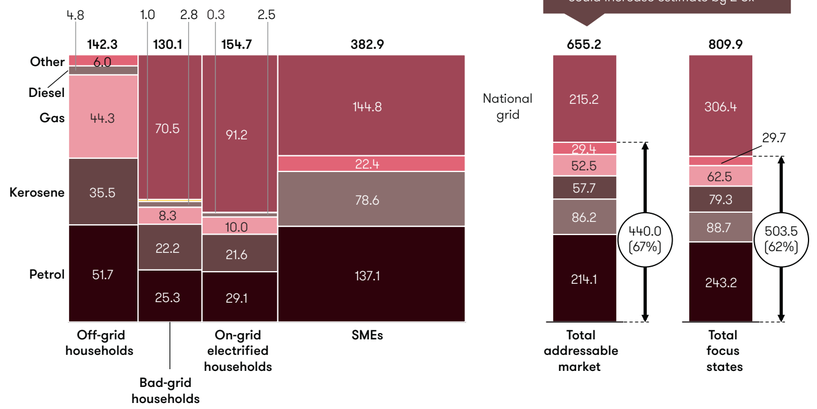
General appliance ownership is high in the Niger Delta, though penetration levels of satellite dishes and A/Cs remain low

Household appliance ownership in focus states, by appliance and connectivity
# of appliances per household, %; n=910



Petroleum products and the national grid comprise the bulk of the c.US$655m in total energy spend in the addressable markets…

Total current energy spend (2015) in focus states, by source[1]
millions US$ per annum



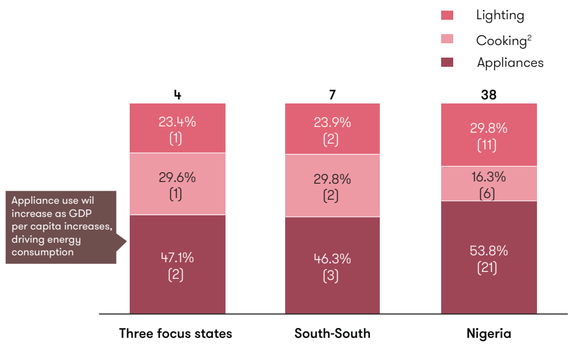
1 Spend data is estimated based on average household consumption and median pricing from survey data, which is assumed to be representative of the broader population; biomass for cooking and heating is excluded from this analysis; NGN 170 = 1 US$

2 Top-line spend figure does not include equipment cost, including kerosene lamps, diesel/petrol generators, gas cook stoves, etc., but includes fixed monthly connection charges for the national grid; generator spend assumes c.NGN 30k per unit replaced twice per annum per household

Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

We have looked at lighting, cooking and appliance use; appliance use is the largest use case overall

Household energy consumption per annum, by use[1]
TWh per annum, %



1 Estimate assumes consumption data from household and SME surveys are representative of the broader population

2 Biomass typically accounts for >90% of household energy consumption (cooking and heating). This is expected to decline as energy efficiency improves with cleaner cook stoves. It has not been included in this analysis as the large share of firewood usage in the whole of Nigeria (versus low usage in the Niger Delta) would bias the analysis of opportunities to a segment that is expected to decline in terms of demand volume

Source: Census 2006; NBS; Household and SME surveys; Dalberg analysis

There are three current primary sources of energy for lighting, cooking and appliances, which we unpack to understand the value chains

Grid electricity	– >50% of the population in Nigeria and the Niger Delta have access to core electricity supplied by the national grid, albeit under-electrified, reflecting the case for total Nigeria – Electricity is the **most important current source of lighting energy (c.70%)[1]**, in the three focus states of the Niger Delta – But **outdated infrastructure and poor economic across all stages of the value chain** hamper the provision of reliable electricity supply to meet current and future demand
Petroleum products	– Despite less competitive long-term economics vis-à-vis other technologies and negative externalities (e.g., pollution, noise, environment, etc.), petroleum products (e.g., diesel, kerosene, etc.) remain a **significant source of energy** in Nigeria and the Niger Delta, both as a primary and back-up source – Petroleum products can be split into the formal sector and the informal sector, of which there is a large illegal refining market in the region – though the difference on end-user price is minimal
Wood and charcoal	– A large proportion of households and SMEs in Nigeria (although not in the Niger Delta) utilise environmentally unfriendly fuels, such as firewood, as the primary sources of energy for cooking purposes. We exclude biomass for cooking and heating in this analysis

1 Includes national grid, mini-grids and generator sets
Source: Company interviews; Household and SME surveys; Dalberg analysis

Even after privatisation, outdated infrastructure and poor economics prevent a reliable supply of electricity to meet demand

Generation	Transmission	Distribution	Retail
– Under privatisation in 2013, six successor GENCOs were formed; NERC issued c.70 licenses to Independent Power Producers, (only 3 are active); and 10 National Integrated Power Projects were commissioned – Despite capacity, **many GENCOs choose not to supply power to meet demand, given poor economics:** – Limited gas availability – Low electricity tariffs cannot cover basic operating costs – Inability of Transmission Company of Nigeria (TCN) to pay GENCOs on time	– State-owned TCN owns the transmission network, which is currently being managed by a private contractor, Manitoba Hydro International (Canada) – Transmission capacity (c.12.3k km) **does not cover many areas of the country,and grid extension is costly** – Average US$8-10k per km; in difficult terrain, costs can increase to US$22k per km – Low demand density/ intensity in many areas make cost recovery difficult – **Outdated transmissions systems experience c.40% losses and frequent outages** (c. 93% of which are unplanned) – Vandalisation of transmission lines, adverse weather and terrain pose additional challenges in the Niger Delta	– There are 11 regional distribution companies (DISCOs) that serve Nigeria – Port Harcourt and Benin DISCOs are responsible for distribution to the three focus states (c.15.5% of the national load allocation); PH and Benin DISCOs served c.347k and 530k customers, respectively, in 2008 – **Low tariffs, absence of proper metering and low collection rates pose major financial challenges for DISCOs:** – Tariffs remain low despite theoretically being calculated to reflect costs – c.50% of distribution is lost through theft – Non-payment on c.40-80% of metered usage	– Retail tariffs – one of the lowest in Africa – vary by customer classes, and are collected as a fixed monthly amount plus per unit cost (NGN 4-25 per kWh) – Federal government subsidies are applied to 'vulnerable' tariff classes; the majority of households in Nigeria fall under these categories – But **low tariffs (which hamper system-wide upgrades) force end-users to pay higher costs for supplemental energy sources** (i.e., private generators) – in the Niger Delta region, c.20% and **c.69% of grid-connected** receive <2 hours and **<6 hours of electricity per day**, respectively

* *GENCO means electricity generation company*
Source: KPMG; NERC; UNDP; Company interviews; Desk research; Stakeholder interviews; Dalberg analysis

Off-grid households and SMEs are unlikely to be materially impacted by grid extension in the medium term; under-electrified may see benefits

1
- The priorities of the government, GENCOs, and TCN in the medium-term will be focused on increasing the capacity of the current grid rather than grid extension:
  - Government will need to address ineffective incentives leading to non-generating capacity
  - Old and inefficient transmission capacity will be a priority to replace, versus investment in grid extension

2
- DISCOs are interested in driving A2E through grid extension and other models, but are cash constrained and have core operational challenges to unwind as immediate priorities; however, they may be key partners to potential scale A2E players in the future

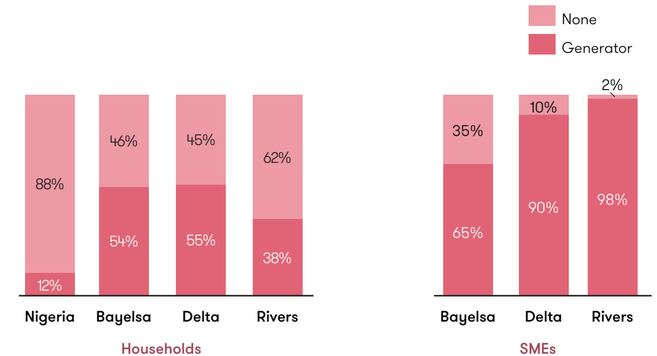
3
- It is unclear how long this dynamic will take to address, and when further grid extension is likely to be considered by electricity sector actors; it is therefore unclear whether there is a credible and of-scale grid extension program that will affect off-grid households over the next 10 years

4
- Under-electrified, including 'bad grid' households and SMEs, are likely to see an increase in the supply of electricity from the grid; although it is unclear whether this will be material in a five year horizon – longer term this is likely to be more significant

Source: Stakeholder interviews; Dalberg analysis

Given lack of reliable alternatives, diesel/petrol generator usage in the three focus states is particularly high

Generator usage in Nigeria and the three focus states, by sector
%, n=910 for; n=165 for SMEs



c.52% of households and **c.91% of SMEs** in the three focus states **use generators for >=4 hours per day** (c.55% and c.74% for >=6 hours per day)

Average household and SME spend on **diesel/petrol generator fuel** is **NGN c.11k and NGN c.36k per month**, respectively

Source: Census 2006; NBS; Household and SME surveys; Desk research; Dalberg analysis

Illustrative costs of popular generator

1kW – NGN 18k

2.5kW – NGN 42k

6.5 kW – NGN 125k

In the three focus states, c.80% of generators owned cost **between 5-60k**; for SMEs, c.80% of generators owned cost **between 15-300k**

Awareness of grid alternatives, especially solar, is increasingly favourable

Solar is most often recognised as generator alternative

> We all know of solar energy – there was a time we had solar within the street lights in some communities.
> *Nembe KII with traditional ruler*

> I love [solar energy] because it helps most; there won't be need for fuel, no dragging of generators and all the rest.
> *Ahoada HH FGD*

Perception of solar in the Delta is generally positive

> Solar is better because when the solar dish is installed that one can't disappoint you like the way NEPA is disappointing us now.
> *Nembe HH FGD*

> You don't need fuel to power solar, because it is free and it's from nature. You don't need to go and buy sun. The only challenge is maybe when the weather is dull, you won't always have this.
> *Warri SE HH FGD*

Niger Delta residents have low awareness of non-solar grid alternatives

> I have not heard of any new alternative energy product or solution, apart from this inverter and solar.
> *Yenagoa SME FGD*

> The solar is moving market more because it is good for our terrain here. But the wind turbine sales are very low.
> *KII with Delta renewable energy business dealer*

Source: Household and SME surveys; Dalberg analysis

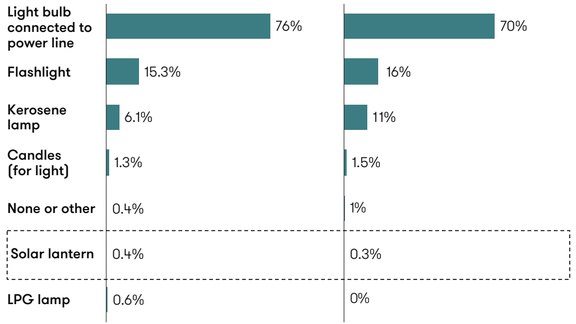
Solar portable lanterns have lower penetration (c.0.3-0.4%) than other sources of lighting in the Niger Delta…

Off-grid lighting sources[1]

%, n=366

On-grid under-electrified lighting sources[1]

%, n=544



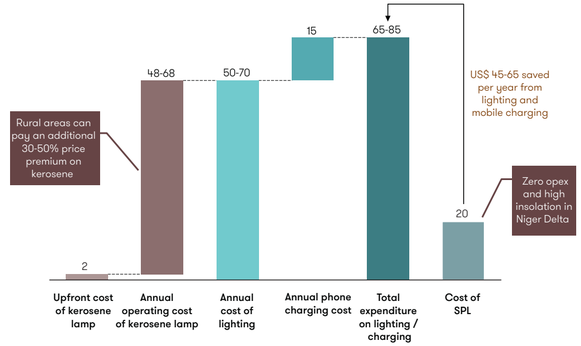
1 Survey respondents were asked to identify all sources of lighting used within their home. Percentages do not sum up to 100% as several identified multiple sources of in-home lighting

Source: Household and SME surveys; Desk research; Dalberg analysis

…despite being relatively attractive on a 'total cost of ownership' basis versus other main sources of lighting such as kerosene

Annual household expenditure on kerosene and mobile charging vs. expenditure on SPL (2011)

US$

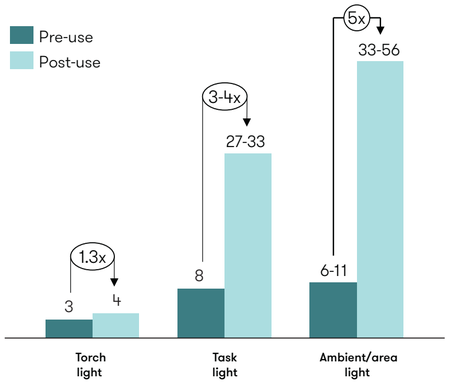


Assumes six hours of kerosene lamp usage per day, average kerosene price of US$ 1.13/litre; mobile charging assumptions based on the charging patterns for the average off grid user (with at least some access to electricity); median entry-level SPL is US$ 20 with three-year straight line depreciation

Source: GVEP; Lighting Africa; Company interviews; Desk research; Stakeholder interviews; Dalberg analysis

Willingness-to-pay is affected by a historical lack of awareness and/or poor experiences with low quality products…

Consumer willingness-to-pay for quality SPLs: pre-use vs post-use
US$



Increased post-use willingness-to-pay is indicative of how a lack of awareness and mistrust created by counterfeits and low-quality generics has affected the solar products market. Marketing and consumer education are key

Source: Lighting Africa; Company interviews; Desk research; Dalberg analysis

…though awareness of grid alternatives, especially solar, is increasingly favorable

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> *KII with Delta renewable energy business dealer*

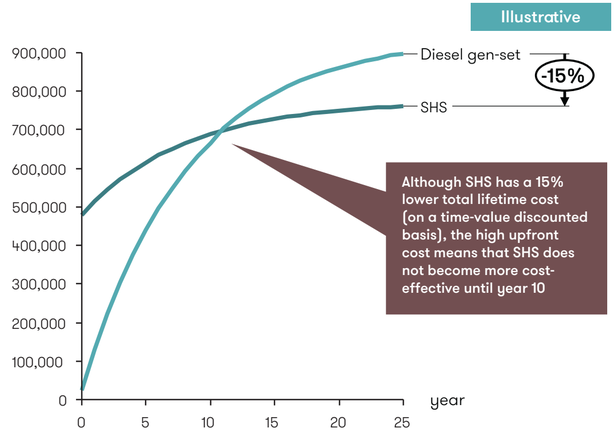
Source: Household and SME surveys; Dalberg analysis

Solar Home Systems (SHS) are likely to be a niche segment, appealing to relatively high-income or businesses with low demands for energy

Range of SHS costs, by capacity
thousands NGN

Despite SHS being more cost-effective than diesel, the high upfront costs may be prohibitive to the poorer; economics may appeal to those with longer-term outlook and ability to pay upfront

Cumulative costs over 25-year life of a 2kW SHS versus diesel gen-set
NGN



Assumptions for diesel (10-year lifetime, NGN 200-225 rural diesel cost, 5-20% maintenance costs, $150 generator for 1 kW capacity to power 4.3 kWh daily for 10 hours); SHS (25-year lifetime, $3,000 for 2 kW system at 20% capacity for 12 hours, generating 4.8 kWh daily, 70% of CAPEX for total maintenance costs, battery replacement every 24 months at NGN 50k); 160 NGN/US$

Source: IFC; Company interviews; Desk research; Dalberg analysis

The market for SHS in Nigeria generally faces similar challenges as SPLs, with affordability as the major constraint

1 **Access to finance for SHS is essential – even more so than SPLs – as prohibitive upfront SHS costs may be the single biggest challenge to widespread market adoption**

High initial upfront costs for SHS may be especially prohibitive for poorer consumers, despite economies over diesel over the longer-term. Some market players (i.e., Solar Kobo) are experimenting with hire-purchase agreements or instalment payment structures to solve the problem of affordability

2 **Trade finance constraints as distributors lack credit needed for working capital**

Trade finance is similarly a major constraint for Nigerian importers, given the need for large and costly working capital stocks. Tax reduction and zero import duties on solar products could encourage the growth of the market

3 **Awareness of SHS is low and low-quality systems leads to distrust in consumers**

There is low market awareness of solar products (both SHS and SPL), especially in rural areas. The lack of information and the prevalence low-quality/counterfeit products discourages market acceptance and penetration. Improved quality control and certification programs at the national/regional levels to reduce product information asymmetries and ensure quality for the end-user are needed

4 **Technical expertise for installation and maintenance remains lacking in rural areas that need it the most**

Improper installation and maintenance reduces the reliability and effectiveness of SHS products. High levels of dew in the Niger Delta, poor technical training, and poor maintenance contribute to reduced generation. Often larger systems are needed to compensate, but these necessarily become less affordable to the end-user

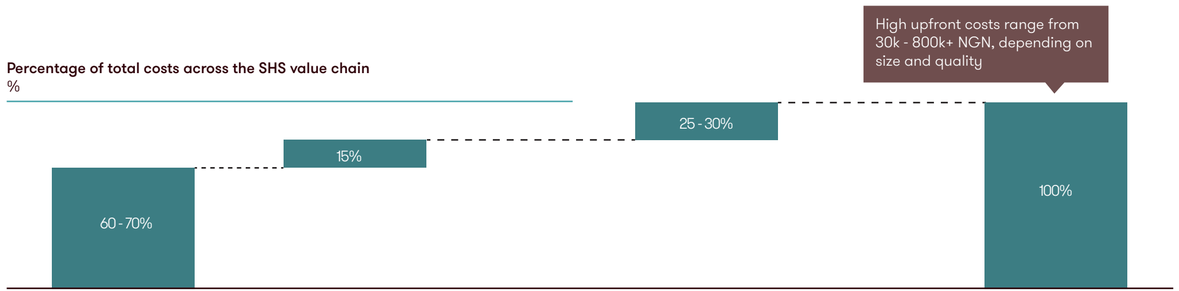
5 **Distribution and after sales support remain difficult in the rural areas where there is greatest need for SHS solutions as they are typically the most uneconomic to reach**

Similar to SPLs, this is especially true in the Niger Delta with its difficult terrain and lack of transportation infrastructure. Often lead times for imported replacement parts can take months to repair systems damaged by storms, reducing the reliability and effectiveness of systems

Source: Lighting Africa; Company interviews; Desk research; Dalberg analysis

Costs along SHS value chain are also decreasing rapidly, but high upfront costs may still be prohibitive to poorer consumers

Percentage of total costs across the SHS value chain
%



Landed cost	Taxes and tariffs	Distribution and installation		After sales support
– Majority of PV modules are of Chinese origin – Charge controllers, inverters and batteries are a mix of local and imported products from US/EU – Wiring is produced locally – Expected cost reductions (25-30%), improved performance – LED, PV, battery – in the next 5 years; increased automation further depressing costs – c.2-3% margin for global manufacturers	– Subject to a 20% import tariff and additional 5% VAT – "Pioneer status" to solar industry, with five-year corporate tax holiday	– Increasing availability of credit for distributors is reducing costs – Distribution to Niger Delta can add 30-50% to costs – c. 30 quality importers/ distributors, with most involved in downstream installation	– Innovative financing is key to spread the high upfront costs – High upfront costs exclude rural poor; high-income urban/ peri-urban or SMEs as end-users – Installation provided by either wholesaler or retailers	– Most quality manufacturers offer warranty support – Particularly important as purchase risk of untested technologies is high and prevalence of low-quality products may affect reputation
		– In scratch-card model, equipment is leased, installation is 10% of lifetime cost, and paid usage up to 90% of lifetime cost.		

Range of values reported by manufacturers and distributors represent 70-80% of the quality market

Source: Lighting Africa; NIPC; Desk research; Company interviews; Dalberg analysis

There are two broad factors that drive what type of mini-grid is optimal and where it should be placed

1 Mini-grid technologies: diesel, solar, wind, gas, hydro, biomass

While the technology types chosen for the electrification of a given village depend on various factors specific to that site, general technical and cost trends narrow the possibilities, advantages and disadvantages of each. Petroleum products, for example, have the advantage of flexibility and reliability; solar power, however, while unpredictable, has zero operating cost (compared to expensive fuel) and is friendlier to health and environment

2 Location-specific factors

- Proximity to energy inputs: diesel, hydro, gas and biomass-based generation costs are sensitive to distribution and logistics costs (c.30-50% premium), especially given the difficult terrain and lack of transport infrastructure in the Niger Delta
- Demand density and size: approximately >250-500 inhabitants per km2 and/or presence of an anchor client
- Connection costs are proportional to the distances between customers, due to spend on transmission and increased losses as transmission distances grow
- Businesses and other energy demand points such as telecoms towers can be large, making it feasible to serve a sparsely populated region if they can be used as an anchor client for a committed baseload
- Terrain conditions can affect construction costs, especially in the Niger Delta region, where swampland can drive a c.60-70% increase in cost
- Proximity to the grid or likely future grid expansion (within c.10-25 km) will negatively affect attractiveness for a potential player, given low national tariffs and uncertainty surrounding feed-in regulations

The spectrum of commercially-viable sizes and business models will depend on the communities' location-specific characteristics[1]

Small mini-grid: B2C
- Low upfront system installation and maintenance costs
- Scaling of smaller sizes to reduce overall CAPEX* to accommodate higher infrastructure and transmission costs from difficult terrain and low-demand density
- Smaller, sparsely-populated, decentralised communities (c.30-50 households)

Medium mini-grid: B2C
- Higher upfront and maintenance costs
- Higher economies of scale to service greater demand density
- Medium, more densely-populated communities (c.50-250 households)

Large mini-grid: anchor B2B + B2C
- High upfront and maintenance costs, supported by stable commercial revenues and cash flows
- High profit margin from anchor/commercial end-use
- Larger systems may be costly in areas of unfavourable terrain, given 60-70% additional infrastructure costs, though high demand density may justify cost
- Larger, more densely-populated areas and/or anchor tenants with concentration of households and small enterprises nearby

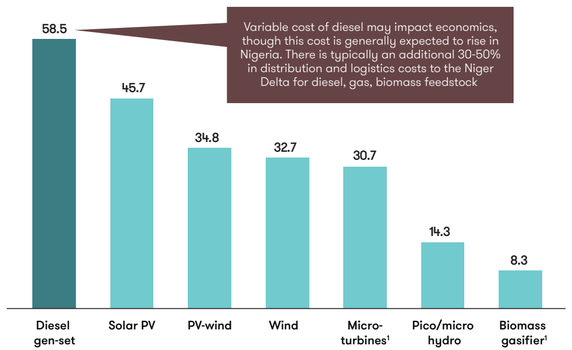
1 Assumes that proximity of grid (or likely future grid expansion) exceeds c.10-25 km; otherwise, mini-grid is not considered commercially viable

* CAPEX is capital expenditure

Source: Company interviews; Desk research; Dalberg analysis

From a cost perspective, the high recurring cost of diesel fuel makes it less cost-effective vis-à-vis these other technologies

Levelised cost of electricity for an illustrative 300W facility, by technology
US$ cents per kWh

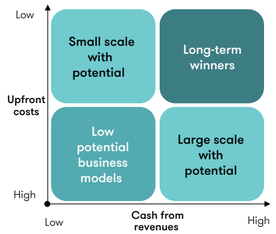


1 Micro-turbines and biomass gasifier costs are based on illustrative 150 kW and 100 kW generation facilities, respectively. Although reduced economies of scale would increase cost per kWh, the directional trend of levelised costs across technologies is expected to remain unchanged

Source: Company interviews; Desk research; Dalberg analysis

Business models that focus on faster cost recovery are most likely to be commercially viable

Models that find the right balance between upfront costs and cash flows are likely to be successful…



…with global players employing many strategies[1] that may be applicable in the Nigeria context

Lowering capital expenditures by focusing on small size

Smaller system size: In India, micro-grids (<1 kW) are low cost and allow for faster installation. Example systems have achieved break-even within c.2-3 years. Mera Gao Power (a pioneer in Indian micro-grids) has plans to expand into the off-grid Nigerian market

Reducing operating expenditures through innovation

Improved payment collections: GVE is trialing prepaid scratch-card technology to lower cost of payment collection. GVE's plant is forecasted to break-even in 3.5 years

Ensuring stable revenues and cash flows from anchor load

Anchor clients:

SMEs: Sky Resources is targeting higher demand density by servicing c.75 mini/micro-businesses to serve as an anchor baseload

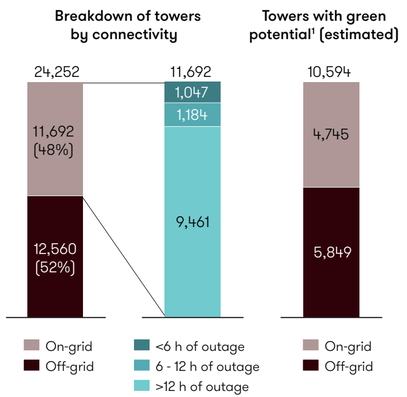
Telecom: Using telecom towers as an anchor-load (common in India) has been explored in Nigeria, but telecoms have shown limited interest. The move towards asset-divestiture to private tower operators, however, has reignited interest from market players. Recent HIS towers consolidation may be of renewed interest in Nigeria

1 These strategies are examples of strategies that have worked in the global context, but are not to be considered exhaustive

Source: Company interviews; Desk research; Dalberg analysis

Illustrative: Commercial enterprises provide a huge market; mobile towers alone can be a US$500–600m revenue per annum opportunity

Grid connectivity for telecom towers in Nigeria (2012)
# of towers



1 Based on GSMA calculations that take into account network parameters such as average site load characteristics and tenancy ratios for towers in Nigeria
2 Estimate based on diesel consumption of a fully off-grid tower in Nigeria
3 5% if the historical average growth rate in Nigeria and 8% is a GSMA predicted average growth rate for Nigeria and Ghana
4 Revenues are calculated based on supplying energy to replace on diesel usage at $0.6/Kwh (a GSMA estimate)

Source: GSMA; Desk research; Dalberg analysis

Opportunity for energy service providers to reduce tower dependence on diesel

- c.52% of mobile towers in Nigeria are situated in off-grid regions; an additional c.40% see outages of more than 12 hours/day
- Mobile towers need power to run 24/7, requiring on average c.5.4k units/month[2]
- An average off-grid tower uses c.1.7k L/month of diesel, while an on-grid tower uses c.1.5k L/month[2]
- In replacing all diesel used in 2012, the mobile tower market was worth $390 million per annum
- Given projected telecom tower growth rates of 8-15%[3], this market opportunity is likely to further increase in the future to roughly $500-600m[4] in 2015
- **There is a shift towards improving operational efficiency and reducing costs:** as mobile network operators offload tower assets to independent tower companies, these fewer but larger potential clients will be more sophisticated on costs linked directly to their core business

Financing and revenue generation are most significant challenges affecting deployment of mini grids in Nigeria

Financing	– As a frontier market for private mini-grid developers, Nigerian commercial finance is poorly equipped to evaluate bankability of projects – Current pilot projects are 100% government/donor-funded, which removes commercial sustainability out of the equation and is crowding out pure-play private sector investment
Operational unknowns and challenges	– Lack of proven commercially viable models (ownership, management, financing) outside of government/donor-funded pilot projects – Addressable models to collection/payment challenge are still in their infancy and being trialled
Opaque governance/ policy	– Lack of clear responsibility amongst government bodies has created a white space of fragmented and ineffective regulations – Lack of visibility on grid expansion plans, potential tariff regimes, etc.
Lack of information and coordination	– The operating environment for prospective mini-grid players in Nigeria lacks the data and platforms that allow stakeholders with intersecting interests (financiers, technology providers, international developers) to effectively collaborate – Accessible information around grid expansion plans, geospatial population mapping, consumer willingness-to-pay, and topology would drastically reduce uncertainties for developers

There is some regulatory uncertainty around mini-grid networks and how they will be treated

What is Independent Electricity Distribution Network (IEDN)?	– NERC released Independent Electricity Distribution Networks Regulations (IEDN) in 2012 to facilitate investment in off-grid distribution networks i.e. mini-grids – NERC grants IEDN licenses to empowers independent power distributors to provide power to people not currently served by national grid - namely, mini-grid operators
When will NERC issue an IEDN license? Does the mini-grid operator need permission of Disco in that area?	NERC may issue a IEDN licence to a mini-grid operator if it is satisfied that 1. there is no existing distribution system within the geographical area to be served by the proposed independent distribution system 2. where the infrastructure of an existing distribution licensee is unable to meet the demand of customers in the area, as long as the mini-grid operator: i. Agrees that the facilities of the DISCO in that area will not be used ii. Ensures there shall not be any parallel overhead lines to existing facility iii. Ensures the safety of equipment, workers and the public iv. Ensures minimum distribution capacity of the IEDNO shall be 5,000kW v. Shows the ability to provide generation capacity for the IEDN 3. the Commission, in making a decision, shall consider if the grant of an IEDN license (a) will maximise access to electricity services and (b) will reduce distribution congestion to the benefit of consumers
How does this work in practice?	– Essentially, it has to be decided on a case by case basis by NERC, and there have not been enough IEDN licenses granted yet to reveal how it will be interpreted – The IEDN regulations gives no indication of how NERC plans to mitigate the challenge of IEDNs encroaching into the areas under the operations of the DISCOs – NERC in making a decision on an application for IEDN licence will likely consider the expansion plans of the DISCOs in the given area – Under 2006 REAP, they are obliged to consider a cost/benefit analysis comparing proposed grid extension and decentralised renewable electricity

There are four main operator models, though a hybrid community-private sector-led model may make the most sense in Nigeria

CAPEX

1
- **Government-initiated electrification initiatives**, which are financed through treasury and/or donor support
- Viability lies in **sustained government commitment** to rural electrification, **effective management and governance**

Ministry of Power is promoting 'Operation Lighting Rural Nigeria' which is an SPV model.

2
- **Local communities own, operate and manage** the mini-grid system; typically requires extensive donor support
- Viability lies in **effective community governance** and **sourcing technical and managerial expertise**

3
- **Private operator models** aim to make profit by investing in energy service delivery models
- Viability lies in **securing upfront financing** and **repayment from customers**
- Crowding out from government-led, grand-funded initiatives is a challenge

4
- **Hybrid model** combining elements of **community-private operators may make most sense, given immaturity of the market in Nigeria** (<5 players in past 5 years)
- Examples of successful pilot community-managed projects, though often grant-funded and less scalable
- **Private sector-led hybrids focusing on rapid cost-recovery of capex and divestiture of assets to community management** may be viable and scalable

Source: Company interviews; Desk research; Stakeholder interviews; Dalberg analysis

Identifying ways to improve access to financing can drive investments in the mini-grid space

Why is finance difficult to access? Perspective of mini-grid operator

- **Tenor of financing (<3 years) is too short** for mini-grid operator needs
- **Lack of fixed assets** considered acceptable collateral by lender
- Lack of a three year **financing history**
- **Cost of loan** (c.25%) may be out of range
- **Negative perception** of equity investors due to potential loss of control over business for the entrepreneur
- **Lack of awareness** of hybrid products
- Perceived uncertainty and **delay in subsidy disbursement**

Finance instruments

- Debt
- Equity
- Grants
- Subsidies

Why is finance difficult to supply? Perspective of financing institution

- Lack of RE SMEs in Nigeria with **well-established business models** – particularly, the inability to prove past experience handling large loans
- Difficulty in distinguishing between **non-quality operators** in the RE space – contributes to a negative perception of reliability
- **Limited understanding of guidelines** among RE SMEs and errors in the application process
- **Matching and aligning expectations** of returns from investments in RE SMEs
- **Crowding out of private sector** investment by government grants

Though a model of customer-focused financing is emerging amongst select banks, building the technical capacities of suppliers remains a strong requisite for success

Source: Company interviews; Desk research; Dalberg analysis

Innovative tariff models and payment collection may help improve revenue generation and commercial viability

Tariffs

- Pay-as-you-go: billed by the kWh (i.e., US$0.40 per kWh)
- Fixed amount: users pay for a fixed amount of energy based on expected power consumption, limiting energy consumption beyond paid amount (i.e., US$7 per 60 W of consumption)
- Other models: fee-for-service, stepped tariff, flat-rate tariff, time-based tariff, customer class tariff, progressive/regressive tariffs. Most mini-grids observed in Nigeria use a power-based fixed weekly or monthly fee

Government regulation:
- No license needed for generation under 1 MW and distribution under 100 kW production
- Tariff regulation is vague/unenforced, but regulations are likely
- Various incentives and regulations have been proposed, including a 50% tariff subsidy in the 'Renewable Energy and Efficiency Bill' for off-grid players

Payment collection

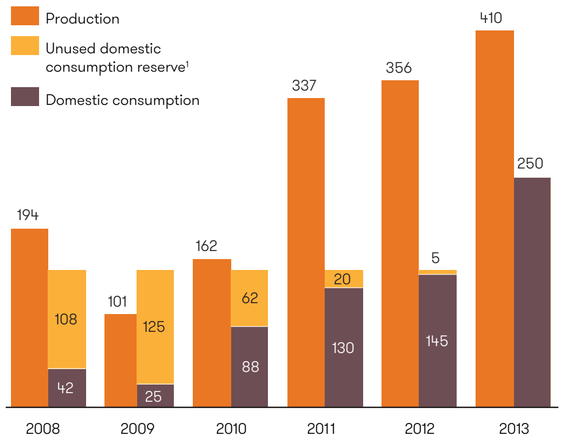
- Human collections: on the ground team collects payment from users, either pre- or post-use
- Partnership with MFIs: MFIs pay mini-utilities directly for plant usage and collects payments from users
- Prepaid (i.e. scratch cards): users unlock electricity from smart-meters after pre-paying (e.g., through scratch cards activated by calling PIN). Emerging success model globally; adds c.10% of battery cost to add SMS enabled charge controller
- Mobile payments: users pay for energy pre- or post-use through mobile money. Nigeria has c.800k mobile money users and 19 mobile money operators, few of which have achieved profitability and scale. The scene is nascent, but poised for growth
- Government-commissioned projects constitute a large proportion of off-grid electrification, for example through Rural Electrification Fund. The model of disbursement usually only covers CAPEX, leaving little financial incentive to ensure OPEX* financial sustainability

Source: NERC; Company interviews; Desk research; Stakeholder interviews; Dalberg analysis

* *OPEX is Operating Expenditure*

Domestic consumption of LPG has increased substantially since NLNG intervened in the market, but it still remains low relative to production

Domestic LPG production and consumption
thousands of MT



- Nigeria LNG intervened in 2007 through domestic subsidies to promote the use of natural gas reserves for LPG, divert LPG away from exports and guarantee supply to the domestic market (of which, NLNG supplies c. 70-80% of the market)
- The intervention of NLNG led to a retail price drop from US$50 to c.US$20 for the 12.5kg cooking gas cylinder
- Despite the domestic earmark, actual consumption levels have remained muted due mainly to limited production, storage and transport/distribution infrastructure
- LPG per capita consumption in Nigeria is still one of the lowest in West Africa (20x less than the African average) at 0.5kg per annum, despite Nigeria being the sixth largest producer of LPG in the world (with reserves of 187 trillion ft3)

1 NLNG reserves 150k MT of LNG production for domestic consumption; the domestic reserve quota was increased to 250k MT in 2013

Source: Indexmundi; NLNG; NNPC; Desk research; Dalberg analysis

There are three key opportunities for harnessing latent LPG production to address A2E in Nigeria

1 **Feed-in energy source for mini-grids**
(analysis included in 'Mini-grids' section)
- LPG can be used as feed-in energy source for gas-powered mini-grids as these solutions scale up
- Nigeria is one of the largest producers of natural gas in the world; the proximity to input would make gas turbine mini-grids more commercially viable vis-à-vis other technologies with costly distribution logistics
- Commercial and pilot models of rural gas-to-power already exist in Nigeria, including successful gas turbine community-operated models

2 **Cooking fuel**
- In Nigeria, LPG is predominantly used as cooking fuel, though only c.10% of households use LPG as their primary cooking fuel; there is a large potential market
- LPG as a cooking fuel has significant health, safety and environmental advantages over firewood and kerosene (e.g., LPG emits no carbon monoxide and is less prone to spillage and causing household fires)
- There are success stories in other large developing markets (e.g., Indonesia quadrupled LPG usage from 500k MT to 4.5m MT in five years)

3 **Adapted diesel generators**
- Potential opportunity is sizeable given ability to piggyback on high incidence and penetration of existing diesel generators
- Conversion of standard diesel generators to LPG generators is technically feasible, cost-effective, and environmentally attractive
- Benefits from reduced exposure to price volatility of diesel/kerosene may outweigh the initial upfront cost of conversion

Source: NLNG; Energia Africa; Household and SME surveys; Dalberg analysis

The main focus of government and utilities is to increase generation and quality; grid expansion is some way off and off-grid is nascent

1 **Government focus in last 10 years has been to plan and execute privatization of the sector – a task that is now complete.**
A series of three policies (in 2001, 2005, 2010) defined the vision and strategy for transforming the power sector. Privatization was achieved in 2013, however there have been challenges to making reforms effective and operational.

2 **The primary focus of post-reform initiatives has been to improve existing grid rather than expanding grid network into un-served areas.**
While increasing national electrification rate is a stated objective – 75% connected to grid nationally by 2020 – in reality this target will not be reached. The task of shoring up existing grid infrastructure is so great that significant expansion to grid network is not viable in short to medium term. Even in best case scenario, grid expansion will barely outpace population growth.

3 **While additional installed generation capacity is needed and planned, this is not silver bullet for Niger Delta.**
Many of the power stations often run at well below capacity. As such, investing in new IPPs that feed into local grid is not an optimal way to addressing the un-electrified market in the Niger Delta.

4 **Experts close to the sector agree that financial and operational challenges of newly privatized Distribution Companies is one of main obstacles to progress.**
Most DISCOs are highly leveraged and suffer significant non-technical losses, mainly electricity theft and inefficient payment collections. Improving revenue capture through payments and collections systems will take precedence over expanding their networks.

5 **The regulatory environment for off-grid solutions is nascent and uncertain.**
As off-grid solutions have not been much of a focus, the rules governing small scale, independent generation and distribution are still being developed and it is uncertain how they will be implemented in practice. This does not provide much incentive or security for investors in off-grid energy.

6 **Public sector agencies are showing recent interest in off-grid energy, but their initiatives are currently uncoordinated, distortionary, and it is unclear whether they will upscale.**
The Ministry of Power and the REA have launched mini-grid pilots – however, these programs have been fully subsidized and it is not clear whether they have right traction to roll out such programs at scale, especially with election period coming up.

7 **Public sector bodies will be unreliable execution partners, but important advocacy targets – relationships with likes of REA, MoP, and State Governors' Offices, should be nurtured, but not relied upon.**
The REA (which falls under the MoP) in particular has a potentially transformative mandate to award tenders to off-grid providers, however the agency has proved itself bureaucratic and might struggle to deliver the mandate. All On shall be advocating with NERC and MoP for attractive off-grid policies, and convening public sector partners in the Delta States to garner buy-in and support for off-grid activity.

8 **The two DISCOs in Niger Delta region are potentially key partners for All On and its portfolio firms – these relationships should be cultivated.**
While mini-grid operators can operate independently of DISCOs, there are also opportunities for partnerships including (i) sub-contracting (ii) feed in of excess capacity to local DISCO network (iii) co-investment and joint ventures. Beyond mini-grids, All On may end up supporting firms providing payments and collection support to DISCOs.

Five key policy documents over the past 14 years have shaped Nigeria's energy sector today

National Electric Power Policy (2001)	– Kicked off series of reforms leading to the liberalization of the market – Set the foundation for the establishment of the National Electricity Regulatory Commission (NERC), the determination of tariffs, customer rights, and the development of a competitive electricity market
Electric Power Sector Reforms (2005)	– Defined the process of assets transferral from NEPA to successor companies, further defined market rules under a privatized competitive power sector – Established the Rural Electrification Agency (REA) and National Bulk Electricity Trading Company
Renewable Energy Action Plan (2006)	– Provides framework to implement national power and renewable energy policy – Defines roles and responsibilities for promoting energy use among government agencies, outlines a strategic approach, financing mechanisms and monitoring and evaluation
Roadmap for Power Sector Reform (2010)	– Defined the tasks and responsibilities of the Presidential Task Force on Power – Established a timeline for the full privatization of NEPA assets – Established yearly targets for fuel-to-power availability, generation, distribution and transmission capacity until 2013, short- to long-term obstacles, and financial incentives for reaching targets
Renewable Energy Master Plan (2005, revised in 2013)	– Sets ambitious targets for renewable energy progress and outlines strategies to achieve them – Implements a set of fiscal and market incentives to support RE deployment, including a moratorium on import duties or renewable technologies – For off-grid renewables, mandates NERC to award mini-grid concessions, develop 'light handed regulation' for those generating >1MW and distributing above 100kW per site, and provide subsidies as necessary

Source: Desk research; Stakeholder interviews; Dalberg analysis

The REMP sets ambitious targets for renewable energy development in Nigeria – not currently on track to being met

Renewable Energy Master Plan (2005, revised 2013)

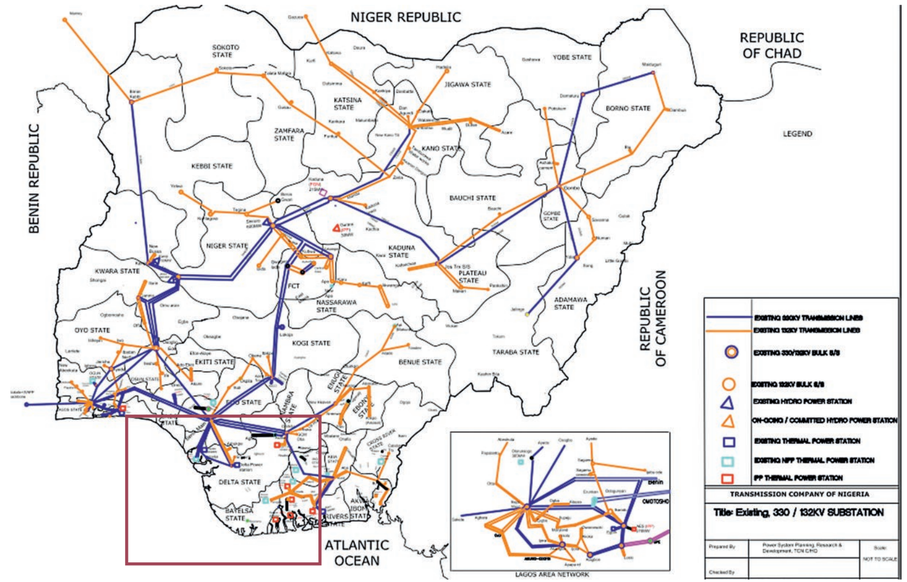
Overall objective	– Increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030 – Renewable electricity would then account for 10% of Nigerian total energy consumption by 2025
Targets	Installed capacity targets: – Small-hydro: 600 MW in 2015 and 2,000 MW by 2025 – Solar PV: 500 MW by 2025 – Biomass-based power plants: 50 MW in 2015 and 400 MW by 2025 – Wind: 40 MW for wind energy by 2025 Electrification rates: from 42% in 2005 to 60% in 2015 and 75% by 2025

Approaches	– Outlines 10 strategy approaches towards achieving targets, notably promotion of investment through demonstration of pilot projects, provision of financial incentives, and establishment of further renewable energy policies and regulations
	– Establishes a feed-in tariff mechanism in order to attract IPP projects – applicable to ground-mounted solar, wind, >30MW capacity hydropower, and biomass/biodiesel
	– 2013 Revision specifies a range of i) economic and ii) fiscal incentives, most notable among which:
	  – 5% interest on public debt for RE projects
	  – Up to 30% subsidy on capital costs for RE utilization facilities
	  – 50% corporate profit tax rebate for RE companies
	  – 10 year tax holiday, 0% import duty on specified equipment and parts, and rated rebate on tax/levy for expenditures on RE technologies

Source: Ren21; REAP; REMP; Desk research; Dalberg analysis

Grid infrastructure is less developed in areas within the box, due to technical challenges and cost of operation and maintenance in riverine terrain

Grid infrastructure of Nigeria
Accessed February 2015



Source: Nigerian Electricity System Operator (NESO) website

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