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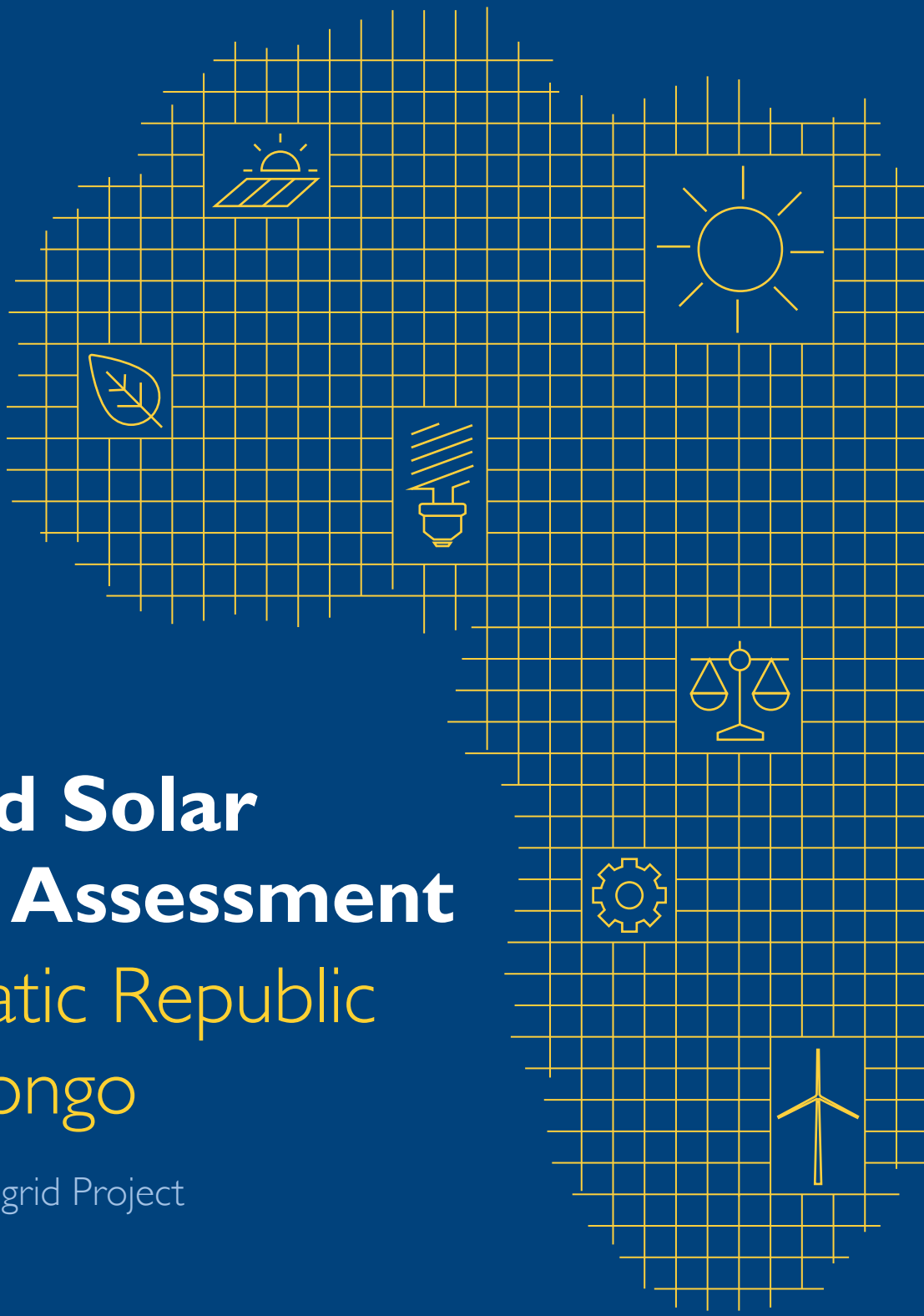

OCTOBER 2019

Off-Grid Solar Market Assessment

Democratic Republic of the Congo

Power Africa Off-grid Project

ABOUT POWER AFRICA

The Power Africa Off-grid Project is a four-year program that launched in November 2018 to accelerate off-grid electrification across sub-Saharan Africa. RTI International implements the project in collaboration with Fraym. Norton Rose Fulbright, Practical Action Consulting, and Tetra Tech. Power Africa is comprised of 12 U.S. Government agencies, over 145 private companies, and 18 bilateral and multilateral development partners that work together, supporting sub-Saharan governments to increase the number of people with access to power.

> *Power Africa aims to achieve 30,000 megawatts of new generated power, create 60 million new connections, and reach 300 million Africans by 2030.*

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Abbreviations and Acronyms

ACERD	Congolese Association for Renewables and Decentralized Energy (Association Congolaise pour les Énergies Renouvelables et Décentralisées)
AfDB	African Development Bank
ANAPI	National Agency of Investment Promotion (Agence Nationale Pour la Promotion des Investissements)
ANSER	National Agency for Rural Electrification Services (Agence Nationale des Services Énergétiques Ruraux)
ARE	Authority for Electricity Regulation (Autorité de Régulation de l'Électricité)
ARPU	Average revenues per user
ASSECAF	Association of Cocoa and Coffee Exporters of the DRC (Association des Exportateurs du Cacao & Café de la République Démocratique du Congo)
BIVAC	Bureau Veritas Inspection, Valuation, Assessment, and Control
BOOT	Build, Operate, Own, Transfer
CACH	Cap pour le Changemont
CDC	Commonwealth Development Corporation
CDF	Congolese francs
CNE	National Energy Commission (Commission Nationale de l'Energie)
DBSA	Development Bank of Southern Africa
DFI	Development finance institution
DFID	Department for International Development
DHS	DRC 2014 Demographic and Health Survey
DRC	Democratic Republic of the Congo
EASE	Energy Access & Services Expansion
EDC	Electricity of Congo (Electricité du Congo)
ENK	North Kivu Energy (Energie du Nord Kivu)
ENERKA	Kasai Energy Corporation (Société d'Énergie du Kasaï)

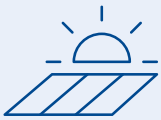
EnerKac	Energie du Kasai Central
ESSOR	For an Environment Conducive to Investment (Pour Un Environnement Propice a l'Investissement en DRC)
EU	European Union
FLP	Fense le Propre
GDP	Gross domestic product
GMG	Green mini-grid
GoDRC	Government of the Democratic Republic of Congo
GOGLA	Global Off-Grid Lighting Association
GUCE	Guichet Unique de Création d'Entreprise
GW	Gigawatt
IFC	International Finance Corporation
IFOD	Financial Institution for Development (Institution Financière pour les Oeuvres de Développement)
KfW	Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau), also known as the KfW Development Bank
km	Kilometer
kW	Kilowatt
kWh	Kilowatt hour
MAP	Making Access Possible
MDP	Market Development Programme
MERH	Ministry of Energy and Hydraulic Resources (Ministère de l'Energie et des Ressources hydrauliques)
MFI	Micro-finance institution
MIBA	Mining Company of Bakwanga (Societé minière de Bakwanga)
MONUSCO	United Nations Organization Stabilization Mission in the Democratic Republic of Congo
MW	Megawatt

MWh	Megawatt hour
NGO	Nongovernmental organization
PAOP	Power Africa Off-grid Project
PAYGO	Pay-as-you-go
PEC	Persistent Energy Capital
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PNSD	National Strategic Development Plan (Plan National Stratégique de Développement)
PSR	Power Sector Reform
RE	Renewable energy
SADER	African Society of Rural Development (Société Africaine de Developpement Rural)
SARL	Société à responsabilité limitée
SE4ALL	Sustainable Energy for All
SEGUCE	Operating Corporation of the Single Window of Foreign Trade of the Democratic Republic of the Congo (Société d'Exploitation du Guichet Unique du Commerce Extérieur de la République Démocratique du Congo)

SHS	Solar home system
SIM	Subscriber identification module
SME	Small and Medium Enterprises
SNEL	National Electricity Utility (Société Nationale d'Électricité)
SOKIMO	Gold Mining Company of Kilo-Moto (Société des mines d'or de Kilo-Moto)
UCM	Unit for Management and Coordination of the Ministry's Projects (L'Unité de Coordination et de Management des Projets)
UDPS	Union for Democracy and Social Progress (Union pour la Democratie et le Progres Social)
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
USADF	United States African Development Foundation
VAT	Value-added tax

INTRODUCTION

This report by Power Africa provides insights into the opportunities and risks associated with the Democratic Republic of Congo's off-grid solar energy market and gives companies, investors, governments, and other stakeholders a deeper understanding of the market. While other stakeholders (i.e., development partners) have conducted market assessments, Power Africa has identified market information gaps and seeks to bridge those gaps in the following ways:



This report provides a comprehensive and detailed review of solar home systems (SHSs), mini-grids, productive use of energy, and other aspects of the off-grid solar value chain. Additionally, this report includes details on policy and regulatory issues, the structure and historical context of the energy sector, and gender mainstreaming.

This report draws upon the most up-to-date sales and investment data from GOGLA in order to keep pace with the ever-changing dynamics of the off-grid solar sector. It also includes a geospatial analysis that highlights potential areas for off-grid solar market expansion.

Insights in this report help Power Africa Off-grid Project (PAOP) plan and prioritize activities across work streams of policy and regulations, market intelligence, business performance, access to finance, and cross-sectoral integration throughout sub-Saharan Africa.

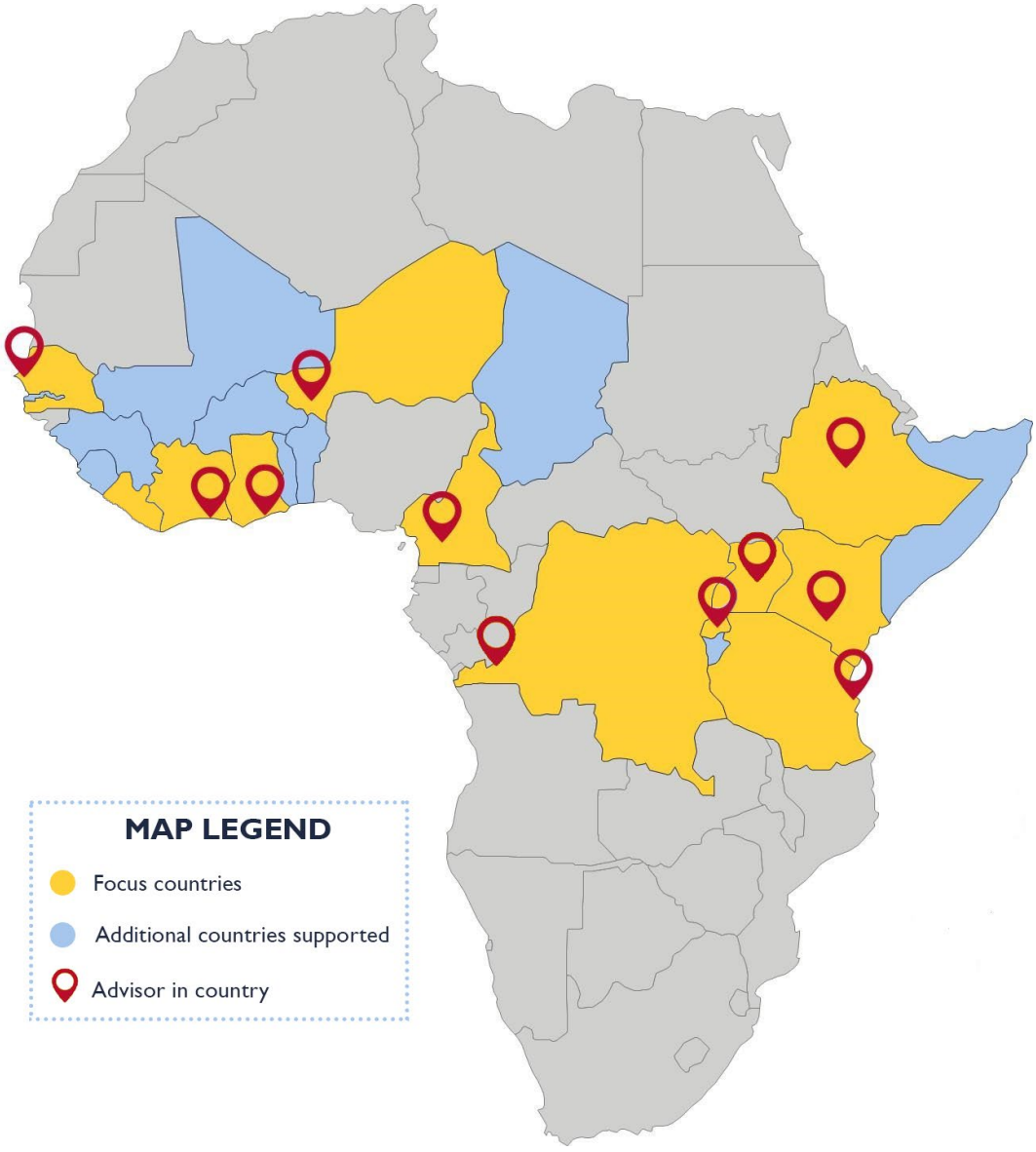
The report also serves as a baseline for Power Africa's technical advisors to guide their continuing work and provides a snapshot that can be used to determine growth and changing dynamics of the market over time. Insights provided in this report include characteristics of DRC's electricity sector, electrification targets, government regulations, donor-funded activities, and details on subsectors of the off-grid solar energy market. Additionally, this report includes expert knowledge from Power Africa lead advisors, information gathered from stakeholder interviews, and data from the Global Off-Grid Lighting Association (GOGLA). For five countries (Cameroon, Côte d'Ivoire, the Democratic Republic of the Congo, Ethiopia, and Niger), a geospatial analysis was performed that leveraged machine learning to identify the potential local markets for off-grid solar energy. The geospatial analysis provides granular details (i.e., latent electricity demand by household income) that will assist companies seeking to expand into new geographic markets.

About Power Africa and the Power Africa Off-grid Project (PAOP)

Power Africa aims to accelerate off-grid electrification across sub-Saharan Africa through targeted, context-specific interventions with private-sector companies, governments, investors, and donors. Power Africa's goal is to increase electricity access by adding 30MW of new generation capacity, and 60 million new connections through grid and off-grid solutions by 2030. The goal of the Power Africa Off-grid Project is to provide support to private off-grid companies and make the markets in sub-Saharan Africa more attractive for investment and operations. Power Africa defines "access" as the direct or actual number of new households and businesses connected to electricity via an on- or off-grid solution. The project focuses on accelerating off-grid energy access through household SHSs and mini-grids, with the goal of facilitating

six million new connections by 2022. The project aims to accelerate off-grid electrification across ten focus countries in Africa: Cameroon, the Democratic Republic of the Congo, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Niger, Rwanda, Senegal, and Tanzania. Figure ES-1 identifies the countries in Africa receiving Power Africa support, with the focus countries highlighted. The pins represent the locations of the project's in-country advisors.

FIGURE ES-1. THE PROJECT PROVIDES SUPPORT TO 20 COUNTRIES IN AFRICA



The Power Africa Off-grid Project is a Power Africa project funded by the U.S. Agency for International Development (USAID). Power Africa brings together technical experts with stakeholders from the public and private sectors to increase energy access rates in sub-Saharan Africa. The Power Africa Off-grid Project is implemented by RTI International and headquartered in Pretoria, South Africa.

1 EXECUTIVE SUMMARY

Democratic Republic of the Congo (DRC) overview. DRC is the fourth most populated country in Africa with an estimated population of 85.8 million people. Approximately 12 million people live in the capital Kinshasa. The remaining population is spread out throughout the country at a low density of 38 people per square kilometer. The growth rate of its population is three percent per year. Currently, more than 40 percent of the population lives in urban areas. Despite a recent period of economic growth, including growth within the energy sector, DRC is still one of the poorest and least developed countries in Africa and has active conflict zones.

Grid electrification. The National Electricity Company (Société Nationale d'Électricité [SNEL]) currently has only 500,000 registered connections, including those served through two hydroelectric- and nine diesel-powered mini-grids.[1] However, SNEL also has a long track record of operational and financial underperformance. Due to a high rate of illegal connections and an extremely low average electricity tariff of $0.07 per kilowatt hour (kWh), which is among the lowest in Africa, SNEL has suffered from continuous operating losses amounting to $300 million in 2014.[2] Although DRC has 100 gigawatts (GW) of hydro potential, which is the highest in Africa, the current total installed capacity only amounts to 2.61 GW. Of this amount, only 1.13 GW are typically available, as more than half of existing hydro plants run under 50-percent capacity because of aging infrastructure and lack of maintenance. DRC's transmission network, highlighted by high-level data provided by SNEL, shows an existing underdeveloped power transmission network that is fragmented into three regional grids. Despite being the largest country in Africa, DRC only has 5,510 kilometers of high-voltage transmission lines.[3]

Power Africa geospatial analysis. Findings from the Power Africa analysis indicate that between 12 and 13 million households in DRC do not have access to electricity, accounting for approximately 84 percent of the population.[4] Households lacking electricity are spread throughout the country, including in both urban and rural areas. Therefore, off-grid solutions are likely to become an important part of DRC's national electrification strategy, likely moreso than in most African countries.

Domestic support. The Ministry of Energy and Hydraulic Resources (MEHR) leads the development of energy policies in DRC. Although no national policy for electricity supply is in place, the Government of DRC (GoDRC) developed the National Strategic Development Plan (Plan National Stratégique de Développement [PNSD]), which has a section focusing on electricity. DRC is also still waiting for the establishment of an electricity regulatory authority and development of a detailed electricity law. The Unit for Management and Coordination of the Ministry's Projects (L'Unité de Coordination et de Management des Projets [UCM]) has been operating since 2015 to support a range of energy projects in DRC. UCM has been supporting a range of programs and coordinating with SNEL since 2017 regarding the rehabilitation of existing grid infrastructure and extension of electricity lines.

[1] Referred to throughout this document as hydro.

[2] Most recent figures that could be obtained.

[3] ICF International, "Conceptual Plan for Enhancing Transmission Infrastructure to Expand Electricity Access in the Democratic Republic of the Congo (DRC)."

[4] Statistics regarding households without access to electricity are based on Fraym data, which pulls data from the DRC 2014 Demographic and Health Survey and LandScan population data. A full discussion of the methodology used to develop estimates for populations without access to electricity are presented in Annex 1.

In July 2018, DRC's renewable energy companies established a national association called the Congolese Association for Renewable and Decentralized Energy (Association Congolaise pour les Énergies Renouvelables et Décentralisées [ACERD]. ACERD coordinates energy companies in DRC to respond to energy access problems and to create a conducive environment for the development of the renewable energy private sector. Currently, ACERD lacks capacity with only approximately 12 members, but it is already establishing itself nationally and has gained membership in the Global Off-Grid Lighting Association (GOGLA).

International support. To improve energy access, the World Bank Group is funding $25 million for the off-grid sector, $10 million for a credit line, and $15 million in provisional grants for both mini-grid and solar developers. This includes a $10 million grant for mini-grids and a $5 million grant for pico-solar companies. The Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau [KfW]), also known as the KfW Development Bank, is developing a hydro-funding program called Pro-Hydro and piloting a project to support the private sector. The Department for International Development (DFID) has been assessing 25 sites for solar mini-grids, where it will fund three pilot projects. In addition, DFID's development program ELAN[5] has been supporting off-grid companies, and DFID's "For an Environment Conducive to Investment" program (Pour Un Environnement Propice a l'Investissement en DRC [ESSOR]) is supporting the mini-grid sector. The ELAN and ESSOR programs both end in 2019. The U.S. Agency for International Development's (USAID) ECODIT program[6] had been supporting the policy and regulatory sector in DRC, but this program ended in 2019.

Pico-solar sector overview. As DRC has a limited electricity grid, this provides a huge opportunity for off-grid solar. DRC might even become the first country where off-grid connections surpass grid connections. However, DRC's pico-solar sector is still in a relatively early stage of development. Only a handful of companies are currently in operation: Altech, BBOXX, d.light, Fense le Propre, AEG, and Greenlight Planet. Most of these companies are still in an early stage of development.

Sales of pico-solar systems in DRC have fluctuated since 2014. A peak in sales occurred in 2017. The data show that sales are generally higher for solar lanterns and lower for solar home systems (SHSs). No data are available regarding pay-as-you-go (PAYGO) versus cash sales, as PAYGO is relatively new in DRC, and most sales have been via cash to date; however, PAYGO sales are starting to pick up. Also, although the limited data show that GOGLA members are predominantly selling quality-verified products in DRC, many low-quality products are being sold in DRC by non-members. However, it is impossible to determine how many of these products are being sold by non-members, as no data currently exist. Although data is limited regarding the sales of bundled appliances in DRC, the available data do indicate that sales of televisions began in late 2017 and the sale of fans has not yet begun. The data also show that there is currently a very large population in DRC without access to electricity and a very low market penetration rate of just five percent of the population. Finally, although total sales of pico-solar systems decreased from 2017 to 2018, they have been increasing significantly toward the second half of 2018, and it is expected that the sales will continue to increase in 2019.

[5] ELAN is the program name, not an abbreviation.

[6] ECODIT, LLC is the company name.

Data regarding investment made in Central Africa only became available from 2016 and show that 2017 had the greatest investment so far, dominated by grants from a donor program. Investment levels dropped in 2018 to levels similar to 2016. However, the number of financial transactions has steadily increased year after year. Investments made in 2017 and 2018 focused on regional expansion and scaling up of existing business models. There was a significant increase in crowdfunding in 2018, which indicates a very positive trend for future investments in the Central African region. The main market barriers that the off-grid solar sector is still experiencing include: a long and expensive importation process; high duties and taxes; high distribution costs, particularly for rural areas; lack of an experienced and skilled local workforce; limited mobile phone reception and mobile money in rural areas; and low access to working capital and consumer finance.

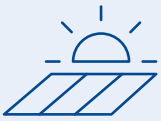
The Renewable Energy Department at MEHR is currently developing a decree to build upon a 2014 law that regulates electricity from hydraulic origins. The decree will clarify ambiguities within the renewable energy sector and include language on solar generation. The Congo Control Office (Office Congolais de Contrôle) with support from the Operating Corporation of the Single Window of Foreign Trade of the Democratic Republic of the Congo (Société d'Exploitation du Guichet Unique du Commerce Extérieur de la République Démocratique du Congo [SEGUCE]), oversees quality standards, but a specific focus on solar systems is currently lacking. In addition, although GoDRC has lifted import duties and valued-added taxes for generation equipment, including renewable generation, it is unclear whether or not these waivers include solar generation. The waivers are not yet being implemented in practice.

Although GoDRC is making efforts to improve financial inclusion, the rate of banking in DRC remains very low at approximately 6 percent. The Central Bank of Congo has been developing incentives for commercial banks and micro-finance institutions (MFIs). The 2014 Making Access Possible (MAP) initiative, in collaboration with the United Nations Capital Development Fund (UNCDF), has completed a detailed analysis of the supply, demand, and regulation of financial services. There have been attempts to collaborate between banks and pico-solar companies; however, little progress has been made. Lending remains too expensive, and banks have little motivation to develop specific SHS financial products, given the perceived repayment risk. To date, the level of investment in off-grid companies has also been low, although a number of new investors are starting to show more interest due to recent economic growth. DRC has approximately 20 MFIs with approximately 1 million customers, including Finca DRC, the Financial Institution for Development (Institution Financière pour les Œuvres de Développement [IFOD]), Advans Bank, Vision Fund, and Baobab. Both Finca DRC and IFOD are starting to develop solar financial products. Mobile money is also starting to develop in DRC due to a relatively high mobile telephone ownership. 56 percent of the population owns at least one subscriber identification module (SIM) card. Although most mobile money operators are still located in urban areas of DRC, they are starting to reach rural areas, with operators currently estimated to cover 41 percent of the country.

Gender equality is a relatively new topic in DRC, and no pico-solar companies currently focus on gender mainstreaming. However, GoDRC recently changed its constitution to improve the conditions for women in society, which will create new opportunity.

Mini-grid sector overview. Based on current grid coverage, it has been estimated that 61 million people could be connected to mini-grids in DRC in the future. This estimate suggests an annual market potential of $921 million, assuming that household spending comprises 60 percent of the total revenue of a mini-grid in addition to revenue from businesses, public-sector buildings, and industrial users. The 141 main population centers located beyond the grid represent a theoretical mini-grid market of 10 million people, valued at $153 million per year. This estimate assumes that the entire population of these centers could be connected to mini-grids.

Although SNEL and some local and international companies—such as Sokimo, the Kasai Energy Corporation (Société d'Énergie du Kasaï [ENERKA]), North Kivu Energy (Energie du Nord Kivu [ENK]), SADER, and Virunga—are investing in mini-grid projects, there are many factors that hamper further sector development and investment. First, the political situation is volatile, and multiple regions are experiencing security challenges. Second, it is difficult for businesses to succeed in DRC. In the World Bank Group's 2017 Doing Business Report, the country ranks 184th out of 190 countries in ease of doing business.[7] The visa requirements are lengthy and burdensome, which discourage business travel and prospective investments. More factors include corruption, limited access to financing, and poor infrastructure. There are several regions of the country that are only accessible by air transport. The Authority for Electricity Regulation (ARE) and the National Agency for Rural Electrification Services (ANSER) are not yet operational, and GoDRC has not yet developed specific mini-grid regulations in full detail. However, several support programs are growing.



Productive-use sector overview. Although asset ownership remains low among households without access to electricity across DRC compared with households with access, a high proportion of off-grid households own land suitable for agriculture or livestock. Solar systems can provide electricity to mills for the processing of crops or animal products, such as peanuts, palm oil, milk, and meat.

Many productive-use off-grid technologies have yet to be developed and implemented in DRC. However, several local companies and organizations have identified opportunities. ASSECAF is one such Congolese association of cocoa and coffee exporters, consisting of 24 cooperatives and company members. In addition to coffee and cocoa, ASSECAF also looks for future opportunities for quinquina, rauvolfia (devil peppers), and papaya. Though not yet involved in the productive use of solar energy, the association welcomes opportunities to grant its farmers access to clean and affordable energy.

[7] The World Bank, Doing Business 2017.

2 DEMOCRATIC REPUBLIC OF THE CONGO ENERGY SECTOR OVERVIEW

2.1 COUNTRY INTRODUCTION

2.1.1 POPULATION SUMMARY

DRC conducted its last population census in 1984, therefore present-day population data is based on projections. The country's population is estimated to be 85,848,600 (see Table 1).

TABLE 1. DRC POPULATION SUMMARY	
POPULATION (GENDER-DISAGGREGATED)	85,848,600; approximately 12 million live in the capital city of Kinshasa
POPULATION DENSITY AND GROWTH RATE	38/km^2 and 3.24% per year
HOUSEHOLD SIZE (MEAN)	5.3 persons
PERCENTAGE FEMALE-HEADED HOUSEHOLDS	Approximately 25%
PERCENTAGE URBAN POPULATION	40.7%
MAIN AND OTHER LOCAL LANGUAGES SPOKEN	French, Kikongo, Lingala, Swahili and Tshiluba.
OTHER RELEVANT DATA	The median age in DRC is 16.8 years.

Sources: [8]

Table 2 provides a summary of recent relevant economic development within DRC.

TABLE 2. RECENT ECONOMIC DEVELOPMENT, DRC	
GROSS DOMESTIC PRODUCT (GDP) AND OTHER RECENT ECONOMIC GROWTH INDICATORS	$35 billion in 2016; GDP growth: 2%–4%; GDP per capita: $400–450
MAIN INDUSTRIES AND EXPORTS	The economy relies heavily on mining, which accounts for approximately one-fifth of GDP and 95% of exports. DRC produces several minerals, including copper, cobalt, zinc, gold, and diamonds. The economy is therefore vulnerable to fluctuations in commodity prices. The World Bank has supported GoDRC's efforts to prioritize its agricultural sector by privatizing several government-owned farms and the establishing agro-industrial parks in several provinces. DRC's most profitable export is copper, followed by crude oil and coffee, its leading agricultural export. Its fourth export, rubber, has been recovering from nationalization. Although some rubber plantations in the Équateur and Mai-Ndombe provinces have been operating for more than 50 years, others have recently been replanted for the first time in more than 20 years.

[8] The World Bank, "The World Bank in DRC"; United Nations Development Programme, "Household Size and Composition Around the World 2017"; East View Information Services, "LandScan Global Population Database"; United Nations, "DR Congo Population."

TABLE 2. RECENT ECONOMIC DEVELOPMENT, DRC (CONTINUED)	
MAIN AREAS OF ADULT EMPLOYMENT IN RURAL AREAS	As of 2019, land under cultivation in DRC currently only constitutes 3.5% of total land area, contributing 18% of GDP and over 60% of new jobs. Only 10% of DRC's arable land is used. This means that DRC currently fails to ensure food independence. DRC has to import many basic food products. Subsistence farming employs the vast majority of the workforce (around four million families) on plots averaging 1.6 hectares. Commercial farming, carried out within plantations is export-oriented but underdeveloped.
LAND AREA	2,267,050 km^2 (second largest country in Africa, behind Algeria).
MAIN CROPS BEING GROWN	The principal crops grown in DRC are cassava, yams, plantains, rice, and maize. Subsistence farmers produce mainly manioc, corn, tubers, and sorghum. DRC is not drought-prone but has limited infrastructure, which is a barrier to effectively supplying food throughout the country.
ORGANIZATIONS ACTIVE WITHIN THE CROP AND LIVESTOCK SECTORS	Feronia Inc. is a public company listed on Canada's TSX Venture Exchange. Operating since 1911 as a large-scale commercial farmland and plantation operator, it uses modern agricultural practices to manage palm oil, and other plantations. Feronia's palm oil subsidiary in DRC is PHC (Plantations et Huileries du Congo), which operates in Équateur and Orientale provinces, managing three established plantations.
OTHER RELEVANT ECONOMIC INDICATORS	DRC has the potential to achieve high levels of economic growth in its mining and agriculture sectors. However, unlocking this potential requires significant policy and regulatory reform, as well as investment in infrastructure and human capital development. To address this, DRC's National Strategic Development Plan (Plan National Stratégique de Développement [PNSD]) for 2017–2021 outlines four priorities: • Stabilize and rebuild conflict zones, particularly in the Kivu region • Consolidate and maintain high economic growth • Create employment through the creation of relevant policies • Increase human development through education, health, and social inclusion

Sources: [9]

2.2 ENERGY SECTOR

2.2.1 GRID ELECTRIFICATION SUMMARY

The state utility in DRC, the National Electricity Company (Société Nationale d'Électricité [SNEL]), has a long track record of operational and financial underperformance. This is due to a high rate of illegal user connections and an extremely low average electricity tariff of $0.07 per kilowatt hour (kWh), which is one of the lowest in Africa. They have also endured continuous operating losses. According to a report by Power for All, losses in 2014 amounted to $300 million. To address these performance problems, provide management and technical advisory services, and prepare a near-term recovery plan, SNEL recruited Manitoba Hydro International with World Bank funding in 2015. The plan, approved in 2016, still requires significant external funding to implement.

Electricity Generation: Although DRC has 100 gigawatts (GW) of hydro potential, which is the highest in Africa, it only has 2.61 GW of generating capacity installed. Of this, only 1.13 GW is typically available. This is because more than half of the existing hydro plants run below 50-percent capacity due to

[9] worldatlas, "Democratic Republic of the Congo"; SEforALL Africa Hub and African Development Bank, "Mini Grid Market Opportunity Assessment: Democratic Republic of the Congo."

aging infrastructure and a lack of maintenance. Of its total hydro potential, 40 GW are concentrated in the Inga Falls area, 140 miles southwest of Kinshasa. Two dams (Inga 1 and Inga 2) with capacities of 351 and 1,424 megawatts (MW), respectively, were completed in 1972 and 1982. A third dam (Inga 3) with a potential of 4,500 MW is at the developmental phase. Other existing hydro plants in DRC include Nseke (248.4 MW), Nzilo (108 MW), Zongo 1 (75 MW), Mwadingusha (68 MW), Ruzizi 1 and 2 (29.8 and 44 MW), and Koni (42 MW). Most were built more than 40 years ago and are running well below capacity due to poor maintenance.

Electricity Transmission: According to high-level SNEL data, DRC relies on an underdeveloped transmission network, divided into three regional grids that, despite supplying the second largest country in Africa, have only 5,510 km of high-voltage (HV) transmission lines.[10] The grids cover the following provinces:

- Western grid: Kongo Central and Kinshasa provinces.
- Eastern grid: North Kivu and South Kivu provinces.
- Southern grid: Haut-Katanga and Lualaba provinces.

The western and southern grids are connected by a 500-kilovolt Inga-Kolwezi link, although the distribution network is poorly developed within the region along the link.

As a result, a whole ecosystem of alternatives has sprung up, including the following:

- Shared generators set up by local entrepreneurs
- Battery-powered flashlights
- Low-quality component-based solar panels bought in the open market

These alternatives tend to be expensive, of poor quality, and even dangerous. It is not uncommon for wild voltage swings from cheap generators to destroy appliances and start fires.

In several towns, electricity is supplied by several formal independent power producers (IPPs), including the following:

- Electricity of Congo (Electricité du Congo [EDC]) in Tshikapa
- Virunga SARL in Mutwanga and Matebe
- Kasai Energy Company (Société d'Energie ïdu Kasaï [ENERKA]) in Mbuji-Mayi
- Mining companies, including Kilo-Moto Gold Mining Company (Société des mines d'or de Kilo-Moto [SOKIMO]), which connects nearby households as part of their social support initiatives
- Faith-based and nongovernmental organizations (NGOs)

However, in many other urban areas, including Gemena, which has 300,000 inhabitants, most households are only able to access electricity informally.

Electricity Distribution: SNEL, the state utility, has just 500,000 registered connections, including those served through two hydroelectric and nine diesel mini-grids.[11] The exact number of users may be significantly higher, as an estimated three to five households connect informally for every formal customer. This practice is encouraged by the fact that approximately 95 percent of SNEL customers are unmetered, being charged a flat monthly fee. This is despite the fact that the electricity service is intermittent and SNEL's poor energy infrastructure causes grid outages over 75 percent of the time. For instance, Kisangani, a city of 1.6 million people, was without power for months when the city's hydroelectric dam broke down. Butembo, a city of 700,000 people, has not had a functioning grid since its independence in 1960. Table 3 lists statistics for DRC's grid connections.

[10] ICF International, "Conceptual Plan for Enhancing Transmission Infrastructure to Expand Electricity Access in the Democratic Republic of the Congo (DRC)."

[11] Power for All, "Research Summary."

TABLE 3. 2019 DRC GRID CONNECTION STATISTICS	
NATIONAL GRID ACCESS RATE	DRC is one of the least electrified countries in Africa, with national electrification estimated to be only 9%.
NUMBER OF GRID-CONNECTED CUSTOMERS IN URBAN AREAS	The electricity access rate is above 50% only in Kinshasa and the territories of Sakania, Kipushi, Beni, and Moanda. In only 10 administrative regions the rate is above 20%. All but 12 of the remaining administrative regions have a rate below 5%.
NUMBER OF GRID-CONNECTED CUSTOMERS IN RURAL AREAS	Most of DRC is not covered by the national grid, and this is likely to remain the case for the foreseeable future due to the current limited reach of its grid, the size of the country, and limited transmission investments in the pipeline.
PERCENTAGE OF POPULATION WITHIN 15 KM OF GRID	African Development Bank (AfDB) analysis estimates that only 19 million people (22% of the population) live within 15 km of the present grid, and that 31 million (36%) live within 15 km of the existing and planned grid. More than 50 million people (58%) live beyond the reach of the existing grid, which presents significant opportunities for mini-grid and off-grid systems.

Sources: [12]

2.2.2 CURRENT ELECTRICITY TARIFF RATES IN DRC

DRC's electricity tariffs are set by SNEL and governed by Decree No. 005/CAB/MIN-ECONAT & COM/2009, established on March 7, 2009, later amended by Order No. 023/CAB/MIN-ECO & COM/2012 of October 11, 2012, which replaced the previous 1978 Law. SNEL's reform was intended to correct their tariff system, which was not financially viable and sustainable in the long-term, requiring that the new pricing system fully reflects all internal and external costs. The exact tariffs are supposed to be calculated based on the cost of electricity production in addition to the distance between the final consumer and the power plant. The price increases with distance. However, although the electricity tariff is regulated, the law also allows SNEL certain latitude when setting the exact prices, making it difficult to determine their exact breakdown. Table 4 outlines the electricity grid tariffs currently being applied in 2019.

TABLE 4. DRC ELECTRICITY GRID COST SUMMARY	
ELECTRICITY TARIFF CATEGORY	GRID COST (TARIFFS) IN USD/KWH
CATEGORY 1: LOW VOLTAGE	
Poor households/low-income users	0.027
Medium-class households/residential 1	0.039
High-class households/residential 2	0.087
Commercial	0.110
Electricity-intensive businesses	0.150
CATEGORY 2: MEDIUM VOLTAGE	
Electricity-intensive businesses	0.098
Developing businesses	0.097
Diplomatic houses and offices	0.095
NGOs	0.087
HIGH VOLTAGE	0.057

Source: [13]

[12] Power Africa, "Democratic Republic of the Congo Power Africa Fact Sheet."
[13] SNEL, "SNEL | Société Nationale d'Électricité."

Decree No. 005 also states that the present electricity tariffs were to be copied from the eastern region of the country and applied in other provinces, including Kongo Central, Kinshasa, Katanga and Bandundu, at least for the low-voltage category.

2.2.3 QUALITY OF GRID ELECTRIFICATION IN DRC

The service offered by SNEL is unreliable, often absent, and poor in quality. The entire DRC electricity network faces many problems:

- A lack of vision or development strategy for the electricity sector that has persisted for more than two decades
- A lack of network maintenance dating back to the colonial era
- Generation sites running below capacity
- Poor or obsolete distribution networks that incur high energy losses
- Rising demand because of a growing demography

Additionally, numerous informal electrical connections overload the lines and decrease the electricity supply quality that reaches registered customers. Although Kinshasa has around 12 million inhabitants and an estimated energy demand of 1,000 MW, SNEL only provides around 45 percent of this. It is now being powered by the Zongo 1 line from Kongo Central as well as lines from Inga 1 and 2 (and Inga 3 in due course). These lines can generate a total output of 1,844 MW. However, due to the problems listed above, they only produce around 900 MW, as most power plants only operate at 50 percent of their capacity. From what is generated by the Zongo 1 line from Kongo Central, Katanga Province receives 300 to 400 MW and Kinshasa receives whatever remains, often 400 to 600 MW. All these elements explain the presence of black pockets. Whole areas of the city receive no electricity due to a lack of connections or structural load shedding from power shortages.

The following statistics on household access to electricity in DRC are based on data from a Power Africa analysis, which uses survey data from the DRC 2014 Demographic and Health Survey (DHS), population data from LandScan, and raw and modeled satellite imagery. A full discussion of the methodology used in estimates for populations without access to electricity can be found in Annex A.

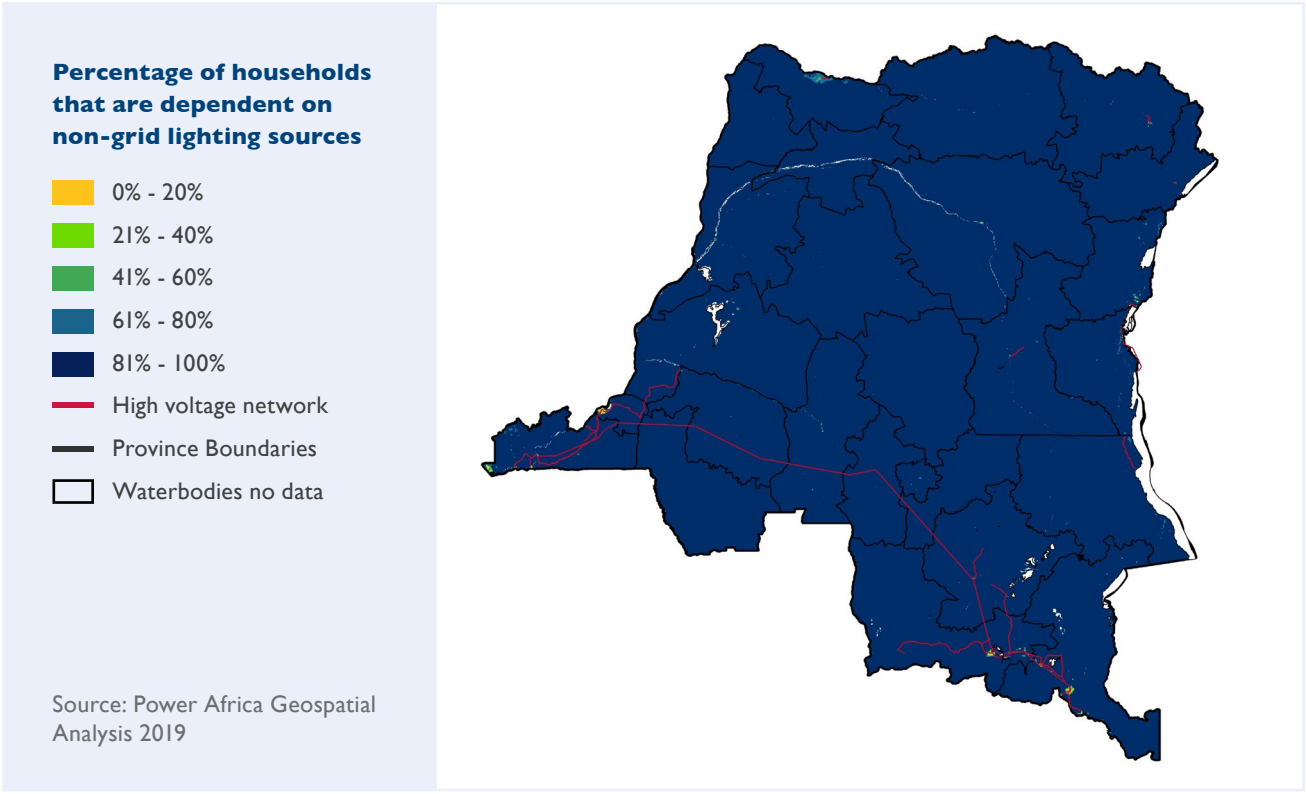
Mapping households without access to electricity

- About 13.1 million households in DRC do not have access to electricity, accounting for about 84 percent of the population.
- Larger cities like Lubumbashi (214,000 households), Matadi (67,000), and Likasi (54,000) have electrification rates above 70 percent, but even in these cities there are still a considerable number of households without access to electricity—60,000 across all three cities.
- Over 80 percent of Kinshasa households have access to electricity, but more than 280,000 households lack access.
- Conversely, other large urban areas, such as Kikwit and Mbuji-Mayi, have large populations but very little access to electricity. In Kikwit, only four percent of 174,000 households have access to electricity, while in Mbuji-Mayi, 12 percent of 200,000 households have access.

Comparison of household electricity access estimates to the HV network

- Power Africa's electricity access estimates align closely with the HV network across DRC, especially in the south (Figures 3 and 4). Specifically, areas with a high proportion of households with access to electricity tend to be located close to the HV network (Figure 5).
- While there are medium- and low-voltage lines servicing communities outside of the range of the HV network, data on the coverage of these lines were either unavailable or unsupported by appropriate third-party sources.

FIGURE 1. PERCENTAGES OF DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY PER KM^2, OVERLAID WITH HIGH-VOLTAGE NETWORK



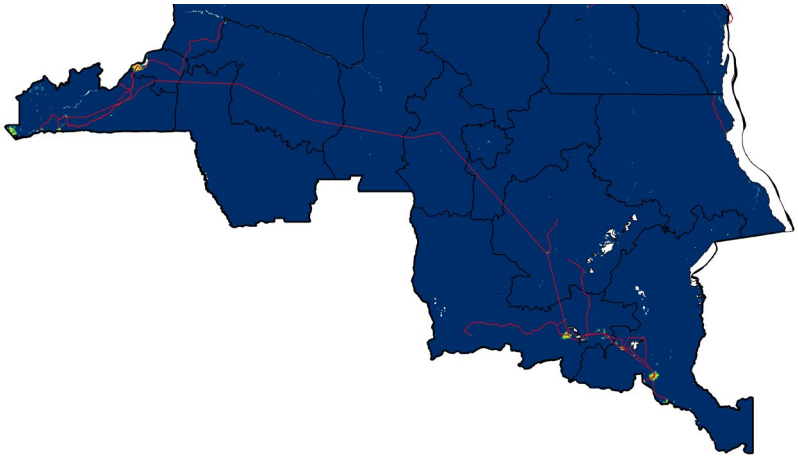
Note: Data on the HV network were obtained from the data collection and mapping work in the World Bank project DRC EASE (Energy Access & Services Expansion). As described by the World Bank, this information was revised and adjusted based on consultation with SNEL and with energy specialists working in DRC and provides the most up-to-date and credible map of the HV network in DRC. Details on data and methods used to identify households without access to electricity can be found in Annex A at the end of this report.

FIGURE 2. PERCENTAGES OF SOUTHERN DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY PER KM^2, OVERLAID WITH HIGH-VOLTAGE NETWORK

Percentage of households that are dependent on non-grid lighting sources

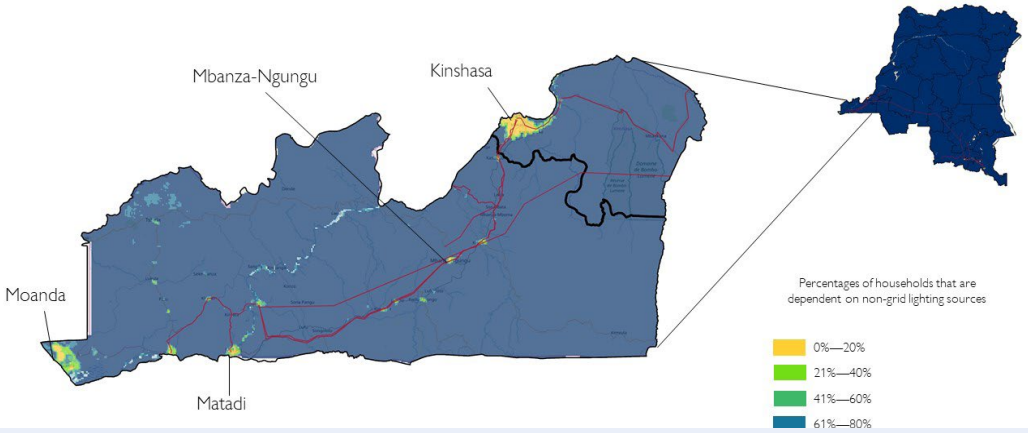
- 0% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%
- High voltage network
- Province Boundaries
- Waterbodies no data

Source: Power Africa Geospatial Analysis 2019



Note: Map focuses on the lower half of the country, where the majority of the HV network is. The World Bank project DRC EASE (Energy Access & Services Expansion) collected and mapped data on the HV network. Details on data and methods used to identify households without access to electricity can be found in Annex A at the end of this report.

FIGURE 3. PERCENTAGES OF HOUSEHOLDS IN KINSHASA AND KONGO CENTRAL REGIONS OF DRC WITHOUT ACCESS TO ELECTRICITY PER KM^2, OVERLAID WITH HIGH-VOLTAGE NETWORK



Percentage of households that are dependent on non-grid lighting sources

- 0% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%
- High voltage network
- Province Boundaries
- Waterbodies no data

While the majority of DRC lacks access to electricity, larger urban areas lile Kinshasa, Matadi, Mbanza-Ngungu and Moanda have higher proportions of households with access to electricity

Source: Power Africa Geospatial Analysis 2019

Note: This map focuses on Kinshasa and Kongo Central regions, where large cities with high proportions of households with access to electricity reside The World Bank project DRC EASE (Energy Access & Services Expansion) collected and mapped data on the HV network. Details on data and methods used to identify households without access to electricity can be found in Annex A at the end of this report.

Current Status of Independent Power Producers (IPPs) and Power Purchase Agreements (PPAs) in DRC

The following is a summary of the current IPPs with any relevant PPAs operating in DRC:

- EDC, an IPP, has 10,000 customers in Tshikapa, consisting of Phase 1, entailing the densification of the existing mini-grid network based on available capacity at Lungudi 1 (0.6–0.7 MW excess capacity) and Phase 2 being the construction of Lungudi 2 (first tranche of 4.27 MW).
- The IPP Virunga has 5,000 clients in Mutwanga and Matebe. The European Union (EU) financed 80 percent of the 400 kilowatt (kW) Virunga hydroelectric plant in Mutwanga and provided $2.5 million in technical assistance for the 12.6 MW hydro plant in Matebe. In 2016, the Commonwealth Development Corporation (CDC) invested $2.5 million in debt in Virunga to expand the Matebe plant distribution grid.
- North Kivu Energy (Energie du Nord Kivu [ENK], PPP), in Beni and Butembo, for construction of the Taliyia 1 (12.1 MW) and Ivugha (2.3 MW) hydroelectric power plant; also targets the construction of the Beni-Butembo transmission line and distribution networks.
- Kananga, Kasai Central Province, Energy of Kasai Central (Energie du Kasaï Central [EnerKac]; PPP): Rehabilitation and extension of the SNEL network, construction of the Tshibashi hydroelectric power plant (2 MW).
- The ENERKA/AEE Power/Katanga Energy (KATen)/Mining Company of Bakwanga (Societé minière de Bakwanga [MIBA]) Consortium benefited from the technical assistance from ECODIT's support program, to develop the contractual framework needed to rehabilitate the hydroelectric power plant of Tshiala, which should supply Mbuji-Mayi in the Kasai Region. ENERKA also supplied the city of Mbuji with financing from the Howard G. Buffett Foundation.

These pilot projects have benefited from sizeable grant funding from the EU-Africa Infrastructure Trust Fund, the World Bank, the CDC, the Howard G. Buffett Foundation, and the Development Bank of South Africa (DBSA). The CDC is expected to invest an additional $6.5 million in debt for the construction of new mini-grids in Lubero and Beni or Rutshuru. In addition, ENK has received financial support from the World Bank and DBSA for its mini-grid project.

2.3 OVERALL POLITICAL LANDSCAPE IN DRC

After several post-independence decades, on December 30, 2018, DRC organized its second round of democratic elections, which led to a peaceful transition and transfer of power from former president Joseph Kabila to President-Elect Félix Antoine Tshisekedi. The Congolese people democratically elected Félix Tshisekedi, the son of Étienne Tshisekedi, a former prime minister and the head of DRC's only opposition party, Union for Democracy and Social Progress (Union pour la Democratie et le Progres Social) (UDPS). The election was disputed by international and national observers, including the Catholic Church, whose opinion influences the stability of the country. The contested elections have slowed President Tshisekedi's ability to form a government, because the two chambers of Parliament are mostly occupied by the coalition Cap pour le Changemont (CACH) led by the government of former president Kabila. However, the protests have slowly dwindled. The international community is slowly coming to accept the elections, and the Catholic Church has become increasingly quiet on the subject. In terms of national security, DRC has endured a lengthy armed conflict in the east that has destabilized the entire country. In the absence of a fully functioning government, GoDRC still effectively operates under the same structure of the outgoing administration. New officials only manage bureaucratic affairs and cannot establish new laws. Tshisekedi's planned program, which has had a slow start, focuses on three areas: the fight against

corruption, respect for human rights, and economic growth. The 2018 democratic elections send a strong signal to investors that DRC is moving towards stability and economic growth. DRC's next election is scheduled for 2024.

2.4 DRC GOVERNMENTAL ENERGY STRATEGY AND INSTITUTIONS

United Nations Development Programme (UNDP) has been supporting the DRC government under the supervision of Ministry of Energy and Hydraulic Resources (Ministère de l'Energie et des Ressources Hydrauliques [MERH]) in its national implementation of the global Sustainable Energy for All (SE4ALL) initiative. This started in 2009 with a nine-month market study that was tasked with identifying energy supply and demand and crafting a statement of needs. The study sets SE4ALL targets for DRC to achieve by 2030. Eleven specific objectives are defined under three main objectives, two of which are as follows:

- Modernization of rural water supply through the promotion of renewable energy systems and modern pumping (electricity, solar, and wind energy).
- Increasing the share of new and renewable energy (RE) in the energy mix from 2.4 percent in 2010 to 30 percent in 2030.

In 2018, the government drew up the National Plan for Strategic Development (Plan National Stratégique de Développement [PNSD]), as well as another important government strategy document, which also focuses on the goal of poverty reduction, the Poverty Reduction Strategy Papers (PRSP) report (from the National Institute of Statistics [Institut National de la Statistique]/Enquete 1-2-3; September 2014). However, both reports contain only one section devoted to electricity sector development, and DRC still has no national policy for electricity supply. In its absence, DRC's SE4ALL study is viewed as the closest version, which aims to tackle the following barriers:

- **Institutional:** As DRC defines the role of its electricity regulator, it also needs to establish a regulatory framework for provision of electricity from a range of sources and technologies.
- **Financial**: Although rich in resources, DRC faces problems in accessing financing and investment, which are too often dependent on foreign capital.
- **Technological:** DRC lags in energy efficiency, energy control, and technology transfer compared to other international or regional countries.
- **Poverty Level:** Poverty limits households' ability to access products because of their low purchasing power.

In addition, DRC is still waiting for the establishment of: (i) a regulatory authority for electricity, (ii) an updated and relevant Electricity Law No. 14/011, promulgated June 17, 2014 (hereafter referred to as the "2014 Electricity Law"), and (iii) the empowerment of leading organizations such as the National Energy Commission (Commission Nationale de l'Energie [CNE]), the Centre for Technical Energy Support, and the National Regulatory Authority for the Electricity Sector (Authorité de Régulation du Secteur de l'Electricité [ARE]). Currently, the 2014 Electricity Law contains no specific mention of pico-solar systems. It only specifically mentions grid and mini-grid systems.

Ministry of Energy and Water Resources (Ministere de l'Energie et des Ressources Hydrauliques [MERH])

MERH is the main authority in the electricity sector. In addition to overseeing the national utility, SNEL, its responsibilities include planning, policy, and program development and oversight. Within MERH, the Unit for the Management and Coordination of the Ministry's Projects (L'Unité de Coordination et de Management des Projets [UCM]) supervises, administers, and coordinates MERH's electricity and water projects. Its responsibilities include identifying renewable energy sites, selecting and preparing medium power plant projects for public-private partnerships (PPPs), analyzing the regulations for the implementation of such projects, and coordinating donor financing programs. CNE collects data and carries out research at the request of MERH to inform energy policy. The National Agency of Investment Promotion (Agence Nationale Pour la Promotion des Investissements [ANAPI]) promotes and facilitates investment opportunities including in the energy sector.

The development of the 2014 Electricity Law helped open the power sector in DRC to private operators. The law did so by removing SNEL's monopoly status and laying the foundation of a new legal framework to promote PPPs and private investments. Following this, GoDRC established a new law in December 2018 (No. 085 RC AB/ MIN/EN RH/I 8) to regulate the contracting of concessions, including the contract type, models of licenses and authorizations of the electricity sector. The 2014 Electricity Law also reviewed the institutional framework, creating new agencies and transferring power to the provincial authorities. The law also required the formation of two new agencies, ARE and the National Agency for the Electrification of Rural and Suburban Areas (ANSER), although neither is yet operational. ARE's main responsibilities will include resolving stakeholder disputes, ensuring fair competition, supporting the tendering of power projects, and ensuring that tariffs submitted by operators work within the cost structure of projects. ANSER's main responsibility will include promoting planning and financing of rural and suburban electrification projects. The 2014 Electricity Law also transfers to provincial governments certain regulatory powers, such as the ability to grant concessions for new generation and distribution projects.

DRC comprises 26 provinces, one of which is the city of Kinshasa. Some provinces have only limited administrative infrastructure and income-generating activities. Each province controls its energy generation and is free to develop new projects, although the involvement of higher authorities will depend on the prospective plant's generation capacity; larger projects are likely to require more centralization and greater involvement of national-government actors in Kinshasa. Likewise, depending on whether the production and supply will be for national use or for only a single province, either the national or provincial governments will provide support.

Despite the incomplete legal framework, some independent power companies have been implementing pilot projects, building or rehabilitating plants and mini-grids, and launching new generation and distribution projects. In addition, the government's Modern Villages program aims to electrify 100 villages using hydroelectric-based green mini-grids (GMGs), although implementation has been slow. The villages of Ngula and Kimbau in the old Bandundu Province have been electrified under this program. MERH has identified an additional seven villages to be electrified: Muluma, Mukoso, Fatundu, Kipuka, Mundundu, Kiefu, and Mongobele.

Unit for Management and Coordination of the Ministry's Projects (L'Unité de Coordination et de Management des Projets [UCM])

Since 2015, UCM has been assisting a range of energy projects in DRC and supporting the World Bank, KfW, and other development partners. Despite the government's goal of universal access to electrification, the present connection rate is very low. GoDRC does not have an integrated development plan and needs to craft a regulatory structure for electricity developers. UCM coordinates all electricity projects in DRC.

It supports increasing investment in the electricity sector and leads all major energy projects in coordination with World Bank, AfDB, the Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau [KfW]), and the like. UCM has also coordinated with SNEL since 2017 to rehabilitate existing grid infrastructure and extend power lines. However, UCM has not yet carried out a detailed energy study, though there is a strong demand for one among stakeholders.

ARE and ANSER

On May 16, 2016, USAID selected ECODIT to manage their Power Sector Reform (PSR) project aimed at reforming DRC's energy sector. The project's mission was to create an environment conducive to increasing access to electricity. ECODIT has supported the Congolese government in implementing the Electricity Law No. 14/011, promulgated on June 17, 2014. ECODIT also assisted several energy projects and directly supported several private operators to increase access to reliable electrification in certain DRC provinces. The project was planned to last for three years, from May 16, 2016 to May 15, 2019 with an extension of about six weeks. However, the project ended on June 30, 2019. ECODIT's mission comprises four components:

- A strategy and policy framework, including the revision of DRC's electricity sector strategy.
- The review and implementation of ARE and ANSER's creation decrees, in accordance with the 2014 Electricity Law, and their effective establishment.
- Providing GoDRC with all the statutory elements required to support ARE and ANSER, including writing pertinent regulations and ministerial decrees and to facilitate the bodies' validation by stakeholders.
- The production, transmission, and distribution concessions contract, which resulted in the improvement of the regulatory framework, including the signing of Decree 0.85 in December 2018.

However, GoDRC has not been able to implement the new institutions or promulgate the prepared acts of legislation in a timely manner. ANSER will be responsible for rural electrification throughout DRC's vast territory. The DRC government has not provided a proper framework for renewable energy, including pico-solar, and has not addressed it under the 2014 Electricity Law.

ANAPI

DRC has been working hard to improve the business environment within the country to try and increase its Ease of Doing Business ranking. ANAPI supports the off-grid sector by providing customs and tax exemption mechanisms. ANAPI also oversees the provision of value-added tax (VAT) on products in DRC.

Ministry of Gender, Children, and Family

This ministry is under the supervision of Minister Chantal Safu. In partnership with MERH's Renewable Energy Division, Clémentine Zamuko is leading the Energy and Development initiative, which will work closely with a new unit under the management of the Gender Ministry. In addition, the Renewable Energy Division has been piloting an initiative called Women's Energy and Development (Femmes Energie et Développement) over the last few years, which aims to promote the participation of women in the energy sector. These initiatives highlight the shared interest of these ministries to support gender mainstreaming within the energy sector. Deepening this relationship may result in more practical initiatives. It is already widely recognized in DRC that women are at the center of the household and are important economic actors. To encourage greater commitment from the Ministry of Gender, Children, and Family conducted a market study demonstrating the benefits of RE solutions for women. Greater efficiency in women's energy consumption has a positive impact on local economies and off-grid stakeholders.

2.5 INTERNATIONAL DONOR PROGRAMS

DFID Programs in DRC

ELAN: DFID's ELAN program was a five-year project lasting from 2014 through 2018 with a six-month extension until July 2019. The program supported private-sector development in agriculture, transport, and access to finance (including mobile money) and RE. ELAN supported the mini-grid sector by conducting a technical and economic feasibility study of various sites, and building the capacity of financial institutions in Kinshasa, Kivu, Kasai Central, and Katanga provinces. Technical-feasibility studies were also conducted by EDC.

ELAN also supported the pico-solar sector in DRC, which was in a very early stage of development when it started. ELAN carried out a market assessment of DRC in 2015 and has advised local companies on how to import reliable, high-quality solar products. Solar companies also need assistance on marketing strategies in order to raise awareness and educate the Congolese population about solar products.

One of the biggest challenges local solar companies face is access to finance, particularly consumer finance, as many households are not able to pay cash for systems. ELAN has been working with local banks on solar credit pilots in both Kinshasa and Goma provinces. ELAN also has been trying to pilot PAYGO in DRC and has been working with several local and international solar companies, including BBOXX and d.light, to do so. In November 2018, ELAN helped create a local solar association in DRC to address issues such as duties, taxes, value-added taxes, and quality standards. This initiative, too, is still developing. The association is moving to have companies pay for membership. The association has already connected the Global Off-Grid Lighting Association (GOGLA) and has around 15 local members, although they are hoping to increase this to 25 soon. ELAN has also been working with Equity Bank in DRC to provide financing and guarantees for off-grid companies. Furthermore, it helped Total to start piloting its Awango program to sell pico-solar systems in DRC. International Finance Corporation (IFC) had a guarantee fund with small and medium enterprises in DRC with Rawbank in about 2014, which could provide useful lessons for a new off-grid guarantee fund.

ESSOR: As the ELAN program mostly focused on solar lanterns and SHSs, DFID's £35 million ESSOR program instead focuses on the mini-grid sector in DRC. This started with an assessment of mini-grid engineering, procurement, and construction companies operating in the country. ESSOR plans to support the construction of three solar GMGs, each with approximately a 3 MW capacity, in three large off-grid towns in DRC. In 2016 they started to develop the business models and facilitate the preparation and tendering of the GMGs with the aim for them to be operational by 2021. Funding is expected to be sourced from private investors and development finance institutions (DFIs). The priority targets for the mini-grids are the cities of Bumba, Gemena, Isiro, Gandajika, and Ilebo, as they have populations between 124,000 and 260,000, solar irradiation between 5.27 and 6.2 kWh/m2/day, and energy demands between 0.45 and 5 MW. The projects will benefit from 15- to 20-year concessions. 21 private companies and 11 DFIs expressed an interest in providing financing for the mini-grids. ESSOR started mapping selected sites in 2017, which included finding developers to carry out both generation and distribution under a build, operate, own, transfer (BOOT) model. The mini-grids will include solar panels and batteries as well as fossil fuel backup generators. In 2018 pre-feasibility studies were completed (including technical and demand studies), and the sites were secured from GoDRC. The funding window was launched in late 2018, and a number of credible expressions of interest were submitted. ESSOR supported the government in assessing them. ESSOR hopes to select the preferred bidder by September 2019, with concession agreements and financial close to be reached by the end of 2019 or early 2020. ESSOR is ending by year-end 2019 but could be extended by one year.

A number of regulatory gaps have been addressed in the concession agreements, as well as Term Sheets, environmental impact assessments, and the range of financing required, including debt, sovereign guarantees, grants, and mezzanine debt. In total, the mini-grids will be financed by about 30 percent grants and 70 percent debt. ESSOR is hoping that if the three mini-grids can prove the concept, this will allow the mini-grid model in DRC to be scaled, with other donors (including World Bank, AfDB and KfW) then providing further funding as required. Although the mapping of present and future grid sites, as well as significant population centers that are still off-grid, could help support the mini-grid sector, very little geospatial mapping has been carried out in DRC. UNDP's 2014 Renewable Energy Atlas is the main public data source available. As noted, the creation of the national electricity regulatory authority (ARE) is in progress, but the process has been very slow, and it is not possible for projects to wait for the regulator to be established.

World Bank: The World Bank-financed Electricity Access and Services Expansion (EASE) project, with a budget of $145 million, aims to increase access to electricity by expanding and rehabilitating independent / green mini grids through both a public and private approach, with technical assistance. Under the public sector support (about $95 million), the independent Gbadolite distribution network, powered by the Mobayi Hydropower Plant, will be rehabilitated and expanded, as well as segments of the Kinshasa distribution network. The two contracts recently finalized through the PSR program were for $200,000 each to Virunga SARL and ENK, to pay the connection fees for their mini-grids in Mutwanga and Butembo, respectively, for new customers who cannot afford the cost. ECODIT has also contracted the technical company Bureau d'Etudes des Géosciences des Techniques et d'Ingénierie to provide technical assistance to SOCODI's mini-grid in Walikale.

Under the private sector support, private companies - including green mini-grid operators and solar home systems distributors - will be supported to expand electricity access through the provision of a credit line ($10 million) and a subsidy/grant facility ($15 million). The credit line represents a refinancing window through which financing for RE could be issued by local commercial banks under the oversight of the Central Bank of Congo. The institutional arrangement for the credit line is being finalized and commercial banks in the DRC will be invited to participate. The exact loans terms are not yet defined as the banks will be the ones making the final decision on whether off-grid and mini-grid companies have sustainable business models, as they will be taking the risk by lending their money. However, the credit terms (interest rate and maturity) are expected to be more attractive than the terms currently available in the DRC. Leading commercial banks should start talking to companies immediately so they can begin developing their business plans.

With regards to the subsidy/grant facility, an initial phase targeting mini-grid operators was rolled out. Virunga SARL received the first grant to expand its distribution network in Nyrangongo, a Northern suburb of Goma, capital city of the North Kivu Province. A second phase, targeting solar home systems operators, is under preparation, and will provide subsidies to SHS installers/distributors using a results-based financing approach. To better design and operationalize this second phase, UCM has already identified 8 to 10 potentially viable off-grid companies who provided further information on their potential business plans regarding the subsidy. As off-grid energy companies often lack collateral, the need for a partial guarantee was discussed. However, it was highlighted that the credit line must demonstrate results before considering such a risk mitigation tool.

Power Africa's Policy Sector Reform Program: ECODIT has been implementing Power Africa's Power Sector Reform (PSR) program since 2016. Power Africa helps GoDRC carry out the 2014 Electricity Law by supporting the establishment and operation of ARE and ANSER and the training of their personnel. Both agencies will be responsible for rural electrification throughout DRC's expanse. The strengthened legal and regulatory framework will attract both private and public capital to investment opportunities in the power sector. Power Africa prepared a study in 2018 of options for expanding grid access in Kwilu,

Kasai, Kasai Central, and Kasai Oriental provinces. It also produced a study detailing four mini-grids in North and South Kivu provinces. Power Africa plans to partner with private-sector investors such as mining companies to bring the mini-grids into operation. During its first three years, the PSR program supported GoDRC in developing its supporting legislation for the ARE and the electricity regulatory framework in general. However, after this period, it became clear that, due to slow progress, it would not be possible to establish the relevant regulator or its commissioner in the near future. Power Africa decided to change the direction of the program to be more transaction focused during its last year, by providing direct support to SHS and mini-grid companies and launching a study of on-grid power in the East Africa region.

Power Africa is also supporting a number of SHS companies that are now moving into the DRC market, in particular North and South Kivu in Eastern DRC. In addition, Power Africa will continue its work on rural electrification with provincial authorities in North and South Kivu, and potentially other provinces, to expand private-sector investment. ECODIT recently made a request for proposals for mini-grid programs and their supporting SHS programs, issuing three subcontracts to support SHS companies. ECODIT has been providing technical assistance to several companies including SECODI, an NGO based in South Kivu that has completed the first phase of development for a hydroelectric project. ECODIT has also provided over a year's worth of technical assistance for an ongoing hydroelectric-project study. Although the project will not be scalable, it will generate useful lessons on providing rural electricity access to a customer base of 6,000 households. ECODIT has also been providing financial assistance to several companies. For example, it provided a $200,000 grant to Virunga Power in early 2019 to increase the number of households on mini-grids by connecting them to hydroelectric power. Under its terms ECODIT connected at least 400 households by increasing the capacity of Mutwanga hydro plant from 13.5 to 29 MWs. ECODIT also provided a grant of $200,000 to ENK, a private mini-grid company in operation for over five years, to make use of their excess generation in an ongoing project to connect 800 poor households in Butembu.

SHS companies also applied for grants, but initially were unable to meet the minimum tender requirements. Recently, however, they were able to receive support from ECODIT:

- ECODIT supported BBOXX's launch in Bukavu, South Kivu, with the goal of providing electricity access to an additional 600 households, in addition to providing financial support for their launch and advertising.
- They also supported Altech in piloting their new program at the refugee camp of Lusende in South Kivu to help 700 new consumers obtain lanterns. Altech will sell lanterns through their Ambassador program, with repayments over 10 months.
- Lastly, ECODIT is supporting Kit4Africa to sell their 20 to 30 W solar systems with the goal of being able to reach 400 new clients in Kinshasa, Kongo Central, and Tanganyika provinces. ECODIT is also providing training on their Solar Ambassador program, selling in Kinshasa, Kongo Central, and South Kivu. ECODIT also assessed Baobab+, PACT, and Finca DRC, although did not provide them with any support.

AfDB: The African Development Bank's Green Mini-Grid Market Development Programme (MDP) aims to foster access to electricity across Africa. The MDP provides assistance to a range of stakeholders in overcoming the challenges of widespread and sustainable implementation of GMG projects in the following ways:

- Establishing a comparable, actionable understanding of the GMG market opportunity in sub-Saharan Africa
- Promoting the links among communities, public institutions, developers, financiers, and technology providers required for successful mini-grid development

- Strengthening the capacity of developers to craft and operationalize GMG business models
- Promoting a sound policy-making and regulatory environment
- Engaging project financiers and supporting the development of suitable financial solutions

The MDP is implemented by the Sustainable Energy for All (SE4ALL) Africa Hub, through a grant from the Sustainable Energy Fund for Africa. The SE4ALL Africa Hub, hosted by AfDB, is a partnership of African institutions dedicated to supporting the continent's progress toward the SE4ALL initiative's three main objectives of energy access, renewable energy, and energy efficiency. AfDB also plans to support the development of master plans for rolling out electrification at the provincial level in DRC.

UNDP: UNDP's 2014 Renewable Energy Atlas has been used as one of the main reference documents for the energy sector in DRC. Some of the data in the Atlas is incomplete or out of date, but it is nonetheless still an important source, identifying more than 300 potential hydro sites across the country. The analysis also defines on- and off-grid areas based on their distance from the power network. Grid regions are defined as being areas within 15 km of the grid. Main off-grid population centers have also been mapped, enabling an analysis of the potential for mini-grid projects.

KfW: KfW is a development bank funded by the Government of Germany, which has been supporting the energy sector in DRC because it touches so many other development sectors. Electrification rates in DRC are very low, particularly outside Kinshasa, and need a lot of support. KfW has been working with the World Bank to support grid rehabilitation, including $20 million in financing for the Inga Hydro Project, which had a kick-off meeting in January 2019. The Pro-Hydro project KfW is developing will focus on RE projects and has identified 19 towns/sites where they could be implemented. The project does not have a fixed model; instead, it can fund any model that seems technically and financially viable. Hydroelectric was its original focus, but as it is technically quite difficult, KfW is open to other technologies. The fund is provisionally $20 million but could be scaled to $50 million if suitable projects can be identified. KfW works closely with other development partners, including the EU, World Bank and AfDB, and on regional coordination projects, such as with Burundi and Rwanda. KfW does not provide funding to private-sector companies directly but could consider funding a SHS project in the future if they can find a way. KfW also has a rural-financing program, which is managed by a commercial bank, FPM, and this potentially could be used to lend to off-grid energy companies if a suitable business model can be identified and the off-grid company is willing to discuss new financing options. Furthermore, KfW has been working on a program to invest in the agriculture sector, and this could be combined with a solar water pumping program or another productive use program. Lastly, KfW has been developing a guarantee fund, which could be used to support off-grid companies in the future, although it is not yet operational.

2.6 CREATING A RENEWABLE-ENERGY ASSOCIATION

In July 2018, many of the leading renewable energy companies in DRC, with support from the ELAN program, established a national association called the Congolese Association for Renewable and Decentralized Energy (Association Congolaise pour les Énergies Renouvelables et Décentralisées [ACERD]). ACERD's primary objective is to coordinate among all the energy companies in DRC to respond to the country's energy-access problems. Their fundamental mission is to help create a conducive environment for the development of the RE private sector in DRC. The association admitted a dozen members in its first wave of participants, with a second wave of about 10 members due to join in late 2019. Current members include all the major players in the sector including BBOXX, Greenlight Planet, BURN, Altech, and DevSolair. ACERD is already a member of GOGLA and has an operational office, as well as an executive and secretariat. The president for its first year has been Orange Energy, a subsidiary of France's Orange Telecommunications Group. ACERD has a management committee that meets at least twice a

month. All of ACERD's management positions are now occupied by the staff of its members, but it is working on fundraising to be able to recruit its own core staff that will be available full time to implement ACERD's activities. An annual general meeting is planned for October of each year. It also has a website that includes general information (www.acerd.org) and will soon have a membership form for new participants and a welcome pack that includes its internal regulations and commitment to transparency.

ACERD is still very new; however, it is developing its constitution and attempting to accelerate its process of formal structuring. Its work plan and medium-term strategy are still outstanding, and it still lacks the fundamental capacity to deliver on its general objective of aiding the development of the RE sector. ACERD nevertheless aims to address cross-cutting issues that slow down the development of the sector, including those related to high taxes and lack of clarity on customs processes, which add more than 30 percent to the final consumer price. The RE market in DRC is young; households have generally low levels of awareness, weak demand and poorly developed supply chains have invited low-quality products, and access to high-quality and affordable systems remains limited. To combat this, ACERD aims to support efforts to better educate DRC consumers, including raising awareness of a range of sustainable and appropriate RE solutions.

2.7 TRAINING INSTITUTIONS, INCUBATORS, AND ACCELERATORS

As noted, the RE sector is still at a very early stage in DRC, with low awareness and a poorly developed ecosystem. DRC has a number of training centers, but none have a particular focus on RE generally or solar in particular, and there are no formal structures focused on off-grid energy training. The Congolese market also lacks the necessary support services to develop the RE sector. For instance, centralized distribution centers do not exist, nor do any databases providing relevant information on potential off-grid customers. There is a directory of Congolese companies within the Federation of Business of the Congo (Fédération des Entreprises du Congo), although it does not provide any services beyond registering companies. Solar companies in DRC need to develop strong after-sales services. After-sales maintenance and repair of RE equipment is currently overseen by employees trained by their companies. There is currently no organized and functioning profession for specialized RE technicians; usually regular electricians do the work, but they are working in an underdeveloped sector, with products which are often new to them.

There are a few incubators operating in DRC, but they cannot strictly be described as accelerators. DRC has three major cities with high concentrations of startups where there is a need for incubators: Kinshasa, Lubumbashi, and Goma. In the Kinshasa region, I&F Entrepreneurial is managed by Val Massamba and focuses on the agriculture sector; Baziks is managed by Narsix Baya and deals with music streaming; and other startups include Lumumba Lab and Ingenious City. In the East there is Kivu Hub, Kivu entrepreneurs, and for Katanga there is Cinolu. Although the number of incubators in DRC is small, the companies are high quality. However, there is no RE-oriented incubator in DRC. Ingenious City in Kinshasa, which hosts more than 42 startups, has a strong structure that can accommodate RE developers. Created in March 2018 by Fely Samuna and François Ngenyi, the incubator offers a space of more than 1,200 m² that can hold 100 offices and hosts coworking spaces and meetings. It offers startup training, coaching, internet access, and electricity, all for $50 per month.

2.7.1 RURAL ELECTRIFICATION STRATEGY

To date large hydro projects have attracted the majority of energy-sector funding in DRC. The AfDB and the World Bank have provided a $377 million grant to rehabilitate Inga 1 and Inga 2, a $68 million grant to develop the Inga 3 hydroelectric plant, and a $106.5 million technical assistance grant to create the Grand Inga Development Authority and other medium-scale hydroelectric projects.

DRC's total hydroelectric potential, estimated at 100 GW, if developed, would make the country a continental powerhouse. The Grand Inga project has a potential of 40 GW with an estimated generation cost of $0.03/kWh, making it one of the cheapest possible sources of electricity in Africa. Some 4,800 MW, corresponding to the Inga 3 hydroelectric project, are currently at the development phase. South Africa and DRC have already signed a PPA for 2,500 MW of Inga 3's capacity (SE4ALL Africa Hub and African Development Bank 2017).

Although the DRC has a target of universal access to electricity by 2050, it has been estimated that as of 2019 there are still between 12-13 million households that are currently not connected to the electricity grid. The largest 170 population centers in DRC have a population of nearly 31 million people. Of these, around 20 million live in 29 towns situated within 15 km of a power network. The remaining 141 towns, which have a total population of approximately 10 million people, are considered to be primary targets for electrification through modern mini-grid solutions. The list includes towns already served by SNEL managed diesel or hydroelectric mini-grids, such as Kisangani, Mbandaka, Moanda, Mokambo, and Uvira, many of which are outdated and non-operational. They also include towns such as Tshikapa served by independent mini-grid companies such as EDC. UNDP produced a Renewable Energy Atlas in 2014 that identified 317 potential small hydroelectric sites. Although data on location and estimated potential is incomplete, 183 sites across the country with a total potential of 1.1 GW were identified. A total of 57 sites with a potential of 165 MW are located within 15 km of the existing power network and could develop the capacity and distribution network of the main grid. Beyond the 15 km buffer, 126 sites with a potential of 945 MW have been identified that could contribute to the development of hydroelectric-based mini-grids. Of the 141 towns identified, 51 are located within 20 km of a potential hydroelectric site.

DRC has several positive factors, including a large US-dollar-powered commodity-based economy and key enablers of off-grid solar systems, such as mobile money, in place. It has large urban economic hubs with serious energy shortages. The result is much higher average revenues per user (ARPU), which holds great potential for future PAYGO companies.

Off-grid solar currently has a low priority in DRC's national electrification strategy. Based on present grid coverage, the analysis estimates an annual potential market of $921 million for mini-grid and off-grid solutions, assuming that 61 million people will be connected to these solutions. The potential market size may be even larger, as modern, decentralized solutions become feasible in areas with grid lines, where households have not yet connected to the grid. The analysis also takes into account a scenario with planned grid extensions, which yields an estimated annual market size of 47 million people, representing $721 million per year.[14]

2.8 DRC'S ENERGY DEMAND

The entire DRC suffers from a very low supply of electricity, which impacts its entire population resulting in a very low demand, although this is projected to increase substantially up to 2030 (Table 5). This low grid demand has created very high demand for off-grid solar solutions. This demand generally varies with users' income, from a simple need for lighting to the power requirements of larger domestic appliances, including refrigerators, ovens, irons, microwaves, and freezers.

[14] SEforALL Africa Hub and African Development Bank, "Mini Grid Market Opportunity Assessment: Democratic Republic of the Congo."

TABLE 5. DRC ENERGY DEMAND: ACTUAL AND PROJECTED, 2010–2030 (IN MWH)					
	2010	2015	2020	2025	2030
Industry	3,449.2	5,742.6	9,800.5	17,141.4	30,947.7
Households	4,135.08	11,480.2	18,497.9	28,155.5	48,781.3
Transport	14.9	44.7	148.9	242.3	335.6
Services	994.7	1,496.8	2,341.3	3,581.7	5,754.5
TOTAL	8,593.88	1,8764.3	30,788.6	49,120.9	85,819.1

Source: Power Africa Technical Advisor Interviews, 2019
Note: MWh = megawatt hours.

In 2017, the development project ÉLAN RDC carried out a market study in 2017 to define the consumer profiles and energy demand in DRC. The study found that households generally aspire to energy systems that offer greater comfort, with more than 40 percent of respondents demanding access to larger solar systems, and 31 percent demanding systems to power their entire house. However, regarding households' ability to pay, the study indicated that over 94 percent of surveyed households can afford systems under $20, as households' first demand is to access low-cost, high-quality lighting. It also noted that demand for solar products over $20 decreases rapidly, as households have low incomes and little ability to pay much higher prices. Only 4 percent of households demanded products priced from $41 to $60, and almost zero wanted systems over $81. A market study by Forcier indicated that low-income DRC households save more than $9 per month using solar solutions. This change of habits creates wealth, either through a new job or increased profitability, and improves people's daily lives through increased access to medical care and children's schooling, better living conditions, and higher wellbeing, all of which all improve household health.

Nationally, about 13.07 million households in DRC do not have access to electricity. These are home to about 70 million people, comprising 84 percent of the national population. In urban areas, 50 percent of households do not have access to electricity, while in rural areas 99 percent of households lack access. About 75 percent of all households without access to electricity, or about 9.8 million families, live in rural areas.[16]

Of the 2.5 million households with access to electricity, about 2.45 million live in urban areas, with about 1.9 million of these households with access to electricity living in the 15 largest cities of DRC.[15] According to 2014 DHS data, households without access to electricity tend to have the following attributes :

- Their homes are built from less durable materials. For example, 8 percent have floors made out of sturdy materials, such as wood, cement, or tile, compared to 89 percent of households with electricity that have floors made from these materials.
- The households have lower levels of financial inclusion. Only about 2 percent have a bank account, compared to 96 percent of households with access to electricity.
- Their heads of household are engaged in agricultural work at higher rates than heads of households with access to electricity. About 60 percent of those heading households without access to electricity are employed in agriculture, compared to 3 percent of those heading households with access to electricity.

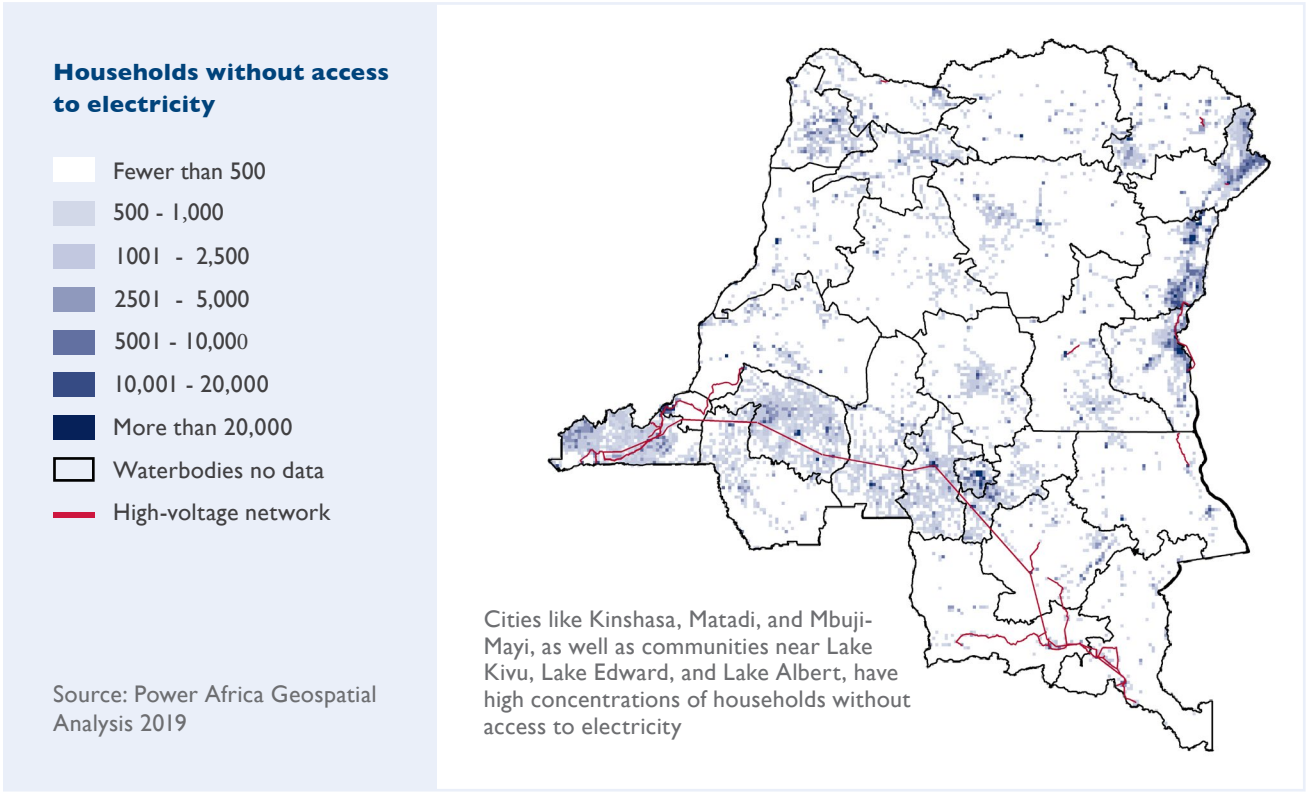
[15] The 15 largest cities in DRC by population, from largest to smallest, are Kinshasa, Lubumbashi, Mbuji-Mayi, Kikwit, Kisangani, Kananga, Goma, Uvira, Matadi, Kolwezi, Mbandaka, Bunia, Bukavu, Likasi, and Tshikapa.

[16] Ministry of Monitoring, Planning and Implementation of the Modern Revolution, Ministry of Public Health, and ICF International, "Democratic Republic of Congo Demographic and Health Survey 2013-14."

› Their heads of household have lower levels of education compared to those heading households with access to electricity. 41 percent of those heading households without access to electricity have either not received any formal schooling or have not completed primary school, compared to 8 percent of those heading households with access to electricity.

Power Africa Off-grid Project analyzed households based on proximity to the national HV network, calculating the number of households without electricity within 5 km, between 5 and 10 km distant, and beyond 10 km distant. The majority of households (60 percent) within 5 km of the HV network have access to electricity. However, this percentage drops for those farther from the grid, as only 20 percent of households between 5 and 10 km from the HV network, and 3 percent of households beyond 10 km, have access to electricity. Of the households lacking electricity access, about 1.28 million, or just under 10 percent, live within 5 km of the HV network; about 390,000 (about 3 percent) live between 5 and 10 km from the HV network; and about 11.4 million (87 percent) live beyond 10 km from the HV network.

FIGURE 4. NUMBER OF DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY PER 10 KM

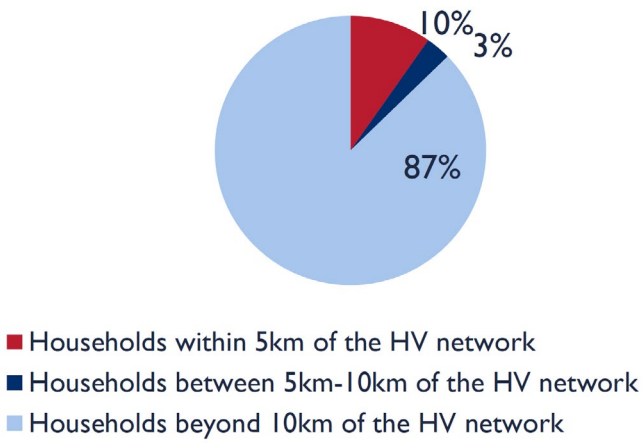


Note: Only areas with at least 500 households per 10 km^2 are shown as squares.

TABLE 6. HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY

TOTAL OFF-GRID MARKET POTENTIAL (NOT INCLUDING BACKUP USE)	WITHIN 5 KM OF HV NETWORK	5 KM–10 KM FROM HV NETWORK	CLIENTS 10+ KM FROM THE GRID
13,070,000	1,280,000	390,000	11,400,000

FIGURE 5. TOTAL OFF-GRID MARKET POTENTIAL



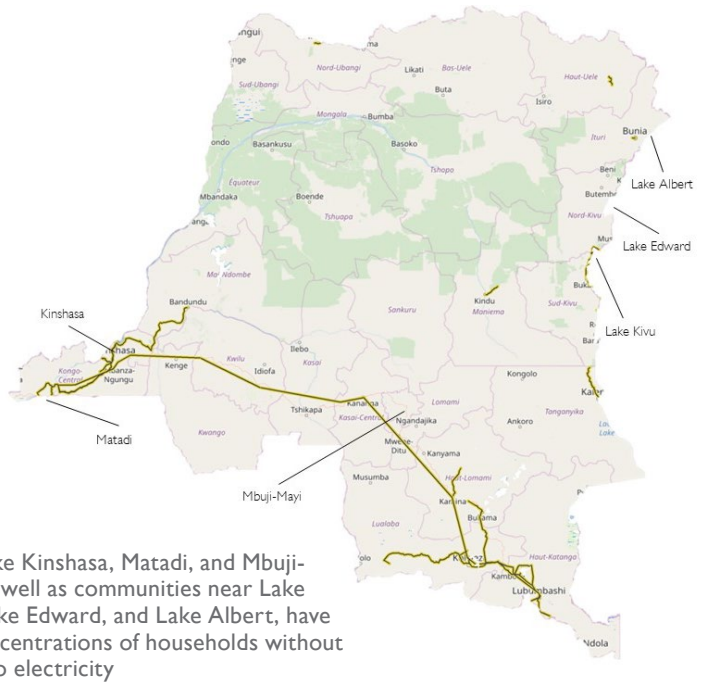
The analysis of proximity to the grid provides a useful framework for understanding the nature of off-grid DRC households, as well as different strategies that may be employed in developing country-wide energy solutions. The following information is provided at a national level, with statistics calculated using Power Africa data and survey data from DRC 2014 DHS. For province-level breakdowns of these statistics, please see Table A2-2 in Annex A.

- Households without access to electricity that are within 5 km of the HV network (Figure 6):
  - Live in communities that are more likely to be serviced with national grid expansion, especially through medium- and low-voltage network connections.
  - Constitute 10 percent of all households without access to electricity. These 1.28 million households are a substantial market in need of energy services that could be efficiently and effectively serviced by solar energy systems.
  - May be best serviced through less-expensive, short-term energy systems such as solar lanterns or small home systems.
- Households without access to electricity that are 5 to 10 km from the HV network:
  - Live in communities that may require additional time before becoming connected to the grid.
  - Comprise only 3 percent of households without access to electricity, but still offer a substantial market of potential customers in need of energy solutions.
  - May be best serviced with longer-term energy solutions, such as solar home systems.
- Households without access to electricity that are beyond 10 km from the HV network (Figure 7):
  - Live in communities that are far enough from the national grid that expansion may take considerable time, especially in more rural areas.
  - Make up the vast majority (87 percent) of households without access to electricity.
  - May be best served by mini-grids, which offer an attractive energy solution for larger communities with high-enough concentrations of households with sufficient spending power.
  - For households with low spending power, a full range of solar lighting and energy systems would be suitable.

FIGURE 6. HIGH-VOLTAGE DRC GRIDLINE WITH 5-KM BUFFER

High-voltage network

5-km buffer



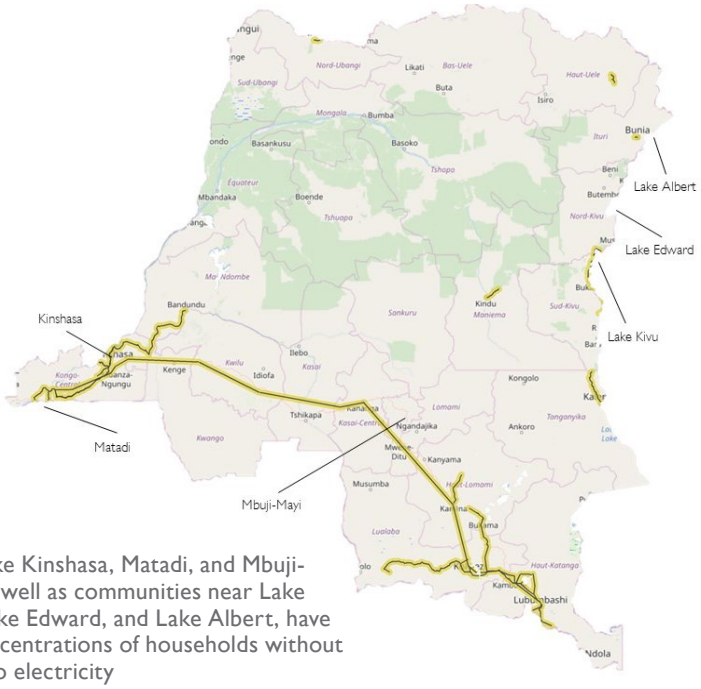
Source: Power Africa Geospatial Analysis 2019

Cities like Kinshasa, Matadi, and Mbuji-Mayi, as well as communities near Lake Kivu, Lake Edward, and Lake Albert, have high concentrations of households without access to electricity

FIGURE 7. HIGH-VOLTAGE DRC GRIDLINE WITH 10-KM BUFFER

High-voltage network

10-km buffer



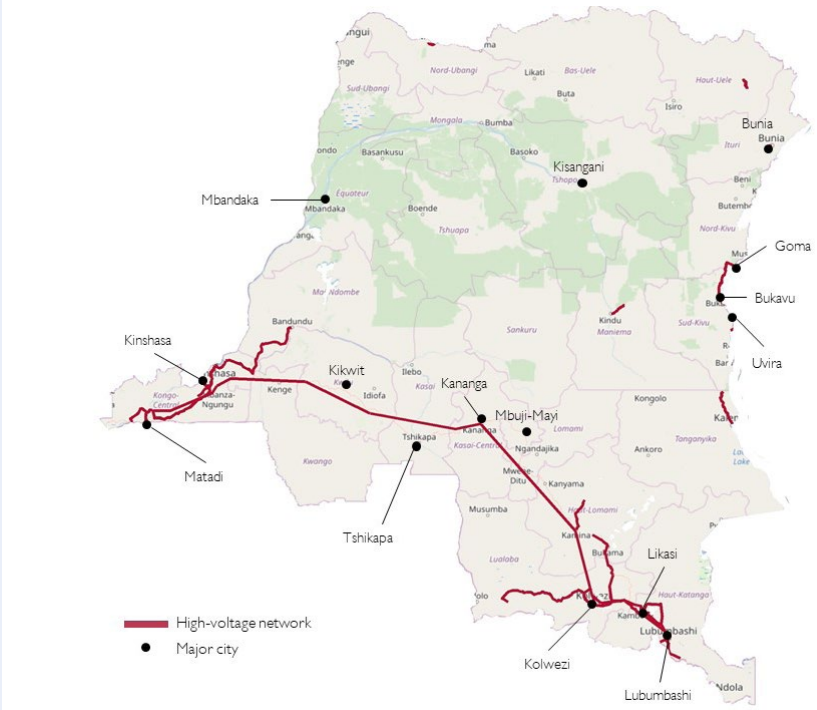
Source: Power Africa Geospatial Analysis 2019

Cities like Kinshasa, Matadi, and Mbuji-Mayi, as well as communities near Lake Kivu, Lake Edward, and Lake Albert, have high concentrations of households without access to electricity

FIGURE 8. THE 15 MOST POPULOUS CITIES IN DRC OVERLAID WITH THE HIGH-VOLTAGE NETWORK

High-voltage network

5 km buffer



Source: Power Africa Geospatial Analysis 2019

To understand potential latent demand for electrification, Power Africa and Fraym used survey data from the DRC 2014 DHS and analyzed socioeconomic indicators and asset ownership across high-consumption-power households that lack electricity access, then compared this group to all households that have electricity. The similarities between these two groups in socioeconomic indicators, asset ownership, and electronic media consumption illustrate the potential demand for energy these high-consumption-power households are likely to have upon gaining access to reliable electricity.

According to 2014 DHS data, households with access to electricity are in the top 90th percentile of the wealth index, while high-consumption-power households are in the top 75th percentile. Power Africa then compared high-consumption-power households lacking electricity access to a subset of households with access to electricity that have more similar rankings on the wealth index than the set of all households with electricity, as described next.[17]

- This subset of households, which comprises about 5 percent of all DRC households and is in the 78th percentile of the wealth index, aligns even more closely across socioeconomic indicators and asset ownership with high-consumption-power households lacking electricity access than the set of all households with electricity. High-consumption-power households tend to have more educated heads of household than this on-grid comparison group (19 percent vs. 11 percent), and 12 percent have better access to bank accounts (vs. 8 percent), More high-consumption-power households than the subset with electricity access own high-range assets like televisions (83 percent vs. 62 percent), computers (11 percent vs. 2 percent), and generators (37 percent vs. 6 percent).

[17] This was done by calculating the average wealth levels for households without access to electricity in the 75th percentile, and then identifying all households with and without access to electricity falling within one standard deviation from this value.

- Only 62 percent of this subset of households own televisions, compared to 83 percent of high-consumption-power households. However, regular television viewership is significantly higher among households with access to electricity: 61 percent of 15- to 49-year-olds in these households watch television regularly, compared to only 34 percent in high-consumption-power households lacking electricity.

With this in mind, Power Africa suggests that these high-consumption-power households have high latent demand for electrification, including to power electric appliances and assets. This group's relatively high wealth suggests they have the ability to pay for large electrical assets, but lack the reliable electricity needed to power them. Particularly interesting is this group's disparity between widespread television ownership and infrequent television viewership. This points to the group's unmet demand for reliable electricity and its dependency on alternatives to the national grid to power their devices. For a full breakdown of key indicators, including ownership of key assets, media consumption, housing quality, head of household education, and agricultural indicators, see A2-6 in Annex A.

Using survey data from DRC 2014 DHS, Power Africa calculated statistics at the household level on asset ownership, housing quality, and the education and occupation of the head of household, then compared these statistics for households without access to electricity to those of households with electricity. To see the national-level breakdown, see Table A2-3 in Annex A. To understand the potential market for different types of off-grid solutions, Power Africa segmented households without electricity based on key household characteristics and assets. The goal was to understand different levels of consumption and the potential spending power within this group. Profiles were developed using survey data from DRC 2014 DHS as well as Power Africa and Fraym data. The majority (53 percent) of households without access to electricity fell into one of the following three groups.

- **High-consumption-power households** are those that have at least one high-range asset such as a car, computer, TV, or refrigerator.
- **Medium-consumption-power households** are those that own a mobile phone and lived in a dwelling with at least one type of high-quality housing material (e.g., cement, stone, bricks, or metal) used for the roof, floor, or walls.
- **Modest-consumption-power households** are those that own at least a radio or mobile phone.

Note that the groups are mutually exclusive, with each household being classified into the highest tier for which it was eligible.

- 30 percent of households without access to electricity fit the profile for **modest consumption.**
  - These households demonstrated the ability to pay for electrical assets. Eighty-four percent own a radio and 38 percent own a mobile phone, but they still lack substantial spending power, as illustrated by lower-quality housing. Only 10 percent have high-quality roofing materials, such as metal or cement. None of these households have high-range assets (car, computer, TV, or refrigerator).
  - 86 percent of these households are in rural areas and 74 percent own agricultural land, the highest percentage across both indicators among all three consumption profiles.
  - There are approximately 3.8 million households in this group.
- 17 percent of households without access to electricity fit the profile for **medium consumption.**
  - 100 percent of these households own a mobile phone, and 54 percent own a radio.
  - These households have greater ability to pay, as illustrated by their use of high-quality housing materials. Fifty-eight percent have walls made from high-quality material (e.g., cement, stone, bricks, or metal), and 92 percent have roofs made from high-quality materials (e.g., metal or cement).
  - A complete lack of any high-range assets within this group (e.g., televisions, computers, generators, or cars) illustrates its limited consumption power.
  - There are approximately 2.2 million households in this group.

› Six percent of households without access to electricity fit the profile for high consumption.

  » These households own at least one high-range asset. Such assets serve as proxies for wealth and also indicate energy demand, as many of them are electric (e.g., televisions, refrigerators, and computers).
  » While 83 percent of households in this group own a television, only 34 percent of adults aged 15 to 49 in these households watch television at least once a week, demonstrating some unmet demand for reliable electricity.
  » These households may rely on alternatives to the national grid to power their electric assets.
  » There are approximately 724,000 households in this group.

The remaining 47 percent of households without electricity have very low consumption power, as indicated by a complete lack of mid- or high-range assets, and dwellings made entirely from lower-quality materials. Power Africa and Fraym further validated this segmentation by analyzing the corresponding wealth distribution for each group, using DRC 2014 DHS wealth index, based on asset ownership and other household characteristics. This analysis confirmed that households with lower levels of wealth were rightly classified as low- and modest-consumption-power households, and those with higher wealth were correctly classified as high-consumption-power households.[18]

Generally, households across all three consumer groups live beyond 10 km from the HV network. About 3.5 million of the 3.8 million modest-consumption-power households, or about 92 percent of households in this group, live beyond 10 km from the HV network. Both medium- and high-consumption-power households tend to live closer to the HV network compared to modest-consumption-power households (Table 7. Consumer groups in relation to the high-voltage network). About 21 percent of medium-consumption-power households, and 28 percent of high-consumption-power households, live within five km of the HV network, compared to only about 7 percent of modest-consumption-power households. For a full breakdown of indicators, including ownership of key assets, media consumption, housing quality, head of household education, and agricultural statistics, see A2-4 in Annex A.

TABLE 7. CONSUMER GROUPS IN RELATION TO THE HIGH-VOLTAGE NETWORK

LEVEL	TOTAL HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	MODEST-CONSUMPTION-POWER HOUSEHOLDS	MEDIUM-CONSUMPTION-POWER HOUSEHOLDS	HIGH-CONSUMPTION-POWER HOUSEHOLDS
National	13,070,000	3,842,000	2,232,000	724,000
Within 5 km of HV network	1,280,000	250,000	470,000	200,000
5–10 km from HV network	390,000	112,000	102,000	29,000
Beyond 10 km from the HV network	11,400,000	3,480,000	1,660,000	495,000

Source: [19]
Note: Households grouped by consumption power include only households without access to electricity. Figures 9, 10, and 11 depict the numbers of modest-, medium-, and high-consumption-power households in DRC per 10 square kilometer grid.

[18] The DHS wealth index is a composite measure of a household's living standards. For a full discussion of the methodology used to construct this index, see USAID, "The DHS Program: Wealth Index," https://www.dhsprogram.com/topics/wealth-index/Wealth-Index-Construction.cfm.

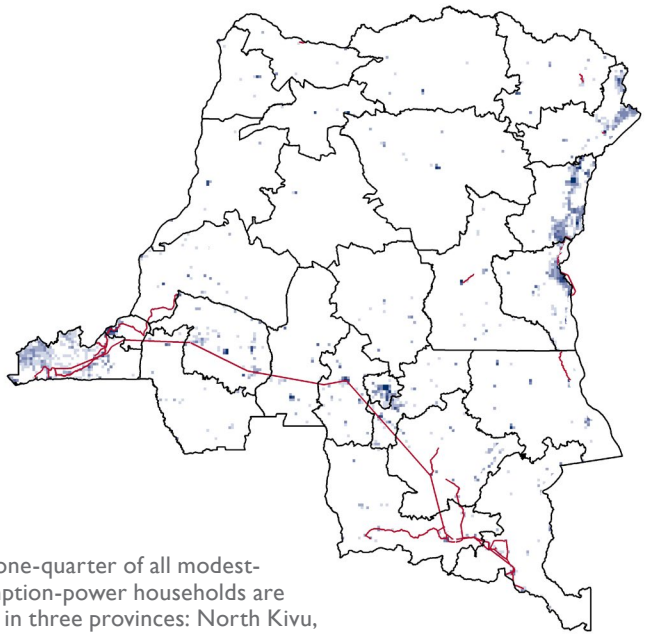
[19] Ministry of Monitoring, Planning and Implementation of the Modern Revolution, Ministry of Public Health, and ICF International, "Democratic Republic of Congo Demographic and Health Survey 2013-14."

FIGURE 9. NUMBER OF MODEST-CONSUMPTION-POWER HOUSEHOLDS IN DRC PER 10 KM^2

Modest-consumption-power households

- Fewer than 250
- 250 - 500
- 501 - 1,000
- 1001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- More than 10,000
- Waterbodies no data
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019



About one-quarter of all modest-consumption-power households are located in three provinces: North Kivu, Kwilu and Ituri. Across these three regions, there are 980,000 households with modest power consumption

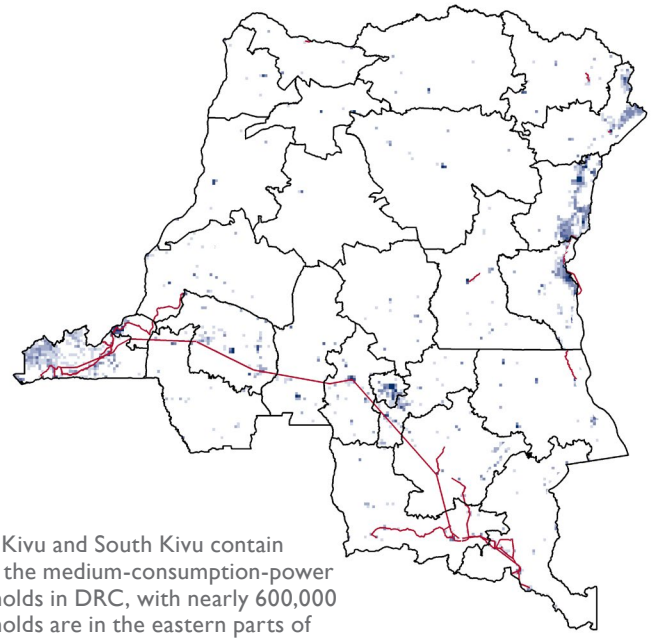
Note: Households grouped by consumption power include only those without electricity access. Areas with fewer than 250 modest-consumption households per 10 km^2 are shown in gray.

FIGURE 10. NUMBER OF MEDIUM-CONSUMPTION-POWER HOUSEHOLDS IN DRC PER 10 KM^2

Modest-consumption-power households

- Fewer than 250
- 250 - 500
- 501 - 1,000
- 1001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- More than 10,000
- Waterbodies no data
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019



North Kivu and South Kivu contain 26% of the medium-consumption-power households in DRC, with nearly 600,000 households are in the eastern parts of provinces. Other provinces with high concentrations of medium-consumption-power households are Kongo Central and Kasai Oriental

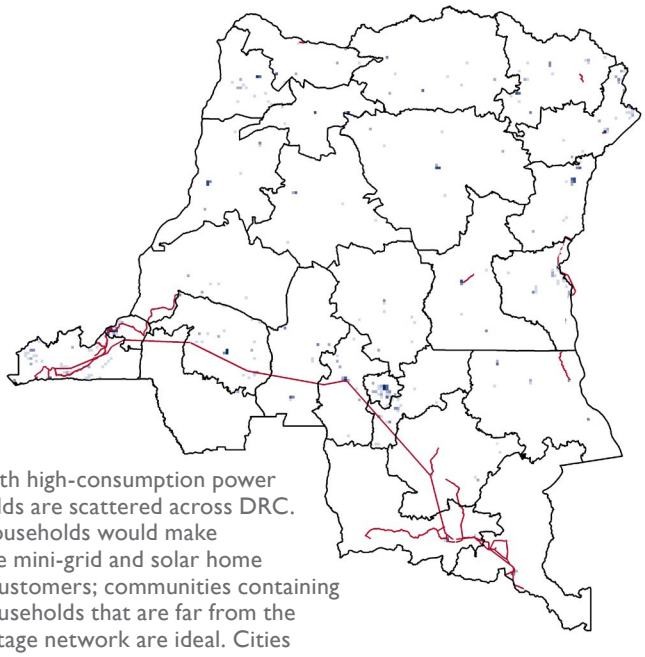
Note: Households grouped by consumption power include only those without electricity access. Areas with fewer than 250 medium-consumption households per 10 km^2 are shown in gray.

FIGURE 11: NUMBER OF HIGH-CONSUMPTION-POWER HOUSEHOLDS IN DRC PER 10 KM^2

Modest-consumption-power households

- Fewer than 250
- 250 - 500
- 501 - 1,000
- 1001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- More than 10,000
- Waterbodies no data
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019



Areas with high-consumption power households are scattered across DRC. These households would make attractive mini-grid and solar home system customers; communities containing these households that are far from the high- voltage network are ideal. Cities such as Gemena, Kisangani, Butembo, and Mbandaka have high concentrations of such households

Note: Households grouped by consumption power include only those without electricity access. Areas with fewer than 250 modest-consumption households per 10 km^2 are shown in gray.

3 PICO-SOLAR SECTOR IN DRC[20]

The DRC's undeveloped grid electrification sector translates into a huge opportunity for the solar energy sector. Given that SNEL only has 500,000 connections, it is not far-fetched to think that DRC could be the first country where the virtual grid surpasses the physical one—where more people are connected with solar home systems than with the grid. Whoever takes advantage of that opportunity stands to win extremely valuable urban energy consumers. The country could become one of the best off-grid markets in the world if companies acquire the expertise and insights to adapt to the local market conditions.

3.1 SHS SALES SUMMARY

Table 7 through Table 16 offer a summary of pico-solar sales in DRC obtained by GOGLA from its members.

Sales of pico-solar systems in DRC since 2014 have fluctuated greatly, peaking in 2017. Available data show that system sales are generally higher for solar lanterns, with SHS sales quite limited. There are unfortunately no exact data available on levels of PAYGO sales compared to cash sales. The majority of payments have been in cash; PAYGO is relatively new in DRC but is starting to pick up.

TABLE 8. SALES DATA IN DRC BY PRODUCT CATEGORY

SALES PERIODS IN DRC	SUM OF 0–1.5 WP	SUM OF 1.5–3 WP	SUM OF 3–10 WP	SUM OF TOTAL
July–December 2014	-	-	-	37,452
January–June 2015	-	-	-	43,000
January–June 2016	750	-	-	73,191
July–December 2016	-	-	-	729
January–June 2017	11,565	33,382	1,128	46,090
July–December 2017	-	-	-	242,271
January–June 2018	-	601	-	11,197
July–December 2018	-	-	-	54,316
Total	12,315	33,983	1,128	508,246

Source: [21]
Note: Wp = Watt peak. Where cell is blank no data on the specific products was available.

[20] This includes companies selling both solar lanterns as well as SHSs.
[21] GOGLA, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data."

TABLE 9. SALES DATA IN DRC BY BUSINESS MODEL

SALES PERIODS IN DRC	BUSINESS MODEL		
	CASH+PAYGO	CASH ONLY	PAYGO ONLY
July–December 2014	37,452	-	-
January–June 2015	43,000	-	-
January–June 2016	73,191	-	-
July–December 2016	729	-	-
January–June 2017	46,090	-	-
July–December 2017	242,271	-	-
January–June 2018	11,197	-	-
July–December 2018	54,316	-	-
Total	508,246	-	-

Source: [2]

TABLE 10. MARKET VALUE BY PRODUCT CATEGORY

SALES PERIODS IN DRC	SUM OF 0–1.5 WP	SUM OF 1.5–3 WP	SUM OF 3–10 WP	SUM OF TOTAL
January–June 2016	-	-	-	$903,549
January–June 2017	66,533	266,483	78,767	$419,009
July–December 2017	-	56,412	72,657	$7,427,997
July–December 2018	-	-	-	-
Total	66,533	322,895	151,424	$8,750,555

Source: [23]

TABLE 11. MARKET VALUE BY BUSINESS MODEL

SALES VOLUMES IN DRC	BUSINESS MODEL	
	CASH ONLY	PAYGO ONLY
January–June 2016	$903,549	-
January–June 2017	$419,009	-
July–December 2017	$7,427,997	-
January–June 2018	-	-
July–December 2018	-	-
Total	$8,750,555	-

Source: [24]

There are limited data on the sale of quality products in DRC, although the data do indicate that GOGLA members are predominantly selling Quality Verified (QV) products. Anecdotally it is known that a lot of low-quality products are sold in DRC, but no data exist on how many.

[22] GOGLA.
[23] GOGLA.
[24] GOGLA.

TABLE 12. GOGLA SALES DATA BY QUALITY VERIFIED BY NON-QUALITY-VERIFIED PRODUCTS			
SALES VOLUMES IN DRC	SUM OF QUALITY VERIFIED	SUM OF NON-QUALITY-VERIFIED	SUM OF TOTAL
July–December 2014	-	-	37,452
January–June 2015	43,000	0	43,000
January–June 2016	-	-	73,191
July–December 2016	-	-	729
January–June 2017	45,553	537	46,090
July–December 2017	-	-	242,271
January–June 2018	-	-	11,197
July–December 2018	-	-	54,316
Total	88,553	537	508,246

Source:[25]

There are also limited data on the sale of bundled appliances in DRC, with the data indicating that sales of TVs only started in late 2017 and that the sale of fans has not yet started (Table 13). The data also show that the vast majority of Congolese lack access to grid or off-grid electricity, with a very low market penetration rate of off-grid products of just 5 percent of the population (Table 14). Last, although total sales of solar systems fell from 2017 to 2018, they have been increasing significantly toward the second half of 2018, and it is expected they will continue to grow into 2019 (Table 15).

TABLE 13. ESTIMATED SALES DATA OF BUNDLED APPLIANCES FOR THE CENTRAL AFRICA REGION		
APPLIANCES	PERIOD	SALES VOLUMES
Fans	July–December 2017	0
TVs	July–December 2017	467

Source: [26]

TABLE 14. ESTIMATED MARKET PENETRATION			
COUNTRY	WORLD BANK ACCESS RATE (2017)	WORLD BANK POPULATION WITHOUT ACCESS (2017)	MARKET PENETRATION ESTIMATION
DRC	19.09%	65,809,230	5.44%

Source: [27]

TABLE 15. COUNTRY-LEVEL TRENDS		
TREND TYPE	% CHANGE H2 2018 TO H1 2018	% CHANGE H2 2018 TO H2 2017
Total sales	385%	–78%

Source: [28]

[25] GOGLA.
[26] GOGLA.
[27] GOGLA.
[28] GOGLA.

TABLE 16. GOGLA ESTIMATED IMPACT IN DRC FROM 2016 THROUGH 2018	
1AI. PEOPLE WITH IMPROVEDENERGY ACCESS (CUMULATIVE)	3,698,036
1AII. PEOPLE WITH IMPROVED ENERGY ACCESS (CURRENT)	3,578,758
1BI. PEOPLE WITH ACCESS TO TIER 1 ENERGY SERVICES (CURRENT)	1,996,562
1BII. PEOPLE WITH ACCESS TO TIER 2 ENERGY SERVICES (CURRENT)	72,712
2B. PEOPLE WHO HAVE STARTED A NEW JOB (CUMULATIVE)	9,840
3. ADDITIONAL INCOME (CUMULATIVE)	$51,067,528
5AI. CHANGE IN LIGHT HOURS USED (CUMULATIVE)	868,969,050
6AI. CHANGE IN ENERGY SPENDING (CUMULATIVE)	$155,418,858
6AII. CHANGE IN ENERGY SPENDING (HOUSEHOLD)	$1,124
7. GREENHOUSE GAS EMISSIONS AVOIDED (CUMULATIVE)	918,624

Source: [29]
Note: Tiers as per World Bank's Global Tracking Framework

Pico-Solar Commercial Overview

Below is a summary of all the main pico-solar companies currently active in DRC (Table 18).

TABLE 17. DRC PICO-SOLAR COMPANY SUMMARY

COMPANY NAME	YEARS OF OPERATION (LAUNCH YEAR)	AREAS OF OPERATION	SALES TO MID-2019 (UNITS)	FINANCE RAISED (US)
Altech Group	6 years (2013)	National market: Kivus, Kinshasa, Équateur, Bandundu	Over 150,000	At least $500K
BBOXX	9 years (2010)	Goma and Kinshasa	Over 4,000	At least $300K
d.light	3 years (2016)	Kinshasa, Kivus	87,431	Over $1 million
Ecomwinda	6 years (2013)	Kinshasa, Équateur, Kongo Central	Over 35,000	Over $300K
GLP	1 year (2018)	Kinshasa, Lubumbashi	Over 1,000	Over $900K
Mastajabu	In solar, 1 year (2018)	Lubumbashi	Less than 1,000	na
Nyika Energy	1 year	North and South Kivu	Included within d.light sales	na
Proton	15 years (2004); in			
solar, 3 years (2016)	Kinshasa, Lubumbashi	Over 4,000	na	
Congo Energy/Forest Group	97 years (1922)	Nationwide	na	na
Schneider Electric	na	Kinshasa	4,000	na
Devsolair	3 years, since 2016	Lubumbashi/Katanga region	Over 25,000	na
Total RDC	30 years	Kinshasa	Over 3,000	na
Kit4Africa/Weast	na	Kinshasa	na	na

Source: Power Africa Technical Advisor Interviews, 2019
Note: na = not available

[29] GOGLA.

BBOXX: BBOXX offers PAYGO solar power to more than one million people across the world. Hardware and software for PAYGO solar products are designed by their engineering team in the UK, manufactured by their team in China and distributed through partners and wholly owned subsidiaries in Africa. BBOXX's four key markets of operation are Togo, Rwanda, Kenya and DRC.[30]

BBOXX entered the DRC market in late 2017 and to date has electrified more than 75,000 people across DRC with PAYGO solar. The launch in DRC started with the support of Shell Foundation grant funding, and after having proven the viability of the business, BBOXX attracted commercial investment from African Infrastructure Investment Managers (AIIM), a South-African based private equity fund to scale PAYGO solar across the country. BBOXX has also built a strong government partnership, including a tax exemption on import of all solar equipment and a joint commitment to electrify more than 500,000 households. Additionally, BBOXX has helped to improve the overall PAYGO solar business environment, benefiting future players, through its key role in government lobbying on behalf of the sector as a founding member and vice-president of the industry association ACERD.[31]

Within DRC, BBOXX operates in the provinces of North and South Kivu (Goma/Bukavu) and in Kinshasa through a strategic partnership with the telecom company Orange, for which it is the supplier of hardware and software. BBOXX is continuing its growth and expansion across the country and plans to open in Lubumbashi, Bunia, and Beni in early 2020 and in Kolwezi, Likasi and Kisangani in 2021. The vision of BBOXX is to become the largest utility in Congo and to make DRC the first country where more people access energy through a decentralized "virtual grid" than a physical one.[32]

In DRC, BBOXX offers three key products:

- Kit Heri – 4 lights, radio, torch, phone charging (20W panel)
  - Installation fee $16
  - Monthly fee $8 for 3 years
  - Maintenance fee $1 per week after 3 years
- Kit Home – 4 lights, radio, torch, phone charging, 24" TV (50W panel)
  - Installation fee $50
  - Monthly fee $25 for 3 years
  - Maintenance fee $2 per week after 3 years
- Kit Confort – 10 lights, 40" TV, fridge, phone charging (300W panel)
  - Installation fee $180
  - Monthly fee $90 for 3 years
  - Maintenance fee - $8 per week after 3 years

The core principle behind BBOXX is to offer long-term electrification to customers. Hence the BBOXX pricing is split into two: i) a fee during the first three years, during which customers pay-off their system and become the owner of the accessories, ii) a maintenance fee for life which covers long-term maintenance of the panel and battery and ensures that products are maintained long-term around the world. BBOXX offers a lifetime guarantee, swapping any faulty components free of charge as long as customers keep up with their maintenance fees. BBOXX also has an extensive distribution network – 120 kiosks with one agent demarcated to each 5 streets to ensure last mile customer service and proximity to clients.[33]

[30] BBOXX, "The DRC - the Best Pay-Go Solar Market in the World?"
[31] BBOXX.
[32] BBOXX.
[33] BBOXX.

With nine years' experience in bringing solar energy to the underserved, BBOXX now aims to expand into related areas. Using technology to deliver other vital utility services, such as cooking, internet and water, BBOXX aims to build a network of 'Next Generation Utilities' across Africa. At the heart of BBOXX's business model is a pioneering management platform, called Pulse, which continuously collects data and insights, enabling them to provide quality services at low-cost. PAYGO gas is the first phase of this expansion into other utility services. Over the past two years BBOXX has developed PAYGO gas hardware and software, running operations across Rwanda, and is now looking to expand this technology to new markets and to scale it up, with DRC being a focus for this new business line.[34]

Altech Group: Altech Group aims to help end energy poverty in DRC by 2030 through a 3-pronged approach consisting of identifying the problem, developing appropriate clean energy technologies and providing appropriate payment solutions. They have sold over 170,000 PAYGO-enabled solar and clean cooking technologies, positively impacting 850,000 people and creating over 300 jobs. By 2030, they aim to sell 2 million products, positively impacting 10 million people and creating 2,000 jobs. Altech Group's customers typically want larger solar systems with more lights, TVs, and other appliances, although most cannot yet actually afford such systems. In response, Altech Group shifted from d.light to Omnivoltaic systems in mid-2017, as they have larger, lower cost systems. To better understand customer needs, Altech Group has been collecting customer service feedback through a mobile app. Altech Group is now bringing in larger 75 W Omnivoltaic SHSs with TVs as well as home lighting and flashlights, which have a two-year warranty.

Altech Group understands that not many of its customers can pay up front and that their manual PAYGO, where they physically collect the regular repayments, is not very cost effective, and believe that mobile money is very important for the future. Altech Group recently shifted its mobile payment system from Angaza to Catalyst so they can integrate with Vodacom M-Pesa together with Omnivoltaic systems. Altech Group has just started a new partnership with Vodacom that may include marketing, distribution, and mobile payment support, although this is still in development. They hope this partnership will help them further scale. For SHSs, Altech Group plans to allow their customers to pay as follows:

- L190/L100 solar kits: customers pay $3 up front and $0.60 per day over 3 months ($57 in total).
- M600 entry level SHS: customers pay $10 up front and $10 per month over 30 months ($310 in total).
- Larger SHS: customers pay $300 up-front and $100 per month over 6 months ($900 in total).
- Larger SHS and Jikokoa Xtra: customers pay $330 up front and $105 per month over 6 months ($960 in total).

Currently all their systems come from China through Dar-es-Salaam in Tanzania to Bukavu, although they are planning to ship products through Dar-es-Salaam to Goma and Kasumbalesa and directly to Matadi port to Kinshasa and other market outlets in the western zone. Logistics is a big challenge for Altech Group; moving systems throughout the whole country is difficult, as sometimes they have to transport them on ferries and even airfreight, which is very expensive. As Altech Group is able to sell products very quickly, they need new financing all the time, which is their biggest challenge. Altech Group has mostly been using its own savings so far, although it has received $30,000 from EPD, a UK investor located in Bukavu; a grant of $25,000 from the United States African Development Foundation (USADF); an ELAN grant of $170,000; and $400,000 from a Swiss agency. In addition, Persistent Energy Capital (PEC) has provided them with a $25,000 loan, which Altech Group has repaid, and a new $200,000 loan, on which PEC have a 10 percent equity warranty on. If the loan goes well, PEC may become an equity investor.

[35] BBOXX.

Also, to improve the logistical operations and marketing of clean energy solutions, Altech Group plans to build 3 distribution centers in Kinshasa, Lubumbashi and Goma. Altech Group is looking for the funding of around $4 million for inventory to build its 3 distribution centers, recently applying for loans from both the World Bank and USAID. Altech Group had been paying customs and import duties which total around 32 percent including VAT, which is very high and contributes to increasing customers' retail prices. However, Altech Group has been granted import duty and tax exemptions by the DRC government in July 2019; a 3-year waiver in Kinshasa and 5-year in Haut-Katanga. In addition, the cost of mobile data is high and the service in DRC is often unstable, which makes it difficult for their operators to collect customer payments. Altech is also looking at productive use systems and has been contacted by poultry sector companies who wish to light and heat their poultry houses as many of the owners are also farmers. They have also started selling systems in refugee camps.

d.light: d.light started operating in 2016, although they only started selling products in 2017. d.light has sold a total of around 87,431 systems, although these are almost all solar lanterns. Some systems are brought in through Goma and Burundi, but it is generally very expensive to import and distribute the systems. They currently have three warehouses in three regions of DRC, each with a regional manager. d.light is focusing on providing support to their distributors to create points of sale. They also need a larger marketing budget, which is very important in DRC, as awareness of SHSs is still so low. Furthermore, they need additional warehouses in other regions. d.light has identified three additional distributors and plans to offer them lines of credit but is also looking for additional distributors. Total is one of their distributors, but they do not have a lot of stock and do not actively market their products. Marketing is d.light's biggest barrier.

GoDRC currently does very little to support the off-grid solar sector or to reduce the import of poor-quality products, which is damaging the market. d.light and their distributors need support to increase knowledge about solar products, improve logistics, find suitable partners, and provide lines of credit for their distributors. d.light has not yet started PAYGO in DRC, but their SHS is PAYGO-enabled. Finca DRC has launched a PAYGO pilot with d.light systems, through Finca Express. Equity Bank is also interested but has not yet begun a pilot. d.light's distributors have been developing their business documents although they still need additional support on this. One innovative model could be through IFOD (Institution Financière pour les Oeuvres de Développement [Financial Institution for Development]), the micro-finance organization of the Catholic Church in DRC, which is currently paying teachers throughout DRC, they could start offering solar systems to them by taking deductions from their salaries.

Fense le Propre (FLP): FLP was formed in 2013 through a partnership with another local company to construct power plants. Since then they have slowly started to sell SHSs and to install larger household solar systems, providing complete systems that include panels, inverters, batteries, and other components for larger systems. Their systems come from China with a delivery time of around three months, and are designed according to orders received, so they generally have limited stock. FLP installs its systems and provides maintenance through a 12-month warranty, disposing of all batteries and waste materials at the city council waste disposal. They target low-income households, as well as telecommunications companies (telcos), and deploy in Kinshasa to offset the relatively low purchasing power in rural areas. Since 2013 they have installed 412 systems in Kinshasa (including Gombe, Bandalungwa, and Limete), ranging from $800 to $1,500. Table 18 summarizes FLP installed solar systems up to mid-2019.

TABLE 18. SUMMARY OF FLP-INSTALLED SOLAR SYSTEMS			
CAPACITY (KW)	COST/KW ($)	NUMBER OF UNITS	SELLING PRICE ($)
1	$700	162	$700
3	$700	142	$2,100
5	$700	63	$3,500
10	$700	45	$7,000

FLP's geographical focus is Kongo Central and Mayi Ndobe in addition to Kinshasa but they are planning to cover villages in all 26 provinces under their long-term plan. They are registered in Kinshasa, as part of the GNN group, and have 10 employees, including 8 technical staff and 2 administrative staff. Currently FLP only sells cash systems but are planning on integrating PAYGO as part of their expansion plan. FLP has recently started working with telcos to power their mobile masts in rural areas to allow them to operate 24 hours a day. However, this will only be profitable if local populations start to make use of mobile systems and start generating other economic activities, thus increasing their purchasing power and creating an energy ecosystem. FLP installs solar systems ranging from 80 W to 5 kW, focusing on providing affordable off-grid systems to poor households. In the future it aims to target rural, peri-urban areas, where the prime needs are lighting and the telephone. FLP also would like to revise downwards by selling 50 W to 100 W systems.

Regarding tax issues, FLP has had ongoing discussions with ANAPI. It requires support in preparing a bankable project, both to access capital and to craft a financial strategy, along with technical commercial support and guidance for financial planning. It has a draft business plan but needs additional help to complete it. FLP does not yet sell any productive-use technologies, but this may also be part of its expansion plans as well if they can find suitable technologies and their customers want them. FLP also does not have any partnerships with MFIs or other consumer finance partners, but this might also be part of their expansion. In 2018 FLP started looking at mini-grids, but during a visit to MERH they realized that obtaining the necessary licenses would be complicated, so they decided to continue with stand-alone solar.

Sodefor: Sodefor is a timber company that has been working in rural areas of DRC with a range of local partners for more than 30 years. Its business is in Kisangani, Bandundu, and Tshikapa, and its main office is in Kinshasa. Sodefor has a number of social projects, including rural health and education initiatives. It has been working on solar for about four years, and has been selling solar systems since February 2018, mostly through their 3,000 employees. It sells the systems to their employees at cost, and their employees then sell them on adding their own margins. Sodefor provides their employees with credit for the systems but then take the payment from their salaries. So far, they have been selling about 500 solar systems per year.

Sodefor plans to open its first shop in Kinshasa soon, selling mostly SHSs, including a 100 W panel, solar refrigerators, fans, DC TVs, and lights. The systems it sells are local Chinese brands that are not quality certified. Following introductions from the Power Africa Transactions and Reforms Program, Sodefor has been talking to Mobisol, d.light, and Greenlight Planet, and may talk to BBOXX soon as well. It has also been discussing new partnerships with Lorentz and Trojan Batteries. So far, Sodefor has found selling on credit to be very difficult owing to trust issues, as Sodefor's perception is that people will not repay loans. There are some MFIs operating in DRC that provide credit, which Sodefor has not yet explored but may do so in the future. For instance, Orange, which recently launched in DRC, is starting to offer mobile money, which is growing in popularity. The main barriers Sodefor faces are consumer finance for its customers and obtaining quality products at reasonable prices, as there are many poor-quality products in DRC.

AEG International: AEG International is a North Carolina, USA, limited-liability company. AEG engineers, designs, and builds high-quality energy solutions that are used in some of the most remote areas of the world and need to perform to a high standard. AEG Congo is an authorized distributor of AEG International and manages sales, solar installations, and services in DRC. AEG Congo has sold and installed 900 solar systems in the country to date. Firefly PAYGO is an SHS developed and designed in AEG's Genesis lab in Charlotte, North Carolina. It includes a 20 W solar panel, lithium-ion battery, keypad, and LCD screen; two USB ports for mobile charging; five 1.2 W, 120-lumen LED lights; and TV, radio, and fan as optional extras. The Firefly Kit with a 19" TV requires customers to pay a $30 down payment, followed by $20 monthly payments for four years. The Firefly Kit without a TV requires customers to pay a $30 USD down payment followed by $15 monthly for four years. Assembly of Firefly kits in DRC has created 60 new jobs to date, with 15 staff members required to produce around 500 kits per week. AEG Congo plans to sell its systems throughout DRC in nine zones, deploying the 11,600 kits that have been ordered to date, including 2,000 systems from each of their partners, Latenba and Fondation Horus. Systems will be distributed as follows: Kasai Central, 2,000; Ituri, 1,500; Sankuru, 1,000; Bacongo, 600; Kongo Central, 600; Bandundu, 600; North Kivu, 500; South Kivu, 500; and Kisangani, 300.

Kit4Africa: Kit4Africa also has been working in DRC for over 3 years and has recently received funding from ECODIT to a pilot a PAYGO program for a number of their SHS and productive-use solar systems in a refugee camp in the eastern DRC.

3.1.1 POTENTIAL NEW MARKET ENTRANTS

Greenlight Planet has wanted to enter the DRC market for a few years, searching for potential distribution partners, but its commitment seems to have been undermined by their perception of the relatively high risk in the country. M-Kopa Solar of Kenya had also been assessing entry, but it stopped this a while ago, and it is not known if it will reconsider. BURN is one of the leading Improved Cookstove (ICS) companies in Africa, who is now interested in starting to sell its stoves and may branch out into solar systems too.

3.1.2 MAIN MARKET BARRIERS

The main barriers for pico-solar companies to the DRC market, and possible solutions, are detailed in Table 19.

TABLE 19. MAIN DRC MARKET BARRIERS AND POTENTIAL SOLUTIONS

BARRIER	DETAILS	POTENTIAL SOLUTION
Importation process	The importation process takes too long—at least three months—which can cause stock shortages.	Companies need to have sufficient cash or credit to order sufficient stock well in advance to be able to sell to their customers when they need to.
Duties and taxes	These are very high, representing approximately 35% of the final price, making the products expensive, and therefore inaccessible for poorer households.	Companies to work with ACERD to advocate with the government to reduce or waive duties and taxes.
Distribution challenges	Many potential off-grid customers live in very remote and difficult to reach areas of the country making it very difficult for companies to cheaply reach them in a timely manner.	Companies need to strengthen their distribution strategies including working with partners who already have established distribution networks, such as telcos and local banks. Other partners include the Catholic church which has the best rural network in DRC.

TABLE 19. MAIN DRC MARKET BARRIERS AND POTENTIAL SOLUTIONS (CONTINUED)

BARRIER	DETAILS	POTENTIAL SOLUTION
Local staffing issues	DRC's underdeveloped education system does not generate a lot of well-trained, qualified, competent workers to fill positions within off-grid energy companies.	Training of potential local staff needs to be provided through dedicated RE training programs, including women in all relevant positions.
Mobile signal access	PAYGO appliances typically need access to a mobile signal for data transfer, particularly for remotely topping up payments of solar systems, which is often challenging in remote rural areas.	Partnerships need to be established between telcos and solar companies to develop joint solutions to increase mobile signal access or alternative solutions such as using Bluetooth.
Lack of skilled labor	Local companies face issues of recruiting skilled personnel for their positions because of the generally poor educational system in the country, particularly in rural areas.	Training programs for solar technicians and sales agents need to be established, including women in all relevant positions.
Low customer purchasing power	Purchasing power of many off-grid Congolese households is very low, especially in rural areas and for households with limited savings.	Access to affordable consumer finance needs to be increased in addition to potential methods of reducing the sale price of solar systems targeted at low-income households.
Access to finance	To ensure a constant flow of high-quality solar systems, companies need access to appropriate and affordable financing.	Access to finance across the entire sector's value chain needs to be increased, including companies' working capital.
Awareness of solar systems	DRC's dispersed and poorly educated population has a limited awareness of high-quality solar systems.	Increase awareness of the solar market in order to communicate the benefits of high-quality solar systems.
Low product quality	There are no mechanisms to control the entry of poor-quality products into DRC, so the market is being flooded with inferior equipment.	Develop and implement an appropriate regulatory framework including adherence that only admits high-quality, certified products to the DRC market.

3.2 MAPPING OF PROMISING LOCATIONS FOR PICO-SOLAR COMPANIES

Urban areas, in particular big cities like Kinshasa, Mbuji-Mayi, or Kikwit, offer particularly large, dense markets for different types of solar energy systems. Depending on the proximity to the HV network and the concentration of different consumption levels, Power Africa recommends various approaches to marketing solar energy products in particular cities.

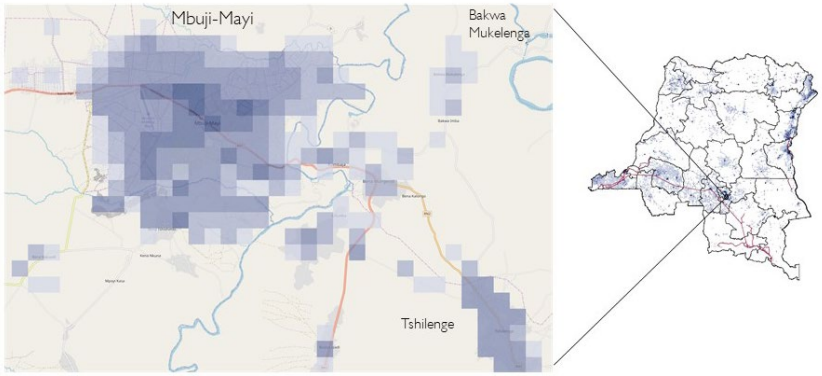
- In Kinshasa City, 17 percent of households (about 281,000 families) do not have access to electricity. With a wealthier population of households lacking access to electricity, but that are close to the HV network, smaller solar energy devices, such as lanterns and small SHSs, may be the best products for these households.
- In Mbuji-Mayi, a city beyond 10 km from the HV network, about 87 percent of households (174,000 families) lack access to electricity. With a high concentration of households in each consumption group, Mbuji-Mayi is an attractive market for all types of solar energy systems, from small lanterns to mini-grids.
- Kikwit City is beyond 10 km from the HV network, with a large proportion of high-consumption households, making it another attractive site for mini-grid development.

For a breakdown of households without access to electricity by consumption power per major city, see Table A2-8 in Annex A. Figure 11 shows the density of households in Kasai Oriental and Mbuji-Mayi City lacking electricity access. Figures 12 through 15 depict the density of households with varying consumption capabilities in given cities and regions.

FIGURE 12. NUMBER OF HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY PER KM² IN KASAI ORIENTAL PROVINCE AND MBUJI-MAYI CITY

Number of households without access to electricity

- Fewer than 250
- 250 - 500
- 501 - 1000
- 1001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000



Source: Power Africa Geospatial Analysis 2019

Mbuji-Mayi City Characteristics

Total Households	200,000
Households without access to electricity	174,000
Modest-consumption-power households	10,000
Medium-consumption-power households	97,000
High-consumption-power households	38,000

Areas with high-consumption power households are scattered across DRC. These households would make attractive mini-grid and solar home system customers; communities containing these households that are far from the high- voltage network are ideal. Cities such as Gemena, Kisangani, Butembo, and Mbandaka have high concentrations of such households

Note: Areas with fewer than 250 households per km² are not included in the map.

FIGURE 13. NUMBER OF MODEST-CONSUMPTION HOUSEHOLDS PER KM² IN KINSHASA CITY

Modest-consumption-power households

- Fewer than 10
- 10 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 1,500
- More than 1500
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019

Kinshasa City Characteristics

Total Households	1.67 million
Households without access to electricity	281,00
Modest-consumption-power households	21,00
Medium-consumption-power households	106,000
High-consumption-power households	81,000

Although only 17% of households in Kinshasa do not have access to electricity, this group is still a sizeable market for solar energy services. Of those without electricity, about 21,000 households in Kinshasa are modest-consumption-power households

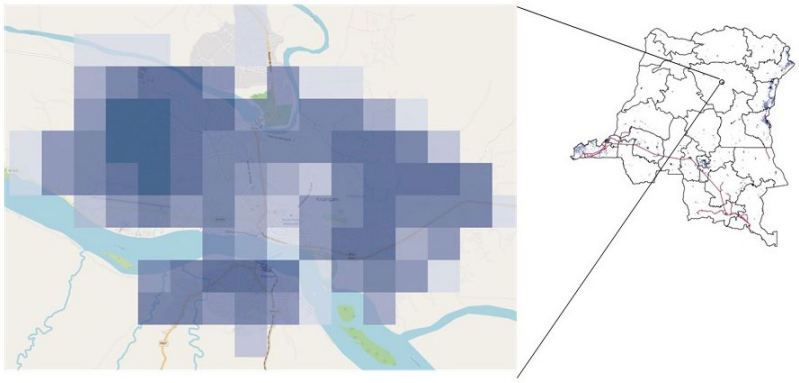
Note: Modest-consumption households only include households without access to electricity. Areas with fewer than 10 households per km² are not included in the map.

FIGURE 14. NUMBER OF MEDIUM-CONSUMPTION HOUSEHOLDS PER KM² IN KISANGANI CITY

Medium-consumption-power households

- Fewer than 10
- 10 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 1,500
- More than 1,500
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019



Kinsangani City Characteristics

Total Households	134,000
Households without access to electricity	78,000
Modest-consumption-power households	19,000
Medium-consumption-power households	28,000
High-consumption-power households	17,000

Located over 300 kilometers from the nearest high-voltage network, and with a large concentration of medium-and high-consumption-power households, Kisangani City offers a large market for solar home systems, and is an attractive potential site for mini-grid development

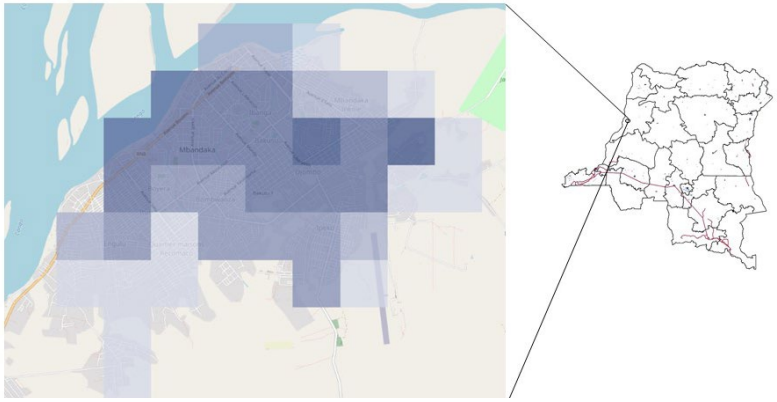
Note: Areas with fewer than 250 households per km² are not included in the map.

FIGURE 15. NUMBER OF HIGH-CONSUMPTION HOUSEHOLDS PER KM² IN MBANDAKA

HIgh-consumption-power households

- Fewer than 10
- 10 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 1,500
- More than 1,500
- Province Boundaries
- High-voltage network

Source: Power Africa Geospatial Analysis 2019



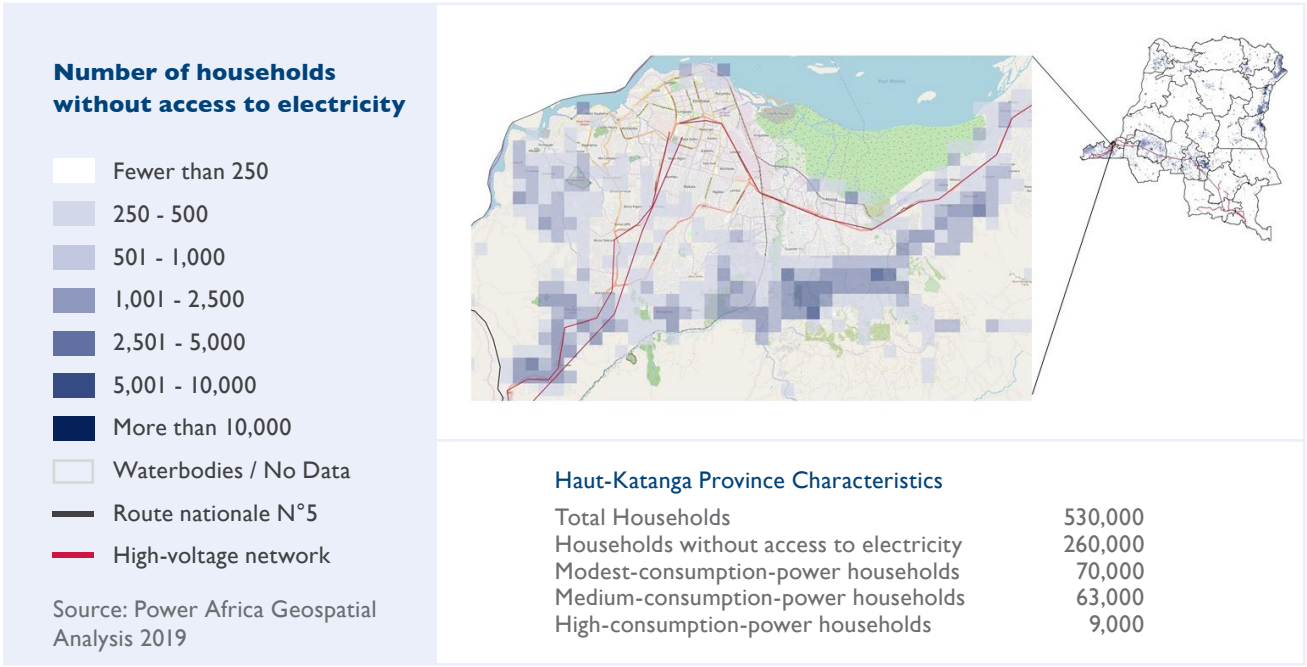
Mbandaka Characteristics

Total Households	61,000
Households without access to electricity	56,000
Modest-consumption-power households	15,000
Medium-consumption-power households	12,000
High-consumption-power households	15,000

Located over 300 kilometers from the nearest high-voltage network, and with a large concentration of medium-and high-consumption-power households, Mbandaka City offers a large market for solar home systems, and is an attractive potential site for mini-grid development

Note: High-consumption households only include households without access to electricity. Areas with fewer than 10 households per km² are not included in the main map.

FIGURE 16. NUMBER OF HIGH-CONSUMPTION HOUSEHOLDS PER 10-KM^2 GRIDS IN HAUT-KATANGA PROVINCE



Nearly 50% of households in Haut-Katanga Province do not have access to electricity. With major urban markets like Lubumbashi, and major roads running through the province, Haut-Katanga makes a large and accessible market of households in need of energy services.

Note: Areas with fewer than 250 households without access to electricity per 10 km^2 are not displayed as grids.

3.3 IDENTIFYING COMMUNITIES WITHOUT ELECTRICITY ALONG MAJOR ROAD CORRIDORS

DRC comprises essentially four markets—the Kinshasa, Goma, and Lubumbashi metropolitan areas, and the interior, which has few methods of transport and limited access to HV lines—with few similarities across the four. Given DRC's size and its lack of transportation infrastructure, these markets are typically served from different entry points, with supply chains into the interior being very difficult. Goods enter Kinshasa from the port nearby in the West, Goma from Uganda and Rwanda, and Lubumbashi from Zambia.

Power Africa identified four major roads that link these three major urban markets, as well as the city of Kisangani. Applying a 5-km buffer from these major roads, Power Africa analyzed the communities that live within these road corridors. About 4.8 million households live within 5 km of these major roads. About 2.8 million of these do not have access to electricity. These major roads are as follows:

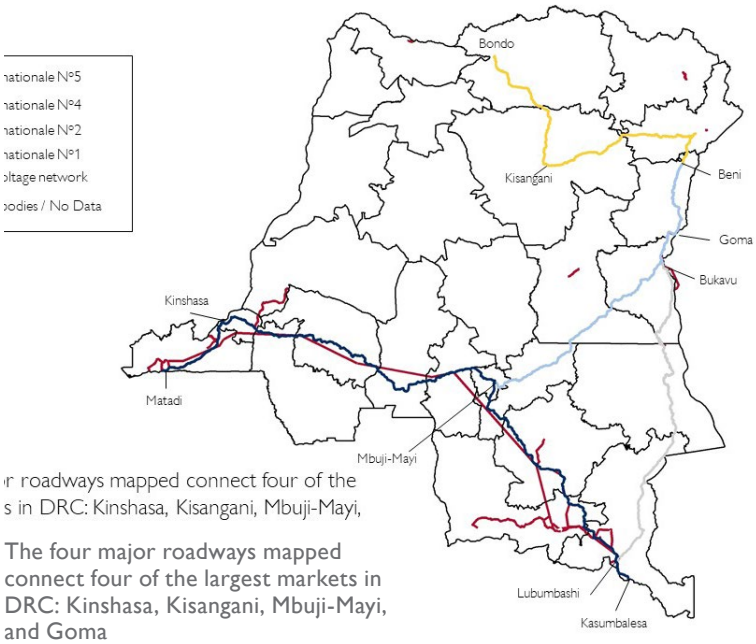
- Route nationale N°1 stretches from Matadi in the east, passing through major cities like Kinshasa, Mbuji-Mayi, and Lubumbashi, and ends in Kasumbalesa. Over 3 million households live within 5 km of this road; 1.4 million of these do not have access to electricity.
- Route nationale N°2 connects Mbuji-Mayi and Goma. About 1.18 million households live within 5 km of this road; 1.02 million of these do not have access to electricity.
- Route nationale N°4 connects Beni and Bondo, passing through Kisangani. About 406,000 households live within 5 km of this road. About 338,000 of these do not have access to electricity.
- Route nationale N°5 connects Lubumbashi and Bukavu. About 617,000 households live within 5 km of this road. About 358,000 of these do not have access to electricity.

› Figure 16 depicts these roads with the DRC HV network. Figures 17 through 20 depict households lacking electricity access within a 5-km corridor around these roads.

FIGURE 17. MAJOR DRC MARKETS AND ROADS, OVERLAID WITH THE HIGH-VOLTAGE NETWORK

- Route national N°5
- Route national N°4
- Route national N°2
- Route national N°1
- High-voltage network
- Waterbodies / No Data

Source: Power Africa Geospatial Analysis 2019



ır roadways mapped connect four of the s in DRC: Kinshasa, Kisangani, Mbuji-Mayi,

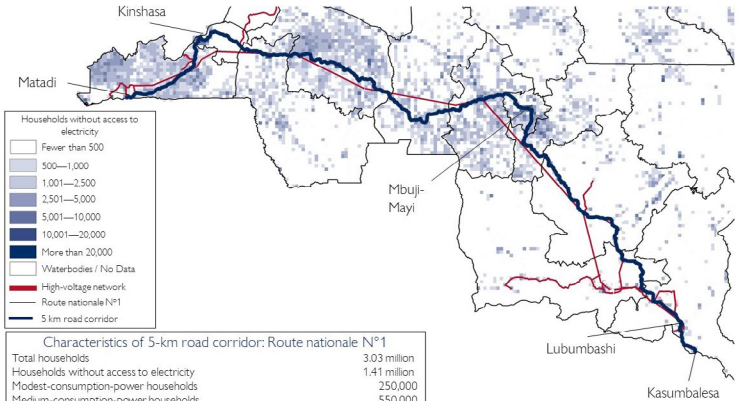
The four major roadways mapped connect four of the largest markets in DRC: Kinshasa, Kisangani, Mbuji-Mayi, and Goma

FIGURE 18. HOUSEHOLDS LACKING ELECTRICITY ACCESS WITHIN 5 KM OF ROUTE NATIONALE N°1, PER 10-KM^2 GRIDS

Number of households without access to electricity

- Fewer than 500
- 500 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- More than 20,000
- Waterbodies / No Data
- Route nationale N°1
- High-voltage network
- 5km road corridor

Source: Power Africa Geospatial Analysis 2019



Characteristics of 5-km road corridor: Route nationale N°1

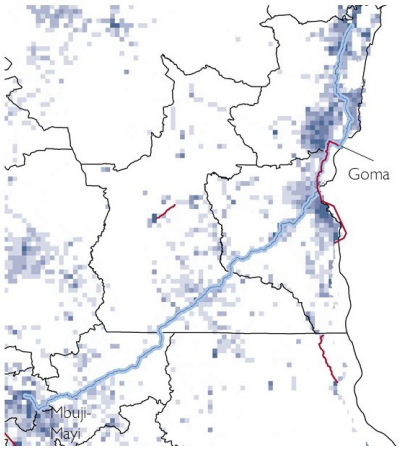
Total Households	3.03 million
Households without access to electricity	1.41 million
Modest-consumption-power households	250,000
Medium-consumption-power households	550,000
High-consumption-power households	240,000

FIGURE 19. HOUSEHOLDS LACKING ELECTRICITY ACCESS WITHIN 5 KM OF ROUTE NATIONALE N°2, PER 10-KM^2 GRIDS

Number of households without access to electricity

- Fewer than 500
- 500 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- More than 20,000
- Waterbodies / No Data
- Route nationale N°2
- High-voltage network
- 5km road corridor

Source: Power Africa Geospatial Analysis 2019



Characteristics of 5-km road corridor: Route nationale N°2

Total Households	1.18 million
Households without access to electricity	1.02 million
Modest-consumption-power households	225,000
Medium-consumption-power households	397,000
High-consumption-power households	82,000

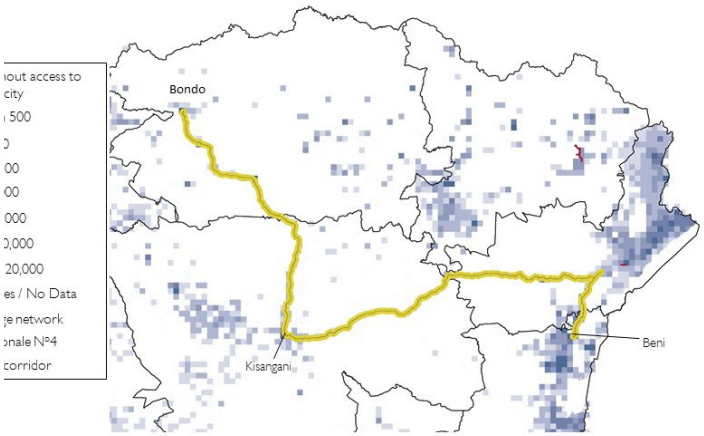
Note: Areas with fewer than 500 households without access to electricity per 10 km^2 are shown in grey.

FIGURE 20. HOUSEHOLDS LACKING ELECTRICITY ACCESS WITHIN 5 KM OF ROUTE NATIONALE N°4, PER 10-KM^2 GRIDS

Number of households without access to electricity

- Fewer than 500
- 500 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- More than 20,000
- Waterbodies / No Data
- Route nationale N°4
- High-voltage network
- 5km road corridor

Source: Power Africa Geospatial Analysis 2019



Characteristics of 5-km road corridor: Route nationale N°4

Total Households	406,000
Households without access to electricity	338,000
Modest-consumption-power households	107,000
Medium-consumption-power households	81,000
High-consumption-power households	33,000

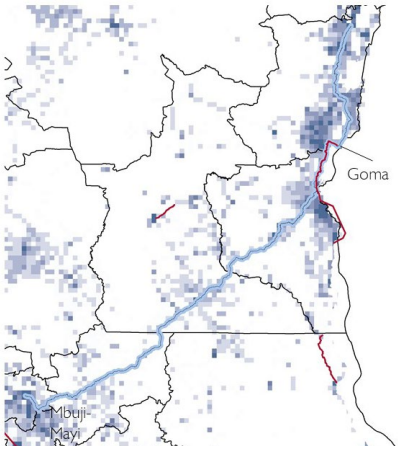
Note: Areas with fewer than 500 households without access to electricity per 10 km^2 are shown in grey.

FIGURE 21. HOUSEHOLDS LACKING ELECTRICITY ACCESS WITHIN 5 KM OF ROUTE NATIONALE N°2, PER 10-KM² GRIDS

Number of households without access to electricity

- Fewer than 500
- 500 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- 10,001 - 20,000
- More than 20,000
- Waterbodies / No Data
- Route nationale N°2
- High-voltage network
- 5km road corridor

Source: Power Africa Geospatial Analysis 2019



Characteristics of 5-km road corridor: Route nationale N°5

Total Households	617,000
Households without access to electricity	358,000
Modest-consumption-power households	80,000
Medium-consumption-power households	130,000
High-consumption-power households	30,000

Note: Areas with fewer than 500 households without access to electricity per 10 km² are shown in grey.

3.4 RELEVANT PICO-SOLAR REGULATIONS

Based on an interview with the head of the Renewable Energy Department at MEHR, Alfred Liboko ben Gele, his department is working on a decree to support the 2014 Electricity Law that will bring more clarity to the RE sector, as currently the Law does not fully cover this sector. Among the ambiguities, the Law currently only targets electricity generated from hydro systems, as this was the main source when the law was written but does not mention solar. It also leaves too much ambiguity, such as whether small-lighting systems with integrated solar photovoltaic panels are considered as electricity generators, whether a consumer who buys a solar lamp produces energy, and what kind of customs regime these different systems fall under. However, this decree is still in the pipeline, with no indication on its exact details or when it is likely to be finalized.

3.4.1 SOLAR QUALITY STANDARDS

Solar quality standards are overseen in DRC by the Congolese Control Office (Office Congolais de Contrôle) with support from the Operating Corporation of the Single Window of Foreign Trade of the DRC (Société d'Exploitation du Guichet Unique du Commerce Extérieur de la République Démocratique du Congo [SEGUCE]). Currently no further details have been obtained with regard to quality standards for off-grid solar technologies.

3.4.2 IMPORTATION PROCESS, DUTIES AND TAXES

SEGUCE is the main operating company responsible for importation and exportation in DRC. It was created in 2014 by Decree No.14/020 as a PPP. SEGUCE is owned by the Congolese State and the Bureau Veritas Inspection, Valuation, Assessment, and Control (BIVAC). BIVAC is a world leader in conformity

assessment, certification, and laboratory testing services. Created in 1828, BIVAC operates in more than 139 countries worldwide. SOGET, created in 1983, helps streamline port operations by organizing intelligent, shared, and instantaneous management of logistics chain information for various public and private operators and may be able to support on the import duties and taxes for off-grid solar systems. In DRC, SOGET in collaboration with BUREAU VERITAS has set up the Single Window of Foreign Trade of the DRC.[35]

DRC is making efforts to improve both foreign trade and the ability to do business in the country through simplifying and harmonizing the import-export process. This includes developing an electronic service platform that allows each company to open an account and carry out its importation operations online while tracking them. Companies are required to submit all required contractual and regulatory information to the Single Window for Foreign Trade, which selects, screens, and filters information, then forwards it to the relevant public and private operators with specific orders and processing feedback. Relevant decisions are then relayed to the companies before a final decision is made to allow the goods to leave the logistics zone, either from a water port or airport, or across land borders. This process aims to improve the logistics process beforehand, reducing risks and importation processing times while lowering cost. The shared management process has allowed GoDRC to better support the sector. Import duties and VAT have been lifted for electricity generation equipment, including for RE. However, it is not clear if these waivers are being implemented and most off-grid solar companies are still paying all duties and taxes, which add around 35 percent to the cost of their systems.

3.4.3 COMPANY REGISTRATION

National Investment Promotion Agency (Guichet Unique de Creation d'Entreprise [GUCE]) was formed in 2009 by Decree No. 14/014 to improve the business climate in DRC. Its head office is in Kinshasa, but each city has a representative. It aims to increase transparency, simplify procedures, build flexibility, and reduce the costs associated with business. One of its biggest successes is that it is now possible to create a new company in just three days, as it provides a one-stop-shop for new businesses. GUCE also provides all relevant information on what is needed to create any type of new company, including a practical guide for starting a business that can be found on their website.

3.4.4 E-WASTE REGULATIONS

DRC has very limited recycling of any sort, with the city of Kinshasa alone producing more than 7,000 tons of waste of all categories from households, businesses, and so forth, and with no suitable garbage collection system in place. The management of all types of rubbish remains problematic in DRC, and there has been no discussion on recycling of solar e-waste; the country lacks regulations regarding its management and disposal and has none in development.

3.5 RELEVANT PICO-SOLAR DONOR PROGRAMS

DFID's ELAN program has been supporting the pico-solar sector for the last four years. They have aided BBOXX in establishing its payment platform, so customers can pay through any mobile system they want, although this is still in development (ELAN is also working with local banks to allow customers to withdraw money from any bank). BBOXX's main issue is the affordability of solar systems, and they are investigating tax/duty exemptions, system subsidies, economies of scale, and local finance. BBOXX has found that if they decrease the down payment for their systems, they get more customers, but these customers often repay

[35] SOGET, "SOGET - About Us."

less often and take longer to do so, so BBOXX typically requires a $50 down payment (around 10 percent), which they do not want to reduce. Customers in DRC have a strong ownership mentality, but BBOXX still needs to do a lot of market education so people do not buy cheap, poor-quality systems. ELAN has been supporting pico-solar companies with a six-month marketing campaign, including roadshows and ads on TV, billboards, and radio. The aim is for ANSER to continue to do more marketing, but they do not have the budget for this, so it is hoped that other organizations such as GOGLA may be able to assist.

3.6 PICO-SOLAR FINANCING OVERVIEW

3.6.1 COMPANY FINANCE AND CONSUMER LENDING

The rate of banking in DRC remains very low at about six percent. GoDRC is making efforts to improve this rate for better financial inclusion of the population. Reasons for the low rate of banking are as follows:

- Households' lack of confidence in the banking system
- The large size the country
- Low rates of education
- Unwillingness of GoDRC to promote financial inclusion, and lack of banks' presence in rural areas
- Lack of access to energy

The DRC Central Bank has established incentives for commercial banks and MFIs. For example, in 2014, GoDRC, in collaboration with the United Nations Capital Development Fund (UNCDF), launched the MAP Initiative (Making Access Possible), aimed at informing the government on financial inclusion. The study included a detailed analysis of the national context of supply, demand, and regulation of financial services.

Attempts have been made at collaboration between banks and pico-solar companies. On the consumer side, there has been a lot of resistance, as lending remains too expensive; on the banks' side, they have little motivation to develop a product for small SHSs, given the perceived repayment risk. Banks have no interest in extending less than $300 in credit because of loan-processing costs. The only banked customers are often government or formally employed company workers, and they often have a high level of debt that likely would disqualify them on a solar-loan eligibility check.

Donor programs, notably the World Bank, aim to stimulate local bank financing to off-grid companies through soft loans (as a credit line), guarantees, and technical assistance. In the case of soft loans, such a credit line is likely to benefit bankable groups entering the off-grid sector as well as international companies, and, eventually, smaller startups as they build their track record.

Data on investment in Central Africa only became available from 2016. They show that 2017 saw the greatest investment so far, dominated by grants from a donor program. Investment during 2018 dropped back to 2016 levels, although the number of financial transactions has steadily increased year to year. Investments in 2017 and 2018 mainly focused on regional expansion and scaling up of existing business models, with a significant 2018 increase in crowdfunding, which indicates a very positive trend for future investments in the region. Table 20 provides GOGLA data on Central African investment.

TABLE 20. BREAKDOWN OF CENTRAL AFRICA REGION FUNDING TYPES, TRANSACTIONS, BUSINESS MODEL, USE OF FUNDING, AND FUNDING FLOW BY INVESTOR TYPE

CENTRAL AFRICA		2012	2013	2014	2015	2016	2017	2018
Type of investment	Grant	$0	$0	$0	$0	$1,518,745	$3,750,000	$0
	Equity—Common shares	$0	$0	$0	$0	$0	$250,000	$0
	Equity—Preferred shares	$0	$0	$0	$0	$0	$0	$0
	Debt—Note or bond	$0	$0	$0	$0	$0	$50,000	$275,568
	Debt—Bank or Financial Institution (FI) loan	$0	$0	$0	$0	$0	$0	$0
	Debt—Crowdfunding	$0	$0	$0	$0	$0	$0	$1,102,270
	Debt—Securitization and/or factoring	$0	$0	$0	$0	$0	$0	$0
	Other	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$1,518,745	$4,050,000	$1,377,838
Transactions	Average transaction size	—	—	—	—	506,248	1,012,500	275,568
	Median transaction size	—	—	—	—	300,000	500,000	275,568
	Number of transactions	0	0	0	0	3	4	5
Business Model	PAYGO	$0	$0	$0	$0	$1,518,745	$4,050,000	$1,377,838
	Non-PAYGO	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$1,518,745	$4,050,000	$1,377,838
Use of Funding	Uncertain	$0	$0	$0	$0	$0	$0	$0
	Business plan development, corporate setup, and proof of concept	$0	$0	$0	$0	$0	$0	$0
	Introduction of the product to the market and/or product refinement	$0	$0	$0	$0	$0	$50,000	$0
	Scale up business and reach critical mass of customers	$0	$0	$0	$0	$518,745	$0	$1,377,838
	Geographic expansion, as well as adding new products and/or making acquisitions	$0	$0	$0	$0	$1,000,000	$4,000,000	$0
	Bridge working capital needs, including financing of consumer loans extended	$0	$0	$0	$0	$0	$0	$0
	Refinancing existing liabilities	$0	$0	$0	$0	$0	$0	$0
	Other	$0	$0	$0	$0	$0	$0	$0
	Total	$0	$0	$0	$0	$1,518,745	$4,050,000	$1,377,838
Funding Flow by Investor Type	Crowdfunding	$0	$0	$0	$0	$0	$50,000	$1,377,838
	Government, including Development Finance Institute (DFI)	$0	$0	$0	$0	$1,518,745	$3,750,000	$0
	Strategic corporations	$0	$0	$0	$0	$0	$250,000	$0
	For-profit finance	$0	$0	$0	$0	$0	$0	$0
	Family office or foundation	$0	$0	$0	$0	$0	$0	$0
	Impact finance	$0	$0	$0	$0	$0	$0	$0
	Unknown	0	0	0	0	0	0	0
	Total	$0	$0	$0	$0	$1,518,745	$4,050,000	$1,377,838

Source:[36]

[36] GOGLA, "Global Off-Grid Solar Market Report: Semi-Annual Sales and Impact Data."

3.6.2 COMMERCIAL FINANCE IN DRC

The Congolese market is occupied by 13 banks of different sizes, across three main categories with different market shares:

- Local banks such as BCDC, Rawbank, Sofibanque, and Trust Merchant Bank (TMB) (27 percent)
- Pan-African banks such as Access Bank, Afriland First Bank, BGFIBank Group, BOA Congo, Ecobank, FBN Bank, UBA, and Equity Bank (formerly Procredit Bank) (53 percent)
- International Banks such as Advans Group, Citigroup, and Standard Bank (20 percent)

Note that local banks outperform the other two categories of banks considering their total balance sheets. Overall Rawbank has the most assets, with just over 2.183 billion Congolese francs (CDF); the smallest is UBA, with CDF94 billion ($1 = CDF1,650).

Rawbank: Rawbank was the first bank in the country created in 2002, and it belongs to the Rawji family, which has been established in DRC for more than 100 years. It was also the first bank in DRC to be rated by the international agency Moody's (B3). Rawbank highlights its support for the private sector, particularly to the Small and Medium Enterprises (SMEs), which it recognizes as a country's driving force for growth. Its credit portfolio is approximately $428 million disbursed in 2017. Rawbank represents 26 percent of the market share in terms of number of customers, and has a network of over 80 branches, and is working to strengthening its presence throughout the country. Rawbank recently launched a new product, Credit Energy, which provides loans specifically to purchase energy systems, but is limited to employees of certain companies.

TMB: TMB is the number one bank in DRC in terms of the geographical extent of its branches, as it offers a strong representation throughout the DRC. TMB has a large volume of deposits, with more than CDF851 billion collected in 2017, representing 12 percent of market share.

Equity Bank: Equity Bank has committed to supporting the energy sector and its customers, but they have not yet identified any suitable companies to finance. There are some energy suppliers in Kinshasa, but they are mostly traders selling solar, and their systems are more for households than for businesses. In the eastern DRC, Virunga is selling energy to businesses through micro-hydro systems. In Katanga region there is very little supply of off-grid energy systems but large demand. ELAN has helped Equity develop solar household solutions, although their financial product is not fully developed yet, and companies need to further develop their business plans. Equity Bank has an Environmental Unit, which measures environmental impact and green finance, but it needs reliable partners. They feel generally that things in DRC are gradually developing and a general economic boom is on the horizon.

Current investors in DRC: There is great potential in DRC for off-grid financial services, as energy is a big issue and demand is very high. However, only a few companies are active in DRC, and there are few sustainable, financially viable solutions.

The greatest challenge of local pico-solar companies is obtaining suitable funding, as the off-grid business is capital intensive. The number of investors willing to put their money into DRC today is small (especially for equity). Part of this is due to the real risk of doing business in DRC, and part is the perceived risk. The development sector can help investors make their first steps into this unknown land and unlock the market. Grant funding from Shell Foundation, USAID, DFID, and the USADF has played a role in facilitating market entry and catalyzing investors. For example, grants enabled BBOXX to persuade its board to take the risk of expanding into DRC and encouraged PEC to invest convertible debt in Altech. Meanwhile, ÉLAN RDC, funded by the DFID, offers a results-based financing scheme for each low-income household electrified in DRC. The PAYGO solar market in DRC is a huge opportunity, ready to take off, but it will still need some

help to get started. These schemes and others (matching equity matching grants, debt guarantees) can help investors consider putting their cash into a market that otherwise might have been far down their list, if on their list at all.

Considering present market conditions, most of the companies operating in RE consider financing by local banks to be unobtainable because of their stringent conditions. Often these companies will seek easier financing from specialized investors outside the country who understand the sector, rather than contracting with a local bank that faces challenges in assessing the transaction risk. This perceived barrier, and the RE sector's intense need for financing, explains the increasing role played by specialized investment funds such as Acumen, Sunref, and PEC. However, many companies still fall short of these specialized investors' standards. Crowdfunding offers another alternative, with platforms such as Trine and Kiva assessing deals in the country.

3.6.3 CONSUMER FINANCE

MFIs

DRC has about 20 MFIs; among the leading ones are Finca DRC, IFOD, Advans Bank, Vision Fund and Baobab+. The largest is Finca DRC, with around 1 million customers. Its credit portfolio is mainly oriented toward SMEs, with all sectors included. Attempts are made to link companies from different sectors with local banks. Energy financial products are also starting to emerge, often being offered to employees, as the existence of an employment contract is a form of guarantee that reduces the banks' perception of payment risk. Generally, payments for energy systems are made through a deduction from employees' monthly salaries at the source, which is an additional guarantee for the bank. Finca DRC is also working on a solar-specific financial product. IFOD, the Catholic Church's micro-finance business in DRC, is looking into providing micro-loans for solar systems, and working on the launch of a consumer-energy credit product. IFOD has approximately 103 community savings groups that are typically located close to populations they serve and have their trust. They do not receive a lot of government support, but lately private-sector financial institutions (e.g., local banks) have started to develop closer relationships with them. MFIs such as Finca DRC and Vision Fund are willing to integrate into communities and start structuring them into savings groups and providing them with loans. Usually, savings groups meet twice a month, share and agree on the savings rules, and are mutually supportive of each other, which is what they rely on with regards to collateral.

Mobile Money

As DRC has one of the lowest rates of banking in Africa, at around 6 percent, there is great opportunity for mobile money to grow rapidly. Operators now have a countrywide penetration rate of 41 percent. Banking rate figures of surrounding countries for 2014 indicate that the number of bank agencies per 100,000 inhabitants in Tanzania, Rwanda, Kenya, and Angola ranged from 2.3 to 12, compared to just 0.8 for DRC. This can be explained by the following reasons:

- Relatively high cost of banking transactions, which are very difficult for low-income households to afford, both in rural and urban areas.
- Low purchasing power of the population keeps banks from investing in expanding their networks, in particular to rural areas. Opening new physical branches generates costs that can only be recouped by a certain volume of banking activity.
- General instability in the country, which reduces the Congolese population's trust in banking institutions, in favor of saving cash in their houses.

In contrast, mobile money supports financial inclusion and has the potential to help reduce the poverty rate. Use of mobile money in DRC has been concentrated in big urban centers, in particular Kinshasa, Katanga, North and South Kivu, Kongo Central, and Kasai, and is used mainly to support extended family members, pay for schooling and health needs, and start commercial activities. The government has recently attempted to remedy this by setting regulations quite favorable to mobile money. UNCDF's MAP Initiative noted that greater flexibility on the part of the Central Bank is needed toward mobile money companies in DRC. Commercial banks are starting to make greater efforts to collaborate with telecommunications companies, but more work is needed. According to a Global System for Mobile Communications Association (GSMA) study, use of mobile money has increased household savings in DRC. Mobile telephone ownership is common in DRC, with 56 percent of the population owning at least one subscriber identification module (SIM) card, while only 6 percent of the population has an account at a financial institution. There are five mobile service providers in DRC: Airtel, Vodacom, Tigo, Orange, and Africell. Airtel Money, Vodacom M-Pesa, Tigo Cash, and Orange Money can be used to store money, transfer it to other people, and pay bills.

Overall the telco sector is growing in DRC. A study carried out in 2016 by Altai Consulting Office revealed that DRC had more than 43 million mobile customers, which represents almost 50 percent of its population.

Of these, 10.8 million subscribers were registered as mobile money customers, of whom 10 percent are considered to be active customers of mobile money. If the sector continues to grow as expected, more than 10 million additional Congolese will be able to access the banking system via their telephone in the next three years. In addition, there has been a rise in banks that offer mobile services of almost 30 percent over the last 4 years. There have been a number of positive interactions between solar companies and mobile telephone companies. Through M-Pesa, Vodacom is starting to work with several solar companies, and Orange Money has a mobile money partnership with BBOXX. Telcos in the DRC region are open to collaboration with the RE sector and starting to catch up to other local countries.

Vodacom: Vodacom has been offering M-Pesa mobile money in DRC for five years, and has been growing well, with 2.6 million active customers throughout the country. M-Pesa has 15,000 agents, 55 percent of them in rural areas. Vodacom sells through two types of shop: their own, with Vodacom staff and products, and partner shops that sell Vodacom products. Vodacom is currently not facing any regulatory issues in DRC regarding mobile money, either from financial or communications regulators. The Central Bank oversees M-Pesa and other mobile money operations. Vodacom uses both U.S. and DRC currency, but as they need customer IDs for accounts in U.S. dollars, they have had to go back and reregister some of their customers to clean up the database. Vodacom currently has 45 percent of the DRC customers and 49 percent of its mobile money accounts, with 84 percent coverage of DRC. Vodacom tried to work with M-Kopa about two years ago, but it did not work out; recently it has started working with Altech on a new partnership, still in development. There are many low-quality Chinese solar products in DRC, which are harming the market, yet customers are mostly unaware of this. Vodacom is able to help Altech raise customer awareness of this, including by sending reminder messages, and may be able to reward regularly paying customers with airtime. Vodacom may also be able to provide Altech credit scoring for potential customers to know which ones to target, depending on their mobile usage over time. They are aiming to start their pilot with Altech by April 2019, but this is not exclusive, so they can work with other companies.

3.7 PICO-SOLAR AND GENDER INCLUSION

Unique barriers exist for women entrepreneurs in DRC impeding their ability to start and scale businesses in the solar sector. A World Bank analysis of the status of women's entrepreneurship in DRC in 2016 found that gender inequality has serious economic consequences for women entrepreneurs. [37] Lower education rates compared to men, disproportionate family responsibilities, harmful stereotypes and gender norms, and limited access to finance create additional challenges for women to participate in an already challenging market.

However, DRC is now advocating gender equality, empowered by a 2016 amendment of the Family Code that allows women to work without a husband's authorization. The Family Code had prevented married women from signing contracts, registering companies, opening bank accounts, and obtaining loans without permission from their husband. Despite the removal of these restrictions, cultural norms—long supported by law and now entrenched—have not reformed accordingly. Thus, in practice, women still do not enjoy equal rights under the law in DRC. As the woman is typically at the heart of household management, decisions of energy expenditure are often hers, extending to collecting firewood in rural areas. This role could open new dialogue between the MERH and the Ministry of Gender, Children, and Family. However, no gender mainstreaming activities are currently being carried out by mini-grid companies in DRC, and there are no GoDRC or donor programs to support gender mainstreaming within the mini-grid sector.

[37] The World Bank, "What Does It Mean to Be a Woman Entrepreneur in the Democratic Republic of Congo?"

4 MINI-GRID SECTOR IN DRC

Based on present DRC grid coverage, analysis has estimated that 61 million people could be connected to mini-grids in the future, with annual market value of $921 million (assuming household spending comprises 60 percent of the total revenue of a mini-grid, along with revenue from businesses, public sector buildings, and industrial users). The 141 main population centers situated beyond the existing grid represent a theoretical mini-grid market of 10 million people, worth $153 million per year. This is an early estimate that assumes the entire population of these towns could be connected to mini-grids. [38]

Several factors make DRC a country with significant potential for GMG development: the country is large; electrification rates are still low; energy demand is higher than supply; and the hydroelectric, solar, and biomass energy potentials are significant.

Under the 2014 Electricity Law, the government has reformed the electricity sector by opening it to private operators and transferring regulatory powers to the provinces. Donors such as the World Bank, AfDB, DFID, and the EU are providing significant funding to develop the sector. Hydroelectric and solar-powered mini-grids have the greatest potential to accelerate electrification rates in DRC, with 51 of the 141 towns lacking electricity access (total population = 2.7 million) within 20 km of a potential hydroelectric site, according to DRC's Renewable Energy Atlas. Although some towns are already being served by diesel mini-grids, they could be primary targets for electrification through hydroelectric mini-grids. An additional five towns located within 15 km of the power grid are also within 20 km of potential hydroelectric sites.

Although some local and international companies are investing in mini-grid projects, multiple factors hinder further sector development and investment. These include a volatile political situation, with multiple regions facing security challenges; a non-enabling business environment (DRC is ranked 184th out of 190 economies in the World Bank Group's 2017 Doing Business Report, and 156th out of 176 on its anti-corruption indicator); and poor infrastructure that makes several regions of the country only accessible by air transport. Limited access to financing and high tax rates also deter development. In addition, the visa requirements are lengthy and burdensome, discouraging business travel.

To encourage new mini-grid developers to establish themselves in DRC they need support in identifying suitable project sites as well as carrying out pre-feasibility assessments. Small towns in DRC generally have very low purchasing power, so they likely need larger grants to make the projects bankable. Several mini-grids built so far in DRC have been heavily subsidized (around 70 percent by grants and 30 percent by debt). DRC does not yet have a database of all of its new mini-grid projects, but this would be very useful for developers. World Bank and AfDB are planning on bringing on a consultant to identify new mini-grid projects in DRC, and KfW is also potentially interested in supporting the mini-grid sector.

4.1 DRC MINI-GRID COMMERCIAL OVERVIEW AND APPLICABILITY TO THE COUNTRY

SNEL Mini-Grids: As outlined previously, a number of towns are being served by SNEL-managed diesel or hydroelectric mini-grids, including two hydro-powered grids in the cities of Kindu and Kisangani and nine diesel mini-grids in the cities of Gungu, Idiofa, Kenge, Malemba Nkulu, Ankoro, Baraka, Fizi, Bena Dibele, and Bikoro. These mini-grids face serious operational problems due to lack of maintenance and the high

[38] SEforALL Africa Hub and African Development Bank, "Mini Grid Market Opportunity Assessment: Democratic Republic of the Congo."

price of diesel. Existing SNEL mini-grids offer additional opportunities for privatization and rehabilitation. Towns like as Tshikapa are served by independent mini-grid companies such as EDC through a hydroelectric mini-grid. Many of these existing local grids are outdated and not operational. Taking into account the planned grid extension, the market size falls to $67 million per year across the 102 towns identified as outlined in the Renewable Energy Atlas.

SOKIMO: This government-owned mining company owns hydroelectric plants and injects excess electricity into local grids. SOKIMO has developed the 11 MW Budana hydroelectric plant through its subsidiary and distributes electricity to the city of Bunia and the town of Mongbwalu.

ENERKA: The Kasai Energy Corporation (Société d'Énergie du Kasaï [ENERKA]) operates MIBA's 18.48 MW Tshiala hydroelectric site, which comprises three hydroelectric plants, namely the 1.4 MW Tshiala 1, the 7 MW Lubilanji 1, and the 10.08 MW Lubilanji 2 plants. It also distributes electricity to 1,700 clients in the city of Mbuji-Mayi in Kasaï Oriental Province. This site was operated by Hydroforce up to 2012.

ENERKA also runs the Kananga solar-hybrid power plant, born from the merger of Megatron Federal DRC, Star Group, and the province of Kasaï Central. The plant was hybridized thanks to a PPP with a SNEL thermal power station, which includes three diesel generators of 750 kW each. It was inaugurated in July 2016, being the first public power plant in DRC and the most powerful, with an installed capacity of 1 MW. It works in combination with a 2.5 MW thermal power plant, and a loan of $3.2 million was obtained from FNB Bank on behalf of the province to finance the construction of the solar power station. However, the plant is not able to supply 1,875 MW as originally agreed with SNEL due to various inefficiencies, currently only generating 500 to 600 kW.

ENK: ENK plans to build and operate distribution grids in the cities of Beni and Butembo and a transport line between them to connect 20,000 to 40,000 new clients with electricity. These grids will be powered by the 23 MW Talihya and 2.3 MW Ivugha hydroelectric plants. Enerdeal and Congo Energy are planning a 1 MW solar mini-grid with 3 MWh of battery storage capacity in the city of Manono, in the old Katanga Province, to supply the local population and small and medium enterprises.

Enterprise Generale Malta Forrest (EGMF): EGMF has applied under the recent request for proposals, based in Kinshasa, to build a 60 kW micro-hydro project in Mbankana.[39]

SADER: African Society of Rural Development (Société Africaine de Developpement Rural) applied to carry out a rural electrification plan for Katanga Province. They also run another mini-grid in Tshikapa run by the same father–son team as ENK but with different investors.[40]

Groupe Shalom International: This company has applied to carry out a feasibility study for a 1 MW hydro in Maniema.

Virunga: Virunga has been operating mini-grids in the east of DRC, around the Virunga forest region.

Congolese Society for Water and Electricity Distribution (Société Congolaise de Distribution d'Eau et d'Électricité): This company has applied to extend its generation and distribution business in Goma, but support for this has not yet been provided.

Other initiatives include PSR's support to Twinstar Congo, Ltd., a Congolese solar company based in Kinshasa, which is aiming to develop a solar project to power 8,000 households and other facilities, although progress has been slow. Integrated Power Systems (IPS), a Kenyan mini-grid company, has also expressed an interest in developing projects in DRC, although they are still at a very early stage.

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[39] Groupe Forrest International, "Electricity."

[40] African Society of Rural Development Congo, "African Society of Rural Development."

4.2 RELEVANT GOVERNMENT AND DONOR MINI-GRID PROGRAMS

SNEL, the national utility, has a long track record of operational and financial underperformance, as well as generators that often run well below capacity due to lack of maintenance. The energy sector as a whole faces the additional problems of a weak and inoperative institutional framework, insufficient capacity, and a lack of data. In light of these gaps, policy makers and planners in DRC need to formally recognize and operationalize the importance of mini-grids to the future development of the energy sector. Critical support is needed to promote capacity expansion of potential local mini-grid developers and to work with financial institutions to reduce local investment risk. Financing mechanisms to reduce the cost of access to electricity for poor communities, such as incentives for decentralized technologies, are also needed.

The country lacks a nationwide electrification plan, but several electrification projects are being developed. The development of realistic national electrification and grid extension plans are hampered by the size of the country and its limited technical and financial capabilities. Current electrification plans are either related to big generation projects such as Inga 3 and Ruzizi 3 or aimed at developing local grids. For example, the World Bank-funded EASE program and the DFID-funded ESSOR program are both aimed at promoting the electrification of all provincial capitals and other major population centers through local hydroelectric and hybrid mini grids. DFID and World Bank are committing significant funding to further development of mini-grids over the next five years. DFID aims to support 33 solar mini-grids across the country through the ESSOR program, and the World Bank plans to develop mini-grids in all electrified provincial capitals and major population centers through EASE. Furthermore, the 2014 Renewable Energy Atlas is currently being updated by UNDP, although it's not known exactly when it will be released.

4.3 RELEVANT MINI-GRID REGULATIONS

The institutional setting relating to mini-grids in DRC is quite complex and involves multiple parties. As noted previously, the 2014 Electricity Law states that the electricity sector involves both central and provincial governments, with MERH being responsible for the sector's oversight, including overseeing SNEL. The law also mandates the creation of ARE and ANSER, and although neither are yet operational, it is expected they will play a significant role in the development of the mini-grid sector in DRC. ARE will have the responsibility of drafting specifications for such generation and distribution projects, and of reviewing and authorizing new electricity tariffs proposed by any new operator. ANSER will promote and finance rural and peri-urban electrification, including mini-grids. Concessions for new mini-grid projects will ultimately be granted by the provincial governments, unless they cover two or more provinces, in which case such concessions will be granted by the central government. Nevertheless, the central government agencies will always be involved in the design and implementation of the tendering process for new mini-grids. Other relevant agencies include CNE, which advises MERH, and ANAPI, which has a mandate to promote and facilitate investments in the country. The responsibilities of some public stakeholders overlap, as with SENEN and ANSER.

There is also a lack of administrative capacity and skilled labor capable of maintaining and operating mini-grids, and information is hard to find or inconsistent. DRC's Electricity Law mentions activities of production, transport, distribution, import, export, and commercialization of electricity produced by any operator. The Law does not distinguish between the sources of energy but legislates according to the production capacity, with two main capacity categories as follows:

Category 1: ≤ 50 kW: Any generation of electricity below 50 kW is considered not to require special authorization, as long as the developer ensures secure system installation that meets all relevant standards and makes use of skilled labor as required.

Category 2: > 50 kW: The law requires that generation of electricity greater than 50 kW must be authorized according to the quantity of electricity produced:

- If an operator produces 50 to 99 kW on private property, this is considered self-production, and they need a declaration.
- If an operator produces 100 kW to 999 kW on private property, they need an authorization for production from GoDRC.
- If an operator produces more than 1 MW on private property, they need a license.
- If an operator produces more than 50 kW on state-owned property or produces any electricity for transport and distribution, they need a concession. There are presently five concessions in the country mainly in the Katanga region.

The contact person for the project developer will vary depending on whether a declaration, authorization, license, or concession is needed; these will be found either in the local, provincial, or central government, as referred to in Decree 0.85 (signed December 2018).

Data: What limited data exist regarding DRC, the electricity sector, stakeholders, and relevant regulations are available online for potential project developers. This includes the Renewable Energy Atlas. It does not provide raw data, however, which limits its potential uses. The only relevant law or regulation on the electricity sector available online is the 2014 Electricity Law. The MERH and other public organizations may have important information but do not have a website, limiting their capacity to make it available to interested parties. The compilation and dissemination in GIS format of more detailed data on the power network, and basic data on population (e.g., population density, major population centers), would be extremely useful.

Licensing: The existing legal framework promotes private-sector involvement in large distribution networks but hampers the development of small-scale rural grids. The 2014 Electricity Law was drafted to promote private investment in generation and distribution across the country. It requires that power distributors of any scale operating for public benefit obtain a concession, lasting up to 30 years, through a tender process coordinated by ARE. Projects are required to present environmental and social impact assessment studies and management plans with their applications.

These requirements may be appropriate to regulate big utility-scale electrification projects, such as those promoted recently by EDC in Tshikapa but are not appropriate for promoting small-scale rural mini-grids. Given the contribution that small, modern mini-grid companies make in providing reliable and affordable energy services at the community and village levels, other countries require only an agreement between the promoters and the local communities.

In addition, despite sometimes stringent regulation, a significant informal electricity sector comprising a wide range of parties is providing services to population centers, often through informal networks that escape government oversight. In addition to the aforementioned private companies, mining companies involved in community outreach projects, as well as faith-based groups and NGOs, are connecting DRC citizens to grids. Even in a city like Gemena, with 300,000 inhabitants, most of the population with access to electricity obtains this through the informal sector, even if such services are of poor quality.

Tariffs: Mini-grid operators can propose tariffs that guarantee an appropriate return on investment. SNEL's tariff on the national grid averages only $0.07/kWh, but mini-grids are not bound by this low threshold. Developers can propose tariffs that reflect the cost structure incurred by the operator. Tariffs must be approved by the MERH and the Ministry of Economy after regulatory review. SNEL reportedly applies tariffs ranging from $0.32 to $0.40/kWh for electricity from their diesel mini-grids, and EDC applies

a tariff of $0.48/kWh at the Tshikapa mini-grid. Independent power producers such as Hydroforce and EnerKac in Kananga sell their electricity to the local grid for $0.31 and $0.39/kWh, respectively.

Grid Arrival: The 2014 law does not provide for the case where the main grid reaches any installed mini-grids. Concession contracts can have a duration of up to 30 years, which should provide some security to mini-grid operators against national utility encroachment. The size of the country, the main grid's constrained reach, and limited investments in transmission also reduce this possibility, but don't eliminate the issue.

Technical Issues: Mini-grid projects follow the general technical specifications for electricity projects. Such specifications must be included in documents for any tender, and any installation must respect the general technical norms and standards in the country. As with licensing, as noted earlier, the specifications are appropriate for utility-scale mini-grids but are too stringent for modern mini-grid companies targeting rural areas with their own ready-to-deploy infrastructure and limit their potential.

4.4 MINI-GRID FINANCING OVERVIEW

Subsidies and Incentives: With ARE and ANSER and the funding they will direct not yet established, support to existing mini-grid developers has mostly been provided by international donors and foundations. Two new programs funded by DFID (ESSOR) and World Bank (EASE) are expected to provide additional funding to mini-grid projects over the next five years, in addition to the $20 million AfDB recently provided to green mini-grids in DRC.[41]

The government has removed import duties and VAT on generation equipment (including for RE), tools, and spare parts destined exclusively for the production of electricity, but it is not clear if these waivers are actually being implemented in practice. Projects not benefiting from this incentive can still benefit from tax and duty exonerations under the general investment code through ANAPI. Created in 2002 by Law 004/2002, which contains the code of investments, ANAPI is a public establishment but with an autonomous management, with the mission of improving the business climate in DRC through administrative support and investor services. RE companies can receive a minimum investment from ANAPI of approximately $10,000 for both national and international companies in the following areas:

- Waiving company income tax and property tax (of interest to mini-grid companies)
- Exemption from entry fees for equipment and other equipment, excluding the 2 percent administrative fee
- Exemption of proportional duties and exit rights for finished products
- Exemption from VAT on imports for equipment and materials

These benefits are granted for a period that varies according to the geographical area where the company will be based, with the country being divided into three economic zones:

- Zone A: the province of Kinshasa; 3 years of benefits
- Zone B: Kongo Central, Lubumbashi, Likasi, and Kolwezi; 4 years of benefits
- Zone C: the rest of the country; 5 years of benefits

The logic is to encourage companies to invest in other areas of the country, in particular the least developed areas. To be eligible, companies need to meet the following criteria:

[41] African Development Bank, "African Development Bank Approves $20 Million Facility for Green Mini-Grid Program in Democratic Republic of Congo."

- Register an office in DRC
- Guarantee a value added of at least 35 percent
- Provide a minimum investment of $10,000 for small and medium enterprises and $200,000 for large companies
- Invest in sectors covered by the investment code, submit the file in ANAPI's format, and pay the associated costs

The RE sector is now listed as a priority, and it hoped that this will lead to increased investment. ANAPI is one of the only government organizations now providing direct support to RE companies. Although these benefits are generally short term, it is hoped they will allow the companies to penetrate the market.

However, it is also important to note that a lack of a complete mini-grid framework has not prevented mini-grid companies, such as Kivu and Virunga, from raising early-stage funding from Camco REPP, ElectriFI, and EAV.[42]

PPAs: Standard PPAs for small RE projects do not yet exist. Nevertheless, some PPAs have been signed between SNEL and independent producers through the technical assistance of ECODIT.[43] For example, in Mbuji-Mayi, the project linking the ENERKA/AEE Power/KATen/MIBA Consortium with the authorities to rehabilitate a water station, ECODIT was asked to put in place the legal documents for the contract. Similarly, ECODIT has provided technical assistance to Hydroforce and EnerKac to allow them to sell the electricity that they produce in Kananga to SNEL. There is also a project to establish an interconnection between Angola and DRC (at Cabinda, Angola), for which ECODIT provided technical support. This process involved the government and the private sector company, AEE Power, with ECODIT working on the legal framework, which was carried out in November 2018.

4.5 MINI-GRID DISTRIBUTION PARTNERS

Although there are presently no strong synergies between companies in other sectors and mini-grid companies, once the potential benefits have been demonstrated, partner companies may be inclined to pilot and collaborate. The Catholic Church has been an important player in the development of solar-solution distribution networks. In DRC it has 47 dioceses with more than 1,500 churches, each with two or three community groups that have many members, and more than 10,000 schools, reaching around half of the Congolese population. In 2016, IFOD, the MFI of the Catholic Church, was created to increase savings, credit, and financial inclusion of rural households in DRC. Via this network, the Church has been handling payment of salaries for more than 137,000 teachers, more than 70 percent of whom are already banked. In addition to paying teachers, IFOD's primary targets are households and small and medium enterprises, but the Church also could use this network to partner with mini-grid companies. IFOD also works frequently with women, who represent more than 34 percent of their clients.

Another potential partner for mini-grid companies is Agricultural Cooperatives, which have a good presence in rural areas and may help these companies develop a portfolio of new projects in unelectrified areas. Their partnership support can help existing mini-grid companies rapidly scale up their operations. In addition, there is the distribution network of Rawji Group, established in DRC since 1922, as well as that of Beltexco, which has 10 branches spread across the country (one in Kinshasa, one in Kongo Central, four in the central DRC, three in the south, and one in the East), and has one of DRC's leading logistics operations. Last, telcos have an extensive network throughout DRC—better deployed than banks—and could play an important role partnering with mini-grid companies.

[42] EDFIMC, "Kivu Green Energy"; Alliance for Rural Electrification, "ARE Member EAV Closes Investment in Kivu Green Energy"; EDFIMC, "ElectriFI Commits USD 2.5M to Support the Expansion of Virunga Power."
[43] ECODIT, "DRC Power Sector Reform (PSR)."

5 AGRICULTURAL AND PRODUCTIVE-USE SOLAR COMPANIES

Although the agricultural and productive-use solar sector in currently in a very early stage of developing in DRC, below is a summary of some of the potential applications for off-grid households, as well as some of the companies that have the potential to scale up such technologies in the future.

5.1 PRODUCTIVE-USE APPLICATIONS FOR HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY

Although asset ownership remains low among households across DRC without access to electricity compared to those with access, a high proportion of these households own land suitable for agriculture or keep livestock. Data on agricultural land and livestock ownership comes from the DRC 2014 DHS.

- Nationally: 65 percent of households without access to electricity own land suitable for agriculture, while 50 percent own some livestock. About 20 percent of households without access to electricity own goats, 45 percent own chickens, and only about 2 percent own cows or bulls.
- Modest-consumption-power households: About 14 percent of these households are in urban areas. The majority of households in this group are engaged in agricultural activities, with 75 percent owning land suitable for agriculture and 60 percent owning livestock. Specifically, 50 percent of these households own chickens, 25 percent own goats, and 4 percent own cows or bulls.[44]
- Medium-consumption-power households: Although 65 percent of these households are in urban areas, about 45 percent own land suitable for agriculture and 45 percent own livestock. Specifically, 40 percent own chickens, 20 percent own goats, and 3 percent own cows or bulls.
- High-consumption-power households: Relative to modest- and medium-consumption-power households, the greatest percentage of these households are urban, at 72 percent; nonetheless, 35 percent of these households own land suitable for agriculture and 45 percent own livestock. Specifically, 40 percent own chickens, 15 percent own goats, and 4 percent own cows or bulls.

Agricultural households that grow crops or produce animal products that could involve some amount of processing, such as peanuts, palm oil, milk, and meat, would benefit from increased productivity through solar-powered energy systems that provide electricity for mills or animal processing plants.

Around 75 percent of households without electricity are engaged in agriculture, defined as owning agricultural land or livestock. These households offer a sizeable market for solar systems. Lights for work spaces, solar irrigation systems, and crop-processing equipment are just a few potential ways in which electricity could increase productivity. For a provincial breakdown of agricultural activity statistics among households without access to electricity, see Table A2-7 in Annex 1.

[44] Households that own land suitable for agriculture and livestock are not mutually exclusive, nor are households that own a specific livestock type.

5.2 AGRICULTURAL AND PRODUCTIVE-USE SOLAR: COMMERCIAL OVERVIEW

Below is a list of examples of businesses and organizations in DRC that have the potential or interest to develop productive use systems.

The Association of Cocoa and Coffee Exporters of the DRD (l'Association des Exportateurs du Cacao & Café de la République Démocratique du Congo [ASSECAF]): ASSECAF is the Congolese association of cocoa and coffee exporters, consisting of 24 cooperatives and companies. In addition to coffee and cocoa, the organization's members grow quinquina, rauvolfia, and papaya. Members include authorized exporters in DRC, agriculture cooperatives approved for exporting, factory operators, carriers, and other shippers. The activities of ASSECAF include supervising smallholder farmers, certifying products, producing and distributing seeds, and offering an agriculture extension to improve yields. In addition, the association manages coffee-washing stations powered by diesel generators, which increases the cost of Congolese coffee compared to that of its neighbors. Because there is a demand for additional washing stations, members need to find an alternative source of energy. ASSECAF also relies on diesel generators to operate a cocoa calibration plant. Although the association has not started investigating the productive use of solar energy, it welcomes support from other organizations in facilitating their smallholder farmers' access to clean and affordable energy.

Strategos Plantations: Strategos Plantations, a subsidiary of Strategos Group based in DRC, is a private organization founded in 2005 by Congolese entrepreneur Luc-Gérard Nyafé as an asset management company focused on frontier markets. Using a collaborative model, it develops plantations for growing a range of products in several parts of the country (Lusanga, Kimpese, Boende, and Kisantu). It provides agricultural loans; distributes seeds, fertilizer, and insecticides; and provides education practices. It is also interested in evaluating the potential of electrification to increase local agricultural production.

Strategos operates several experimental plantations, which serve as training sites for smallholder farmers and seed production. The company is under contract with 1,000 farmers but has identified 20,000 more living near its plantations with whom they might collaborate. The company provides farmers with seeds and fertilizers and has committed to collecting and paying for their crops. They recently initiated a land distribution pilot with 10 families, one hectare per family, with the aim of granting them titles. In September 2018, the company installed a mill in Lusanga with a one tonne per hour production capacity and powered by a 300 kilovolt-ampere diesel generator. Its ambition is to install a mill in each small town of the region.

Given the high cost of using fuel-powered machinery, one of Strategos's short-term projects is to revive the use of animal traction for land preparation in small-scale farming practices, as is still the case in North and South Kivu. Around 20,000 smallholder farmers throughout DRC require technical assistance to facilitate the purchase of small irrigation systems, which will significantly improve their incomes and living standards, which could be powered by solar.

PACT Ventures: PACT has been working in Southeast Asia within the energy access sector, in particular Myanmar, and is considering expansion into other areas, including East Africa. It has made an equity investment into Amped Innovations, a U.S. SHS company, and is also investigating the use of productive use systems in Nigeria with mini-grid companies. PACT has been working in DRC with artisanal miners with the goal of supporting their energy needs. They have spoken with Amped about potentially supplying miners but are generally looking at larger solar systems. They are still developing their business model for DRC but are most interested in understanding the state of the energy market in DRC, who the main players are, the regulatory environment, people's income, and

their ability to pay. PACT is now seeking funding for techno-economic feasibility assessments to understand their potential to be powered by mini-grids.

5.3 POTENTIAL PRODUCTIVE-USE DISTRIBUTION PARTNERS

The following is a list of agricultural organizations that have expressed an interest in getting more involved in energy generation and may be suitable distribution partners for productive use of energy technologies:

- **The Breeders' Society of Bandundu (SEBO)** is an industrial breeding enterprise (including cattle, sheep, swine, poultry, and goats) that also runs slaughterhouses and offers industrial processing of meats. The company operates farms in Mont Ngafula, specifically in Kimwenza and the former Bandundu Province, where it operates several outlets and cold rooms, which could benefit from RE generating systems.
- **Commerce and Plantations Company (Compagnie de Commerce et des Plantations)** produces palm oil in Équateur Province from its own plantations, and those of the nearby villages of Lisafa and Ndeke. The factory at Lisafa is responsible for treat palm oil and producing soap. It also grows coffee; 3,488 hectares of its plantations are devoted to palm trees, and 372 hectares to coffee. It is a major local employer, with almost 4,000 workers on its payroll, and is one of the most successful businesses in the area.
- **The Society of Livestock Farms of Bas-Congo (GEL Bas-Congo)** is a subsidiary of Elwyn Blattner Group. The company has invested since 2003 in palm and rubber plantations in Binga and Bosondjo, in Équateur Province. It has also invested in a third factory in Binga to produce granulated rubber. Its farm holdings are expanding at around 1,800 hectares a year, to fully respond to the local demand for palm oil.
- **CONAPAC** is the national confederation of agricultural producers in DRC, with more than 500,000 members throughout the country. Its objectives include the defense and promotion of agricultural producers' interests, providing them all the information they need to help them better develop their profession, and aiding each category of producer in shaping its agricultural world. In 2015, it launched a partnership with AEG International to supply solar equipment for productive use to smallholder farmers and cooperatives. They also have expressed interest for another organization to strengthen this partnership.
- **Lushebere Dairy and Cheese Factory** owns pristine pastures in North Kivu and a farm with more than 400 cows. Lushebere Farm, covering an area of 558 hectares, is located in a green area of the Masisi Territory. In 2012, the acquisition of new farm equipment allowed the dairy and cheese company not only to pasteurize milk, but also to increase its cheese production by 7 times. They are currently investing in equipment that could be RE-powered and allow them to branch into additional value-added products.

ANNEX A POWER AFRICA GEOSPATIAL ANALYSIS DATA SOURCES

The Fraym database used in the geospatial analysis of African populations combines satellite imagery and existing household surveys that are harmonized and reweighted based on population data from third-party sources like multilateral and bilateral development actors, ensuring that indicators are comparable across countries and over time.

For this study, individual and household indicators were sourced from the DRC's second Demographic and Health Survey, conducted in 2014 by the Ministry of Monitoring, Planning and Implementation of the Modern Revolution and the Ministry of Public Health of DRC, with funding from USAID, PEPFAR (The US President's Emergency Plan for AIDS Relief), the Department for International Development, the World Bank, the Global Fund, the UN, and the Bill & Melinda Gates Foundation.[45] These surveys were meant to be nationally representative and used a stratified two-stage sample design. The DHS data were collected in 2014, with a total sample size of 18,171 households.

After data collection, post hoc sampling weights were created to account for any oversampling and ensure survey representativeness. Fraym triangulated the weights and resulting population proportions by using independent, third-party sources, such as the United Nations' Population Division and the World Bank's World Development Indicators.

As medium- and low-voltage network data were unavailable, data on the high-voltage network was used. These data were obtained from the World Bank project DRC EASE (Energy Access & Services Expansion), which provided the most up-to-date and credible map of the DRC high-voltage network.[46]

SPATIAL PREDICTION

To create spatial layers of households without access to electricity, machine learning was used to combine cluster-level survey coverage data with satellite imagery to identify spatial relationships and predict patterns at a hyper-local scale. In particular, the analysis relied on a survey question that asked, "Does your household have electricity? (referring to materials and equipment that works)."

Forty-two spatial covariates (satellite images) were employed for this process. These covariates were selected because of their availability across time and space, and their high predictive power. A combination of raw and modeled satellite data layers are provided by respected organizations including LandScan, the U.S. Geological Survey, the European Space Agency, the Socioeconomic and Applications Center, and the Center for International Earth Science Information Network.

[45] The DHS Program, "Congo Democratic Republic: Standard DHS, 2013-14."
[46] The World Bank, "Democratic Republic Congo (COD) - Transmission Network (2018)."

Although the particular process for creating spatial layers is proprietary, related approaches are detailed in the academic literature, including:

- Gething, Peter, Andy Tatem, Tom Bird, and Clara R. Burgert-Brucker. 2015. Creating Spatial Interpolation Surfaces with DHS Data (DHS Spatial Analysis Reports No. 11). Rockville, MD, USA: ICF International.–available at: http://dhsprogram.com/publications/publication-SAR11-Spatial-Analysis-Reports.cfm#sthash.U4CPy69y.dpuf
- Engstrom, Ryan, Jonathan Samuel Hersh, and David Locke Newhouse. 2017. Poverty from Space: Using High-Resolution Satellite Imagery for Estimating Economic Well-Being. World Bank Policy Research Working Paper No. WPS 8284. Washington, DC: World Bank. Available at: http://documents.worldbank.org/curated/en/610771513691888412/Poverty-from-space-using-high-resolution-satellite-imageryfor-estimating-economic-well-being

TABLE A-1. DATA DICTIONARY

INDICATOR	DEFINITION
Access to Electricity	
Households without access to electricity	Households that responded "no" to the survey question: "Does your household have access to electricity?"
Total off-grid market potential	Defined as all households that were not connected to the national grid at the time of this analysis. This does not include backup use.
Assets	
Mid-range electrical asset	Mobile telephone or radio.
High-range assets	Televisions, refrigerators, computers, generators, or cars.
Consumption Power* and Financial Inclusion	
Bank account	Households were classified as having a bank account if any member of the household had a bank account, regardless of use.
Modest consumption power	Household without access to electricity that owned at least one mid-range electrical asset but lived in a house made from either unfinished or partially finished components, such as dirt floors or mud walls.
Medium consumption power	Household without access to electricity that owned a mobile telephone and lived in a house made with some advanced materials, such as metal, wood, or covered brick.
High consumption power	Household without access to electricity that owned at least one high-range asset, as defined above.
Media Consumption	
Regular TV watcher	Individual who watched TV at least once per week. Only included individuals ages 15–49 years old.
Regular radio listener	Individual who listened to the radio at least once per week. Only included individuals ages 15–49 years old.
Indicator	Definition
Housing Quality	
Advanced finished roof	Roofing made from any of the following materials: corrugated iron sheet, concrete or cement, asbestos sheets, bricks.
Advanced finished floor	Flooring made from any of the following materials: parquet or polished wood, cement, plastic or brick tiles, ceramic or marble tiles.
Advanced finished walls	Walls made from any of the following materials: stone, cement, blocks, bricks, steel, corrugated iron sheets, and asbestos sheets.
Some advanced material	A house had some advanced material if either the floor, walls, or roof was made from an advanced finished material.

Table A-1. Continued

INDICATOR	DEFINITION
Education of Household Head	
Did not finish primary school	Household head received no schooling or did not finish primary school.
Finished primary	Household head completed primary, and may have attended, but not completed, secondary.
Finished secondary	Household head completed secondary and may have had some higher education.
Some higher education	Household head received at least some higher education.

* Households without electricity are segmented based on consumption power. Each segment is mutually exclusive, and each household is placed into the highest consumption group for which it is eligible.

TABLES

The following tables are referenced in the main body of this text. Sections where these tables are referenced also provide citation information for data found in these tables. Unless otherwise stated, the population statistics provided use Fraym data as well as the DRC 2014 DHS.

TABLE A-2. DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY NATIONWIDE AND BY PROVINCE

ADMINISTRATIVE AREA	TOTAL HOUSEHOLDS	HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	PERCENTAGE OF HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY
National			
DRC	15,590,000	13,070,000	84%
Province			
Bas-Uele	260,000	260,000	100%
Équateur	310,000	290,000	94%
Haut-Katanga	530,000	260,000	49%
Haut-Lomami	340,000	320,000	94%
Haut-Uele	430,000	420,000	98%
Ituri	830,000	790,000	95%
Kasaï	560,000	560,000	100%
Kasaï-Central	680,000	670,000	99%
Kasaï-Oriental	560,000	530,000	95%
Kinshasa	1,760,000	330,000	19%
Kongo Central	1,050,000	860,000	82%
Kwango	440,000	440,000	100%
Kwilu	1,100,000	1,070,000	97%
Lomami	470,000	460,000	98%
Lualaba	300,000	220,000	73%
Mai-Ndombe	390,000	370,000	95%
Maniema	460,000	450,000	98%
Mongala	370,000	360,000	97%

Table A-2. Continued

ADMINISTRATIVE AREA	TOTAL HOUSEHOLDS	HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	PERCENTAGE OF HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY
Nord-Kivu	1,360,000	1,250,000	92%
Nord-Ubangi	250,000	240,000	96%
Sankuru	390,000	390,000	100%
Sud-Kivu	1,010,000	900,000	89%
Sud-Ubangi	510,000	500,000	98%
Tanganyika	360,000	320,000	89%
Tshopo	540,000	480,000	89%
Tshuapa	330,000	330,000	100%

Note: Percentage of households without electricity is the number of households without access to electricity out of all households.

TABLE A-4. NATIONAL-LEVEL BREAKDOWN OF KEY DRC INDICATORS, BY STATUS OF HOUSEHOLD ACCESS TO ELECTRICITY

INDICATOR	HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	HOUSEHOLDS WITH ACCESS TO ELECTRICITY
Key assets		
Mobile telephone	32%	96%
Radio	39%	71%
Television	5%	86%
Refrigerator	< 1%	34%
Computer	1%	17%
Generator	2%	10%
Car	< 1%	9%
Agricultural land	66%	26%
Bank account	2%	96%
Housing quality[1]		
Advanced finished floor	8%	89%
Advanced finished walls	20%	94%
Advanced finished roof	28%	98%
Education of household head		
Did not finish primary school	41%	8%
Finished primary	42%	31%
Finished secondary	13%	30%
Some higher education	4%	30%
Household head occupation[2]		
Employed	¬91%	90%
Agriculture	60%	3%
Sales	11%	23%
Skilled manual labor	4%	19%
Professional[3]	9%	23%

[1] Advanced housing components are defined as durable materials like concrete, metal, and brick.
[2] Occupation data only includes household heads aged 15–49.
[3] Examples of professional occupations include technical fields, scientists, teachers, and administrators.

TABLE A-3. DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY BY PROXIMITY TO HIGH-VOLTAGE (HV) NETWORK, PER PROVINCE

PROVINCE	TOTAL NUMBER OF HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	WITHIN 5 KM OF HV NETWORK		5 KM–10 KM FROM HV NETWORK		BEYOND 10 KM FROM HV NETWORK	
		NUMBER OF HOUSEHOLDS	% OF ALL HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	NUMBER OF HOUSEHOLDS	% OF ALL HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	NUMBER OF HOUSE-HOLDS	% OF ALL HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY
Bas-Uele	260,000	—	0%	—	0%	260,000	100%
Équateur	290,000	—	0%	—	0%	290,000	100%
Haut-Katanga	260,000	90,000	35%	10,000	4%	160,000	62%
Haut-Lomami	320,000	30,000	9%	10,000	3%	280,000	88%
Haut-Uele	420,000	10,000	2%	10,000	2%	400,000	95%
Ituri	790,000	40,000	5%	10,000	1%	740,000	94%
Kasaï	560,000	10,000	2%	10,000	2%	530,000	95%
Kasaï-Central	670,000	140,000	21%	50,000	7%	480,000	72%
Kasaï-Oriental	530,000	—	0%	—	0%	530,000	100%
Kinshasa	330,000	260,000	79%	60,000	18%	10,000	3%
Kongo Central	860,000	190,000	22%	60,000	7%	620,000	72%
Kwango	440,000	10,000	2%	20,000	5%	400,000	91%
Kwilu	1,070,000	60,000	6%	40,000	4%	970,000	91%
Lomami	460,000	40,000	9%	20,000	4%	400,000	87%
Lualaba	220,000	80,000	36%	10,000	5%	130,000	59%
Mai-Ndombe	370,000	—	0%	—	0%	360,000	97%
Maniema	450,000	50,000	11%	10,000	2%	390,000	87%
Mongala	360,000	—	0%	—	0%	360,000	100%
Nord-Kivu	1,250,000	60,000	5%	20,000	2%	1,170,000	94%
Nord-Ubangi	240,000	10,000	4%	—	0%	240,000	100%
Sankuru	390,000	—	0%	—	0%	390,000	100%
Sud-Kivu	900,000	170,000	19%	50,000	6%	680,000	76%
Sud-Ubangi	500,000	—	0%	—	0%	500,000	100%
Tanganyika	320,000	20,000	6%	—	0%	300,000	94%
Tshopo	480,000	—	0%	—	0%	480,000	100%
Tshuapa	330,000	—	0%	—	0%	330,000	100%

Note: Dashes indicate provinces with no data within a specific distance or range from the HV network; that entire province is beyond that given distance. For example, all of Bas-Uele lies beyond 10 km from the HV network.

TABLE A-5. KEY SOCIOECONOMIC AND ASSET-OWNERSHIP STATISTICS AMONG DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY: CONSUMPTION POWER PROFILES

INDICATOR	MODEST-CONSUMPTION-POWER HOUSHOLDS	MEDIUM-CONSUMPTION-POWER HOUSHOLDS	HIGH-CONSUMPTION-POWER HOUSHOLDS
Living in urban areas	14%	65%	72%
Average wealth percentile	40th	66th	73rd
Key assets			
Mobile telephone	38%	100%	85%
Radio	84%	54%	82%
Television	0%	0%	83%
Refrigerator	0%	0%	7%
Computer	0%	0%	11%
Generator	0%	0%	37%
Car	0%	0%	3%
Bank account	1%	5%	12%
Media consumption[1]			
Regular TV watcher	5%	13%	34%
Regular radio listener	36%	40%	47%
Agricultural indicators			
Agricultural land	74%	45%	33%
Owns livestock	61%	45%	46%
Housing quality[2]			
Advanced finished floor	1%	26%	48%
Advanced finished walls	7%	58%	65%
Advanced finished roof	10%	92%	77%
Household head education			
Did not finish primary school	33%	23%	12%
Finished primary	48%	46%	41%
Finished secondary	16%	20%	28%
Some higher education	3%	11%	19%

[1] Media consumption only includes individuals aged 15-49 years old. "Regular" is defined as at least once per week.

[2] Advanced housing components are defined as durable materials like concrete, metal, and brick.

TABLE A-6. DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY BY CONSUMPTION POWER PROFILE, NATIONWIDE AND BY PROVINCE

ADMINISTRATIVE AREA	MODEST-CONSUMPTION-POWER HOUSHOLDS	MEDIUM-CONSUMPTION-POWER HOUSHOLDS	HIGH-CONSUMPTION-POWER HOUSHOLDS
DRC	3,842,000	2,232,000	724,000
Bas-Uele	86,000	14,000	11,000
Équateur	70,000	22,000	27,000
Haut-Katanga	70,000	63,000	9,000
Haut-Lomami	96,000	50,000	6,000
Haut-Uele	150,000	33,000	27,000
Ituri	290,000	133,000	34,000
Kasaï	170,000	60,000	19,000
Kasaï-Central	190,000	108,000	38,000
Kasaï-Oriental	100,000	200,000	74,000
Kinshasa	33,000	120,000	88,000
Kongo Central	270,000	223,000	75,000
Kwango	150,000	32,000	0
Kwilu	320,000	172,000	90,000
Lomami	140,000	80,000	22,000
Lualaba	66,000	47,000	9,000
Mai-Ndombe	100,000	44,000	19,000
Maniema	150,000	39,000	28,000
Mongala	110,000	29,000	25,000
Nord-Kivu	370,000	367,000	0
Nord-Ubangi	76,000	12,000	9,000
Sankuru	120,000	19,000	4,000
Sud-Kivu	268,000	220,000	35,000
Sud-Ubangi	153,000	27,000	25,000
Tanganyika	89,000	65,000	14,000
Tshopo	136,000	44,000	31,000
Tshuapa	69,000	9,000	5,000

TABLE A-7. KEY DRC SOCIOECONOMIC AND ASSET OWNERSHIP STATISTICS: HIGH CONSUMPTION-POWER HOUSEHOLDS VS. HOUSEHOLDS WITH ACCESS TO ELECTRICITY

INDICATOR	MODEST-CONSUMPTION-POWER HOUSEHOLDS	MEDIUM-CONSUMPTION-POWER HOUSEHOLDS	HIGH-CONSUMPTION-POWER HOUSEHOLDS
Living in urban areas	72%	97%	99%
Average wealth percentile	73rd	78th	88th
KEY ASSETS			
Mobile telephone	85%	90%	96%
Radio	82%	55%	71%
Television	83%	62%	86%
Refrigerator	7%	8%	34%
Computer	11%	2%	17%
Generator	37%	6%	10%
Car	3%	0%	9%
Bank account	12%	8%	26%
MEDIA CONSUMPTION[1]			
Regular TV watcher	34%	61%	76%
Regular radio listener	47%	43%	45%
AGRICULTURAL INDICATORS			
Agricultural land	33%	24%	16%
Owns livestock	46%	24%	14%
HOUSING QUALITY[2]			
Advanced finished floor	48%	48%	66%
Advanced finished walls	65%	65%	83%
Advanced finished roof	77%	77%	95%
HOUSEHOLD HEAD EDUCATION			
Did not finish primary school	12%	16%	8%
Finished primary	41%	45%	31%
Finished secondary	28%	28%	30%
Some higher education	19%	11%	30%

[1] Media consumption only includes individuals aged 15-49 years old. "Regular" is defined as at least once per week.

[2] Advanced housing components are defined as durable materials like concrete, metal, and brick.

TABLE A-8. AGRICULTURAL ACTIVITY STATISTICS AMONG DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY, BY PROVINCE

PROVINCE	% WITH AGRICULTURAL LAND	% WITH LIVESTOCK	% WITH CHICKENS	% WITH GOATS	% WITH SHEEP	% WITH COWS OR BULLS
Bas-Uele	37%	55%	48%	14%	2%	0%
Équateur	31%	25%	20%	7%	4%	0%
Haut-Katanga	86%	48%	43%	13%	0%	4%
Haut-Lomami	86%	67%	60%	26%	6%	0%
Haut-Uele	58%	53%	47%	22%	1%	0%
Ituri	80%	44%	35%	23%	3%	4%
Kasaï	65%	50%	46%	16%	2%	0%
Kasaï-Central	56%	58%	51%	28%	2%	2%
Kasaï-Oriental	25%	33%	28%	12%	0%	0%
Kinshasa	7%	14%	13%	0%	0%	0%
Kongo Central	69%	54%	47%	13%	3%	0%
Kwango	82%	63%	53%	31%	4%	12%
Kwilu	43%	49%	44%	16%	5%	5%
Lomami	76%	69%	63%	32%	3%	1%
Lualaba	74%	45%	41%	14%	2%	1%
Mai-Ndombe	85%	39%	29%	6%	7%	2%
Maniema	48%	43%	37%	12%	3%	0%
Mongala	84%	70%	66%	18%	7%	1%
Nord-Kivu	67%	43%	33%	20%	3%	0%
Nord-Ubangi	90%	64%	60%	14%	4%	5%
Sankuru	71%	60%	52%	28%	3%	1%
Sud-Kivu	67%	42%	25%	23%	3%	6%
Sud-Ubangi	80%	65%	62%	23%	3%	6%
Tanganyika	91%	58%	51%	28%	11%	0%
Tshopo	80%	52%	45%	12%	1%	0%
Tshuapa	80%	52%	45%	14%	3%	1%

TABLE A-9. DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY, BY MAJOR CITY AND CONSUMPTION-POWER PROFILE

MAJOR CITY	ALL HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY	MODEST-CONSUMPTION-POWER HOUSEHOLDS	MEDIUM-CONSUMPTION-POWER HOUSEHOLDS	HIGH-CONSUMPTION-POWER HOUSEHOLDS
Bukavu	31,000	4,000	17,000	8,000
Bunia	36,000	5,000	18,000	12,000
Goma	54,000	8,000	31,000	3,000
Kananga	98,000	14,000	43,000	21,000
Kikwit	164,000	22,000	74,000	45,000
Kinshasa	282,000	21,000	106,000	81,000
Kisangani	78,000	19,000	28,000	17,000
Kolwezi	19,000	3,000	8,000	4,000
Likasi	15,000	2,000	6,000	4,000
Lubumbashi	25,000	2,000	8,000	5,000
Matadi	17,000	2,000	6,000	4,000
Mbandaka	55,000	15,000	12,000	15,000
Mbuji-Mayi	174,000	10,000	97,000	38,000
Tshikapa	35,000	5,000	17,000	6,000
Uvira	39,000	6,000	17,000	5,000

TABLE A-10. DRC HOUSEHOLDS WITHOUT ACCESS TO ELECTRICITY, BY MAJOR CITY AND PROXIMITY TO HV NETWORK

MAJOR CITY	HOUSEHOLDS WITHIN 5 KM OF THE HV NETWORK	HOUSEHOLDS WITHIN 5 KM–10 KM OF THE HV NETWORK	HOUSEHOLDS BEYOND 10 KM OF THE HV NETWORK
Bukavu	31,000	—	—
Bunia	36,000	—	—
Goma	51,000	3,000	—
Kananga	90,000	8,000	—
Kikwit	—	—	164,000
Kinshasa	235,000	47,000	—
Kisangani	—	—	78,000
Kolwezi	19,000	—	—
Likasi	15,000	—	—
Lubumbashi	25,000	—	—
Matadi	16,000	1,000	—
Mbandaka	—	—	55,000
Mbuji-Mayi	—	—	174,000
Tshikapa	—	—	35,000
Uvira	38,000	1,000	—

Note: Dash indicates no households within the specified range of the high-voltage network.

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IMPORTANT NOTICES:

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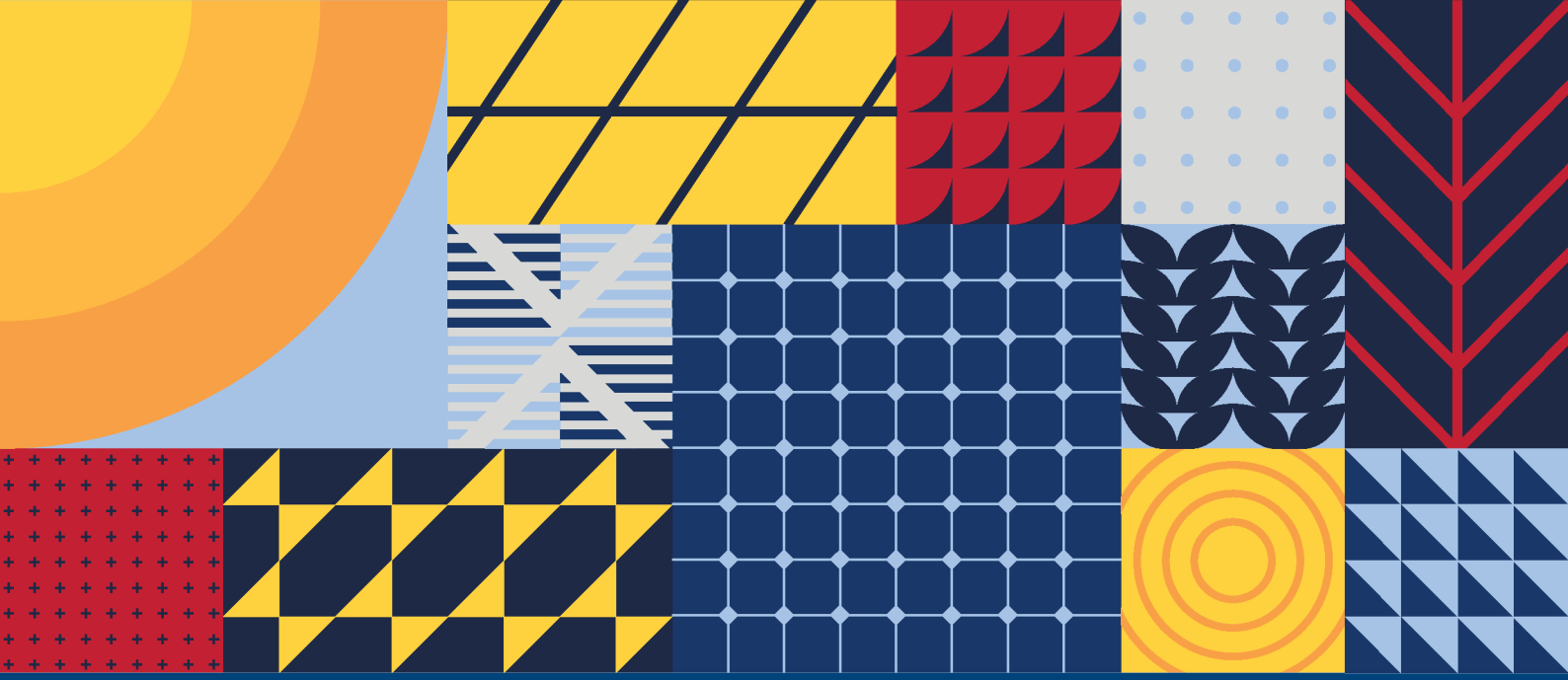

Power Africa aims to achieve 30,000 megawatts of new generated power, create 60 million new connections, and reach 300 million Africans by 2030.