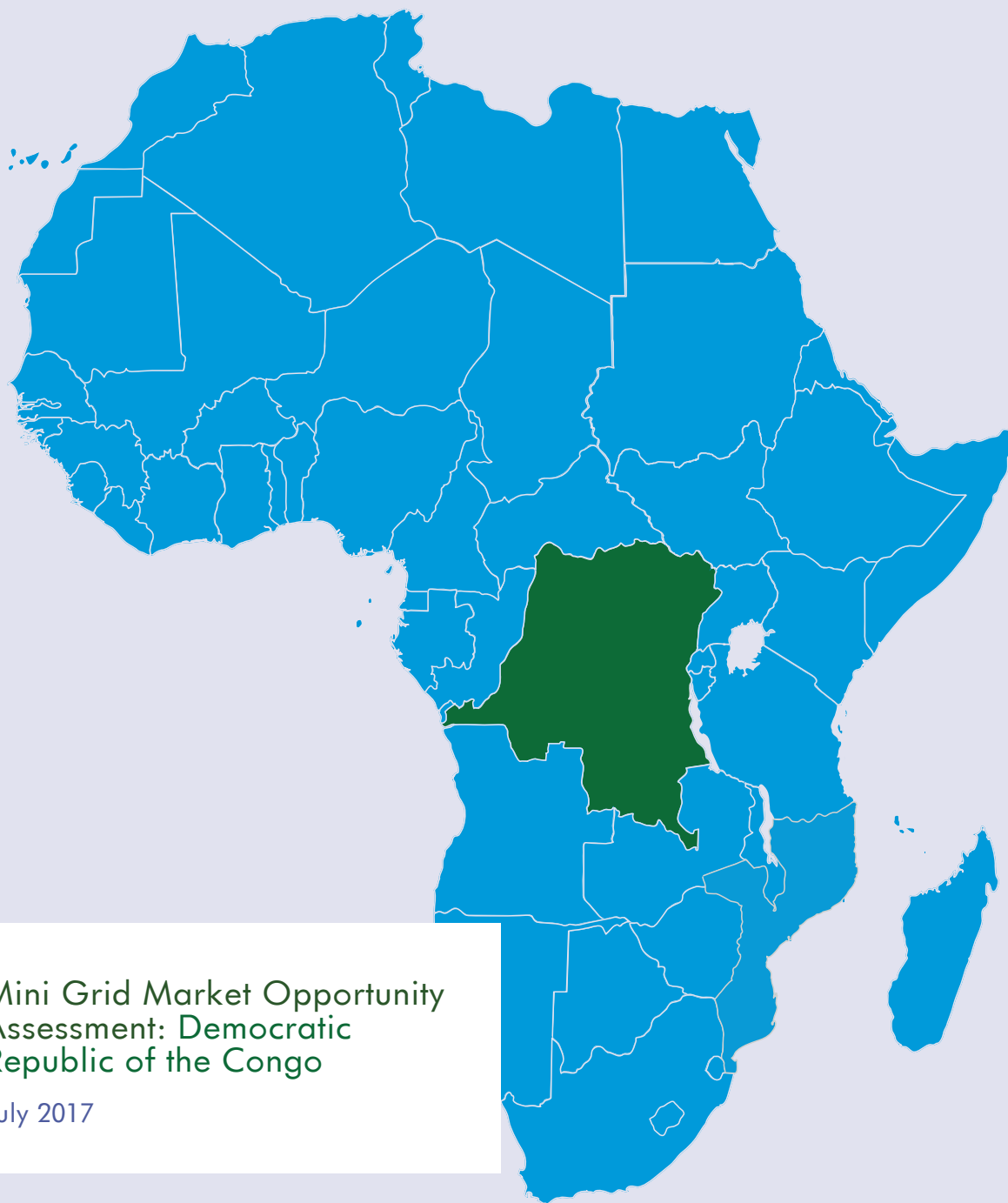


Green Mini Grid Market Development Programme

SEforALL Africa Hub
African Development Bank



Mini Grid Market Opportunity
Assessment: Democratic
Republic of the Congo

July 2017



Prepared by



PREFACE

This paper, part of the Green Mini-Grid Market Development Programme (GMG MDP) document series, assesses the green mini-grid market for rural electrification in the Democratic Republic of Congo. This includes mini-grids powered by renewable energy resources – solar radiation, wind, hydropower or biomass – either exclusively, or in combination with diesel generation.

Mini-grids are not a new phenomenon in Africa. Almost all national utilities own and operate diesel-powered generating facilities not connected to the main grid, which supply electricity to secondary towns and larger villages. This solution to rural electrification inevitably results in significant financial losses for the utility as it is required to sell power at prices significantly below the cost of production and delivery. Moreover, it leaves the most remote towns and villages non-electrified. The latest Sustainable Energy for All (SEforALL) Global Tracking Framework estimates that the urban-to-rural divide in access to electricity in Africa is as high as 450 percent given that 69 percent of the population in urban areas is electrified compared to only 15 percent in rural areas.

There are three principal options for providing new connections to currently unserved populations in Africa, namely: extension of the national grid; installation of separate “mini” grids to operate independently from the main grid; and stand-alone generating systems that supply individual consumers. The most cost-effective approach for powering mini-grids is to use renewable energy sources, which are widely available across Africa.

The development of GMGs is not without its challenges however. In addition to unfriendly policy and regulatory frameworks, barriers to growth of the private mini-grids sector in Africa include the lack of proven business models, market data and linkages, key stakeholder capacity, and access to finance.

In response to these challenges, the SEforALL Africa Hub at the African Development Bank designed and launched Phase 1 of the GMG MDP in 2015, with grant funding from the AfDB’s Sustainable Energy Fund for Africa (SEFA). The GMG MDP is a pan-African platform that addresses the technical, policy, financial and market barriers confronting the emerging GMG sector. It is part of a larger DFID-funded GMG Africa Programme, which also includes GMG initiatives in Kenya and Tanzania; country-specific GMG policy development through SEFA; and an action learning and exchange component implemented by the World Bank’s Energy Sector Management Assistance Program (ESMAP).

In its *Africa Energy Outlook 2014*, the International Energy Agency predicted that by 2040, 70 percent of new rural electricity supply in Africa will come from stand-alone systems and mini-grids. The GMG MDP, SEforALL, SEFA, ESMAP and similar programmes, which are contributing to falling costs, technological advancements and more efficiencies in GMG development, will help ensure that up to two thirds of this supply is powered by renewables.

The goals of the green mini-grid programme are central to AfDB’s mission of spurring sustainable economic development, social progress and poverty reduction in its regional member countries. Off-grid and mini-grid solutions are a key component of the AfDB’s New Deal on Energy for Africa, launched by the Bank’s president in January 2016. The New Deal, a transformative, partnership-driven effort, aspires to achieve universal access to energy in Africa by 2025.

This report was prepared by Carbon Trust, UNEP and ECREEE at the request of the AfDB. It was written by Marco Sampablo, Samy Geronymos and Guy Henley of Carbon Trust and Eugene Ochieng of UNEP. Carbon Trust is a mission-driven organization helping businesses, governments and the public sector to accelerate the move to a low carbon economy. The United Nations Environment Programme (UNEP) is a leading global environmental authority.

The content of this report was reviewed by Jeff Felten of the AfDB’s GMG team and cleared by Dr. Daniel-Alexander Schroth, SEforALL Africa Hub Coordinator at the AfDB. The report was edited by Kimberlee Brown.

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List of Acronyms

AFD	<i>Agence Française de Développement</i> (French Development Agency)
ANAPI	<i>Agence Nationale pour la Promotion des Investissements</i> (National Agency for the Promotion of Investments)
ANSER	<i>Agence Nationale de l'Électrification et des Services Énergétiques en Milieu Rural et Périurbain</i> (National agency for the electrification of rural and peri-urban areas)
ARC	African Risk Capacity
ARE	<i>Autorité de Régulation du secteur de l'électricité</i> (Electricity Regulation Authority)
AREF	Africa Renewable Energy Fund
CAPP	Central Africa Power Pool
CDC	Commonwealth Development Corporation
CNE	<i>Commission Nationale de l'Énergie</i> (National Energy Commission)
DBSA	Development Bank of South Africa
DFI	Development Finance Institution
DFID	Department for International Development
DIAGF	DFID Impact Accelerator Facility
EAIF	Emerging Africa Infrastructure Fund
EAPP	Eastern Africa Power Pool
EASE	Electricity Access Service Expansion
EDC	<i>Électricité Du Congo</i> (Congo Electricity)
EIB	European Investment Bank
ENK	<i>Energie du Nord Kivu</i>
GAP	Green Africa Power
GMG	Green Mini-Grid
HVDC	High Voltage, Direct Current
ICRC	International Committee of the Red Cross
MERH	Ministry of Energy and Hydraulic Resources
MIBA	<i>Société Minière de Bakwanga</i> (Bakwanga Mining Company)
PIDG	Private Infrastructure Development Group
PNSD	<i>Plan National Stratégique de Développement 2017-2021</i> (National Strategic Development Plan for 2017 - 2021)
PPA	Power Purchase Agreement

PPP	Public Private Partnership
PRG	Partial Risk Guarantee
RC	Republic of the Congo
RE	Renewable energy
SAPP	Southern Africa Power Pool
SEFA	Sustainable Energy Fund for Africa
SEforAll	Sustainable Energy for All
SENEN	<i>Service National des Energies Nouvelles</i> (National Service of New Energies)
SNEL	<i>Société Nationale de Électricité</i> (National Power Company)
SNV	<i>Stichting Nederlandse Vrijwilligers</i> (Netherlands Development Organisation)
SOKIMO	<i>Société des mines d'or de Kilo-Moto</i> (Company of the Kilo-Moto Gold Mines)
TA	Technical Assistance
UCM	<i>Unité de Coordination et de Management des projets du ministère</i> (Ministry's Unit for Project Coordination and Management)
UNDP	United Nations Development Programme
WB	World Bank

EXECUTIVE SUMMARY

The DRC is the largest and fourth most populated country in Africa. It spreads over 2,345,441km² in Central Africa and has a population of around 80 million people. It borders nine countries, including the Central African Republic and South Sudan in the north, Zambia and Angola in the south, Uganda, Rwanda, Burundi and Tanzania in the east and the Republic of the Congo in the west. The capital Kinshasa is located in the western part of the country and has a population of over 11 million.

DRC has registered high growth rates in recent years but remains one of the poorest countries. Between 2010 and 2015 the country registered an annual growth rate of 7.1%, fuelled by the mining and the services sectors. Political instability resulting from the suspension of scheduled elections has had a significant toll on economic performance, slowing growth to 3.9% in 2016. GDP per capita stands at US\$456.

The electricity sector in DRC is characterised by low electrification rates and an underdeveloped and dysfunctional grid. While accurate energy access surveys do not exist, it is estimated that the electrification rate stands at around 9%.¹ A significant portion of electricity consumers are connected illegally or to informal grids, with the national utility SNEL accounting for only 500,000 registered household connections. Total installed capacity amounts to 2.61 GW but only 1.13 GW is available as more than half of existing hydro plants run under 50% capacity due to aging infrastructure and lack of maintenance.²

Green mini-grids could have significant potential in DRC. A combination of factors make the country a potentially fertile ground for mini-grids. It has a large potential market, with a population of some 80 million people, a low electricity access rate and unreliable service. In addition, the country is the largest in Africa, making it difficult and expensive to expand the existing power grid and distribute fuel to run diesel generators. It has also solid renewable energy potential, including the biggest hydro potential in the continent. However, significant obstacles such as a volatile political situation and a poor business environment hamper investments and prospects for rapid development of the mini-grid sector.

Based on current grid coverage we estimate an annual potential market of US\$921 million for mini-grid and off-grid solutions.³ This assumes that 61 million people will be connected to mini-grid and off-grid solutions. The potential market size could be even larger as modern decentralized solutions may also be feasible in areas within grid proximity where population centres close to the grid are not yet electrified due to limitations of the national power network assets. The same analysis, conducted taking into account the planned grid extensions scenario, yields an annual market size of 47 million people, representing US\$721 million per year.

Main cities across the country represent an obvious priority target for mini-grid solutions. We have identified and reviewed the main 170 population centres in the country, with a total population of about 31 million people. Of these, some 20 million people live in 29 towns situated within 15km of the power network. The remaining 141 towns (Table 2) with a total population of about ten million people can be seen as primary targets for electrification through modern mini-grid solutions. These 141 population centres situated beyond the current grid represent a theoretical mini-grid market worth US\$153 million per year.⁴ The list includes towns already served by local diesel or hydro mini-grids. Included in this list are towns such as Kisangani, Mbandaka, Moanda, Mokambo, and Uvira served in part by SNEL, and towns such as Tshikapa served by independent mini-grid companies such as EDC. Nevertheless, many of the existing local grids are outdated and non-operational.

1 ICF/USAID, 2017

2 UN, SNV, SEforALL, 2014, Renewable Energy Atlas (Atlas des énergies renouvelables)

3 World Bank Global Consumption Database. The data is from 2010 in USD. Nominal 2010-2016 GDP growth rates from the IMF were applied to calculate a 2016 approximation.

4 World Bank Global Consumption Database. The data is from 2010 in USD. Nominal 2010-2016 GDP growth rates from the IMF were applied to calculate a 2016 approximation.

Hydro and solar powered mini-grids have the largest potential to accelerate electrification rates. The United Nations Development Program (UNDP) produced a Renewable Energy Atlas in 2014 that identified 317 potential small hydro 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 165MW are located within 15km of the existing power network and could contribute to develop the capacity and distribution network of the main grid. Beyond the 15km buffer, 126 sites with a potential of 945MW have been identified that could contribute to the development of hydro-based mini grids. Of the 141 towns identified above, 51 are located within 20km of a potential hydro site.

The Electricity Law 2014 opened the power sector to private operators. The Law removed SNEL's monopoly status and laid the foundation for a new legal framework to promote public-private partnerships and private investments. However, three years later, no procedures and guidelines to obtain concessions, leases, or management contracts have been developed. Despite the incomplete legal framework, some independent power companies have implemented pilot projects, started building or rehabilitating plants and mini-grids, and launched generation and distribution ventures. EDC has 10,000 customers in Tshikapa, Virunga SARL has 5,000 clients in Mutwanga and Matebe and Enerkac supplies the city of Kananga. These old pilot projects have benefited from sizable grant funding.

The Ministry of Energy and Hydraulic Resources (MERH) is the main authority in the electricity sector. In addition to overseeing SNEL, its responsibilities include planning, policy, and program development and oversight. Within the Ministry, the Unit for the Management and Coordination of the ministry's projects (UCM) is in charge of supervising, administering and coordinating MERH's electricity and water projects. Its responsibilities include identifying renewable energy sites, selecting and preparing medium power plant projects for Public-Private Partnerships (PPP), analysing the regulations for the project's realisation and coordinating donor financing. The National Energy Commission (CNE) collects data and carries out research on the Energy Minister's request to inform energy policy. The National Agency of Investment Promotion (ANAPI) promotes and facilitates investment opportunities including in the energy sector.

DFID and the World Bank are committing significant funding to further development of mini-grids over the next five years. DFID's £35m Essor programme plans to support the construction of 33 solar GMGs by 2021 by facilitating the preparation and tendering of these projects. Funding is expected to be sourced from private investors and DFIs. The cities of Bumba, Gemena, Isiro, Gandajika and Ilebo with populations between 124,000 and 260,000 people, solar irradiation between 5.27 kWh/m²/day and 6.2 kWh/m²/day and energy demands between 0.45MW and 5MW have been identified as priority targets. The projects will benefit from 15 to 20 year concessions. The World Bank Group's Energy Access & Services Expansion (EASE) programme, with a budget of US\$147 million, aims to electrify provincial capitals using GMGs. In addition, it aims to rehabilitate the Mobayi hydro plant and the Gbadolite grid.



1. INTRODUCTION TO THE GREEN MINI-GRID MARKET DEVELOPMENT PROGRAMME

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 for widespread and sustainable implementation of green mini-grid (GMG) projects by:

- Establishing a comparable, actionable understanding of the GMG market opportunity in SSA (Sub-Saharan Africa);
- Promoting the linkages between communities, public institutions, developers, financiers, and technology providers required for successful mini-grid development;
- Strengthening capacity of developers to develop and operationalise GMG business models;
- Promoting a sound policy and regulatory environment; and
- Engaging project financiers and supporting the development of suitable financial solutions.

This country report is one of five pilot country reports in the first phase of the Market Intelligence business line of the MDP, providing an analysis of the potential for GMGs per country. Successive phases of the MDP will include additional countries to provide comparable, actionable data on the potential for GMGs across countries in Sub-Saharan Africa.

The Market Development Programme is implemented by the Sustainable Energy for All (SEforALL) Africa Hub, through a grant from the Sustainable Energy Fund for Africa (SEFA). The SEforALL Africa Hub, hosted by the African Development Bank, is a partnership of African institutions dedicated to supporting the continent's progress towards the SEforALL initiative's three main objectives on energy access, renewable energy and energy efficiency.

The development of green mini-grids is promoted by the Clean Energy Mini-Grids Partnership under the SEforALL Initiative. The African Development Bank is playing a lead role for Africa. The partnership will galvanize action on the barriers facing the sector, with the engagement of public, private and civil society expertise and resources. The Clean Energy Mini-Grids Partnership, including the coordination group, secretariat and wider membership, is the established forum for discussion and coordination of the efforts of development partners to advance the adoption of GMGs. The MDP is designed from the beginning to be integrated and closely coordinated with the activities carried out in the framework of the partnership.



2. COUNTRY OVERVIEW

The DRC is the biggest and fourth most populated country in Africa. It spreads over 2,345,441km² in Central Africa and has a population of around 80 million people. It borders nine countries, including the Central African Republic and South Sudan in the north, Zambia and Angola in the south, Uganda, Rwanda, Burundi and Tanzania in the east and the Republic of the Congo in the west. The country has a 27km coastline at the outlet of the Congo River flowing into the Atlantic. In 2015, a new administrative division was adopted increasing the number of provinces from 11 to 26. The capital Kinshasa is located in the western part of the country and has a population of over 11 million.

The country straddles the equator, with a variety of landscapes and climates. There are mountain ranges in the north and west, a vast central plain through which the Congo River flows, the volcanoes and lakes of the eastern Kivu region and dense tropical rain forest in the central river basin and eastern highlands. The climate is hot and humid in the river basin and cool and dry in the southern highlands, with a cold, alpine climate in the Rwenzori Mountains. The country possesses half of the continent's fresh water resources with rainfall averaging 1,070mm per year.

The economy is heavily reliant upon the mining industry, which accounts for one-fifth of GDP and 95% of exports. The country produces multiple minerals, including copper, cobalt, zinc, gold, diamonds and others, making the country vulnerable to fluctuations in commodity prices.⁵ Agriculture accounts for one-fifth of GDP,⁶ but the sector is in decline with only a tenth of arable land used, the majority of which focuses on subsistence farming. The government, with the support of the World Bank (WB), has made the agricultural sector a development priority, proposing to privatize several government-owned farms and establish agro-industrial parks across all provinces.

DRC has registered high growth rates over the last years but remains one of the poorest countries. Between 2010 and 2015 the country has registered an annual growth rate of 7.1%, fuelled by the mining and the services sectors. Political instability resulting from the suspension of the scheduled elections has had a significant toll on economic performance, slowing growth to 3.9% in 2016. GDP per capita stands at US\$456. Although the poverty rates have been on a positive trend falling to 63.4% of the population in 2012 from 71.3% in 2005 and 80% in 1990⁷, the country still ranks 176 out of 187 countries on the United Nations Human Development index.

In the long term, the DRC has the potential to achieve significant rates of growth, particularly in the mining and agricultural sectors. Nevertheless, unlocking this potential will require significant policy and governance reforms, the fostering of human capital, and investments in infrastructure. The National Strategic Development plan for 2017-2021 (PNSD - *Plan National Stratégique de Développement 2017-2021*) enumerates eleven objectives and prioritises four, namely, to stabilise and rebuild conflict zones such as the Kivu region, consolidate and maintain high economic growth, create decent jobs through the creation of adapted policies and increase human development levels through education, health and social inclusion.

5 DFID Essor, 2016, Access to Electricity Solar Powered Mini-grids in the DRC

6 World Bank Data, 2015, Agriculture, value added (% of GDP)

7 AFDB, 2016, DRC Outlook; UNDP, Rapport National OMD

3. POTENTIAL OF GREEN MINI-GRIDS

3.1 INTRODUCTION

Green mini-grids have significant potential in DRC. A combination of factors make the country a potentially fertile ground for mini-grids. With a population of more than 80 million people, an electricity access rate of only 11% and current unreliable service, the market for GMGs is substantial. In addition, the country is the largest in Africa, making it difficult and expensive to expand the existing power grid and distribute fuel to run diesel generators. It further has sizeable renewable energy potential, including the biggest hydro potential in Africa.

The 2014 Electricity Law aims to promote private investments and utility-scale mini-grids across the country.⁸ The 2014 Electricity Law opened the sector up to private investment. Private companies such as *Electricité du Congo* (EDC), Virunga SARL, *Société d'énergie du Kasai* (Enerka) and *Société des Mines d'Or de Kilo-Moto* (SOKIMO) are operating local grids in cities such as Tshikapa, Mutwanga, Matebe, Mbuji-Mayi, Bunia and Mongbwalu. Significant opportunities for further local mini-grid developments exist. The UK's Department for International Development (DFID), through the Essor programme, aims to support 33 solar mini-grids across the country over the next four years. The World Bank, through the EASE programme, aims to develop mini-grids in all electrified provincial capitals and other major population centres.

However, significant obstacles hamper investments and prospects for rapid sector development. Although some local and international companies are investing in mini-grid and off-grid projects, sector development and further investments are hampered by multiple factors. These include: a volatile political situation in the country, with multiple regions facing security challenges; a non-enabling business environment, with DRC ranked 184th in the WBG's *Doing Business Report*; and poor infrastructure, making several regions of the country accessible only by air transport.

3.2 ASSESSMENT BACKGROUND

Estimating the potential for mini-grids is a challenging task that requires substantial data and many assumptions. Certain physical factors such as resource availability and geographic features may be collected remotely through satellite data, but other factors require the availability of local datasets and surveys. Some non-physical factors such as demand and consumption patterns require the collection of precise settlement-level data. This data is often not available, is out of date or is highly resource intensive to obtain. An opportunity assessment relies on a number of assumptions and criteria that are driven by the particular business model and approach of the implementing agency for each case. A detailed assessment in this report is unlikely to address the needs of all various stakeholders for which it is intended. Therefore, this report captures available data, and highlights general assessments relevant to most mini-grid stakeholders. Raw data is provided with this report to allow stakeholders to conduct further their own in-depth analyses.

Limited and inaccurate data exists for DRC. The last population census was conducted in 1984. As a result, population data is largely inaccurate and based on projections and guesstimates. This analysis relies upon population density data from LandScan Global Population Database and on urban population data compiled in 2004 by the Geographic Information System (GIS) unit at MONUSCO.⁹ With respect to the transmission network, current high level data was provided by the National Electricity Utility – SNEL (*Société Nationale d'Electricité*). UNDP's 2014 *Renewable Energy Atlas* was also referenced. The Atlas has incomplete and sometimes inaccurate information, but is an important source, identifying more than 300 hydro-sites across the country. This analysis defines grid and off-grid areas based on their distance from the power network. Grid regions are defined as being the areas within 15km of the grid. Main off-grid population centres were then mapped, enabling an analysis of the potential for mini-grid projects. Analysis has been conducted using both the current and projected power networks.

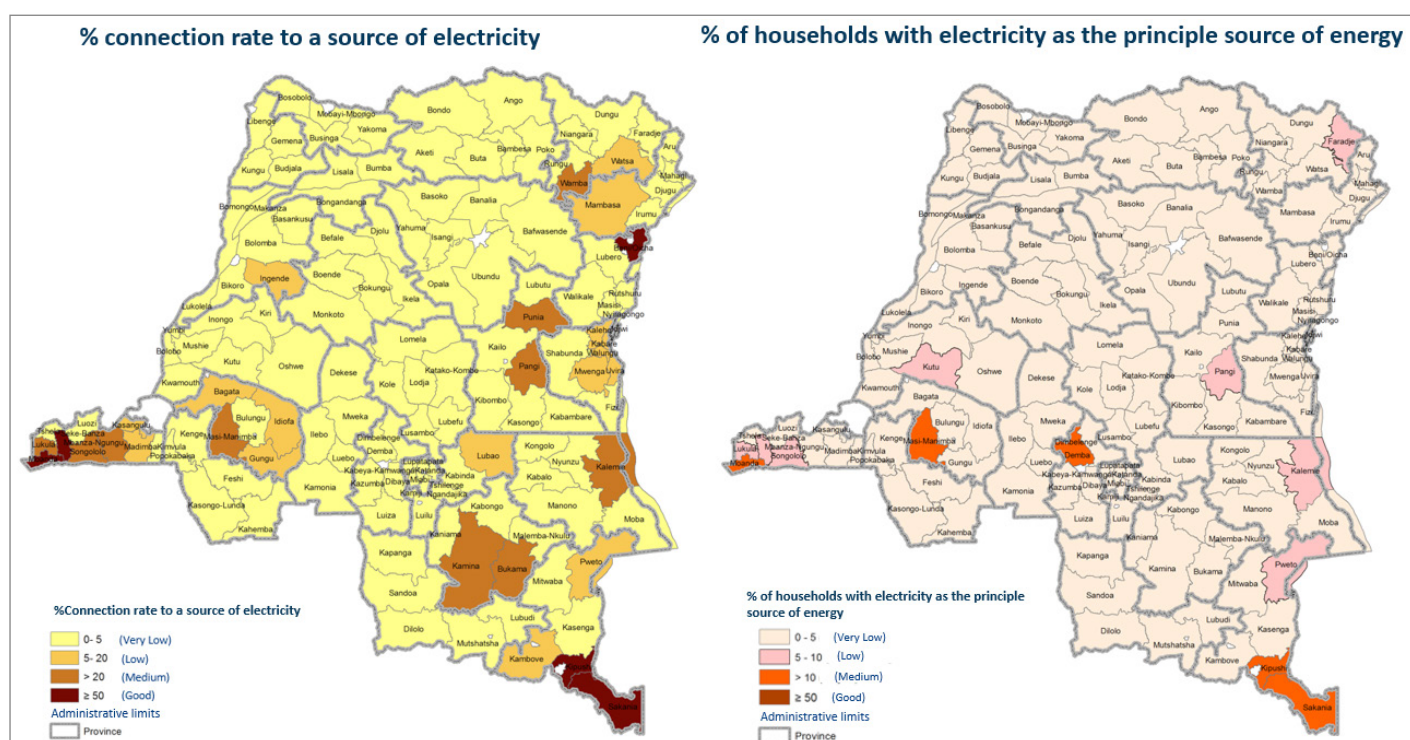
8 Law n°14/011 of June the 17th, 2014

9 Developed by East View Geospatial. The underlying map has commercial restrictions and cannot be included with the report.

3.3 MINI-GRID POTENTIAL ASSESSMENT

The existing power grid is undeveloped and electricity access rates are low across the country. Statistics are often of poor quality and contradictory, but all point to a low level of electricity access. Figure 1 shows that the electricity access rate is above 50% in only Kinshasa and the territories of Sakania, Kipushi, Beni, and Moanda. In ten districts the rate is above 20%, and in all but twelve of the remaining districts the rate is below 5%. Nevertheless, the rates of households using electricity as the primary source of energy are even lower. With the exception of Kinshasa, only in five territories is the rate above 10% and only in eight territories is it above 5%. The existing power network is fragmented into three regional grids. The western grid covers the Central Congo and Kinshasa provinces, the eastern grid covers North Kivu and South Kivu provinces and the southern grid covers the Haut-Katanga and Lualaba provinces. While the western and southern grids are connected through the 500kV Inga-Kolwezi link, the distribution network across the link is under-developed.

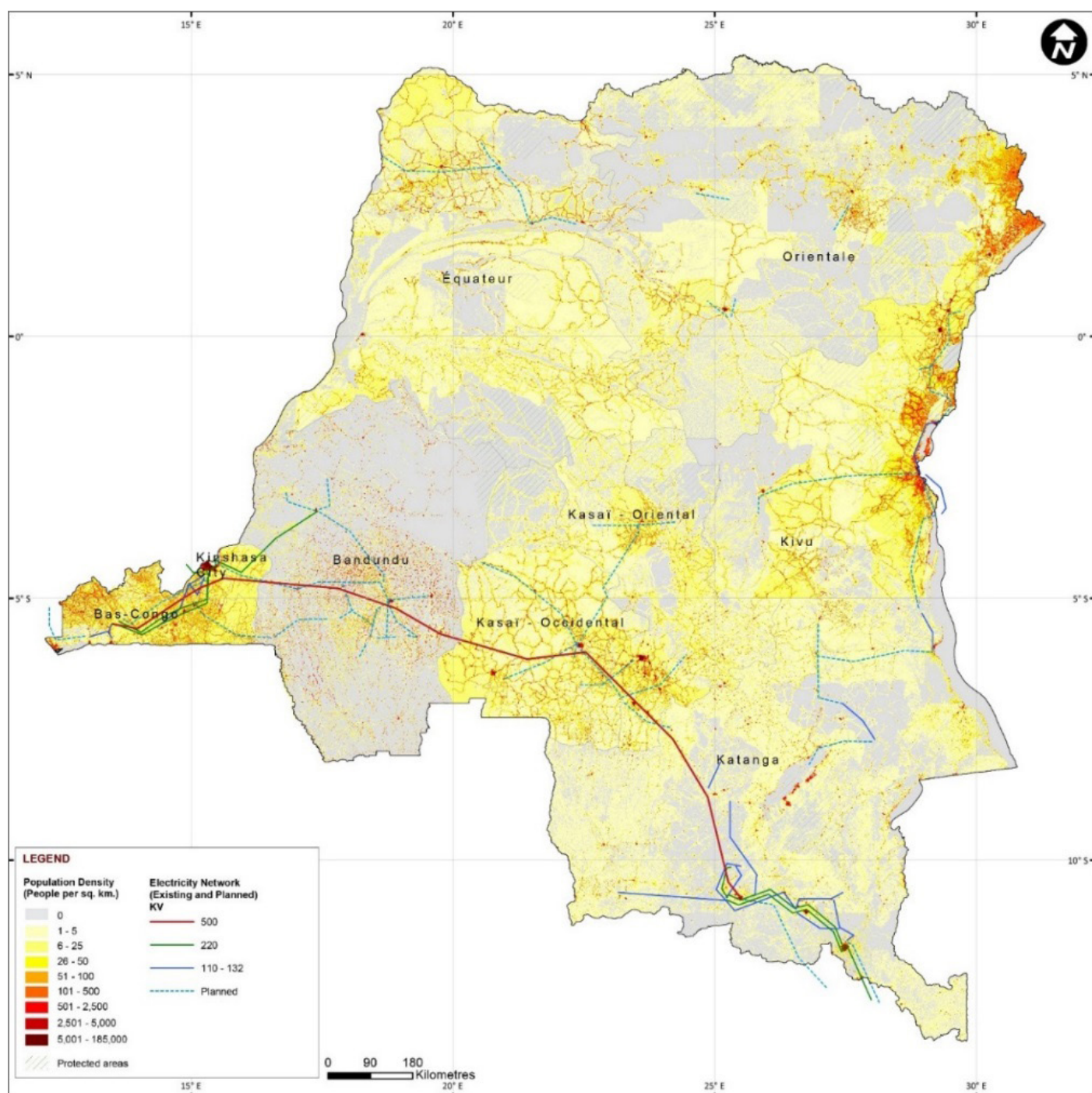
Figure 1. Electricity connection rates and household electricity use rates, by province



Source: CAID, 2015

The limited reach of the grid creates significant opportunities for off-grid solutions in most of the country. This analysis estimates that only 19 million people (one quarter of the population) live within 15km of the current grid and that 31 million live within 15km of the current and planned grid (Figure 2). More than 50 million people live beyond the reach of the current grid, creating significant opportunities for mini-grid and off-grid solutions. A number of mini-grids, relying mostly on hydropower and diesel generators exist across the country.

Figure 2: DRC population density map and existing and planned grid



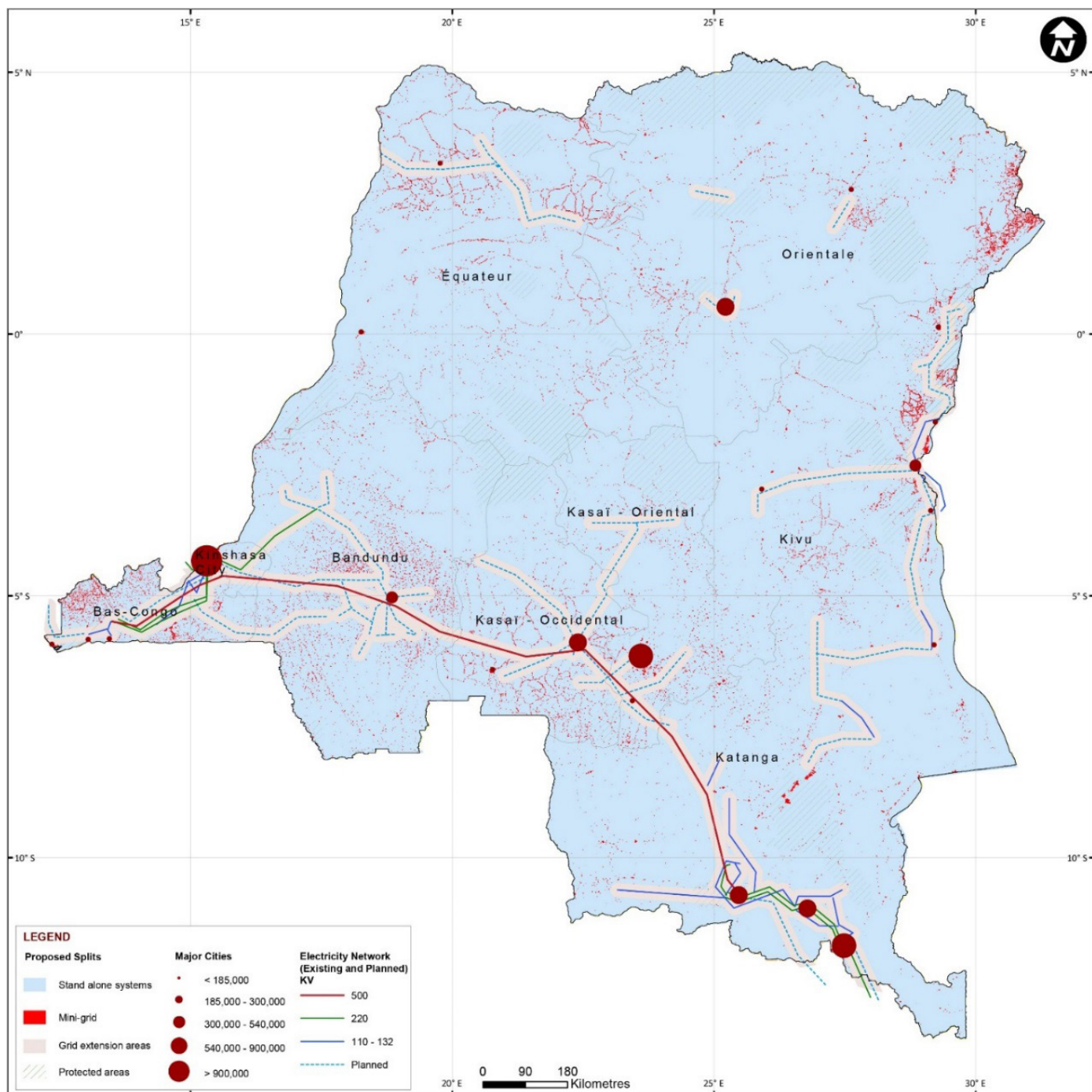
Source: East View Geospatial 2015, SNEL, Carbon Trust analysis

Based on current grid coverage this analysis estimates an annual potential market of US\$ 921 million for mini-grid and off-grid solutions.¹⁰ This assumes that 61 million people are connected to mini-grid and off-grid solutions. The potential market size may be even larger as modern decentralized solutions may also be feasible in areas within grid proximity where population centres close to the grid are not yet electrified due to limitations of the national power network

10 World Bank Global Consumption Database. The data is from 2010 in USD. A nominal 2010-2016 GDP growth rate from the IMF has been applied to calculate a 2016 approximation.

assets. The same analysis conducted taking into account the planned grid extensions scenario, yields an annual market size of 47 million people, representing US\$721 million per year. Table 1 details the estimated annual market size for off-grid solutions against two scenarios: the current grid only and the current and planned grid.

Figure 3: Potential areas for mini-grids and standalone systems based on population density



Source: East View Geospatial 2015, SNEL, Carbon Trust analysis

Table 1. Estimated annual household market size for mini-grid and off-grid solutions¹¹

Province	Population living in grid areas (in million)	Population living in mini-grid and off-grid areas (in million)	Mini and off-grid market size (US\$ million)
Scenario 1. Existing Grid			
Bas-Uele	-	1.3	19.8
Equateur	-	1.6	24.3
Haut-Katanga	1.8	0.9	13.7
Haut-Lomami	0.2	1.5	22.8
Haut-Uele	-	2.2	33.5
Ituri	-	4.2	63.9
Kasai	0.2	2.6	39.5
Kasai-Central	0.6	2.9	44.1
Kasai-Oriental	0.0	2.9	44.1
Kinshasa	8.4	0.7	10.6
Kongo-Central	2.1	3.2	48.7
Kwango	0.2	2.0	30.4
Kwilu	1.7	4.0	60.8
Lomami	0.4	1.9	28.9
Lualaba	0.7	0.8	12.2
Mai-Ndombe	0.0	1.9	28.9
Maniema	-	2.4	36.5
Mongala	-	1.8	27.4
Nord-Kivu	0.6	6.2	94.3
Nord-Ubangi	-	1.3	19.8
Sankuru	-	2.0	30.4
Sud-Kivu	1.5	3.7	56.3
Sud-Ubangi	-	2.6	39.5
Tanganyika	0.2	1.6	24.3
Tshopo	-	2.7	41.1
Tshuapa	-	1.7	25.8
TOTAL	18.8	6.1	921

Source: Carbon Trust analysis, based on data from East View Geospatial 2015 and SNEL

11 Total market size is estimated based upon household energy market size. This assumes that 60% of household energy spend is on electricity, and that household spending comprises 60% of the total revenue of a mini-grid (when including revenue from businesses, public sector buildings and industrial users).

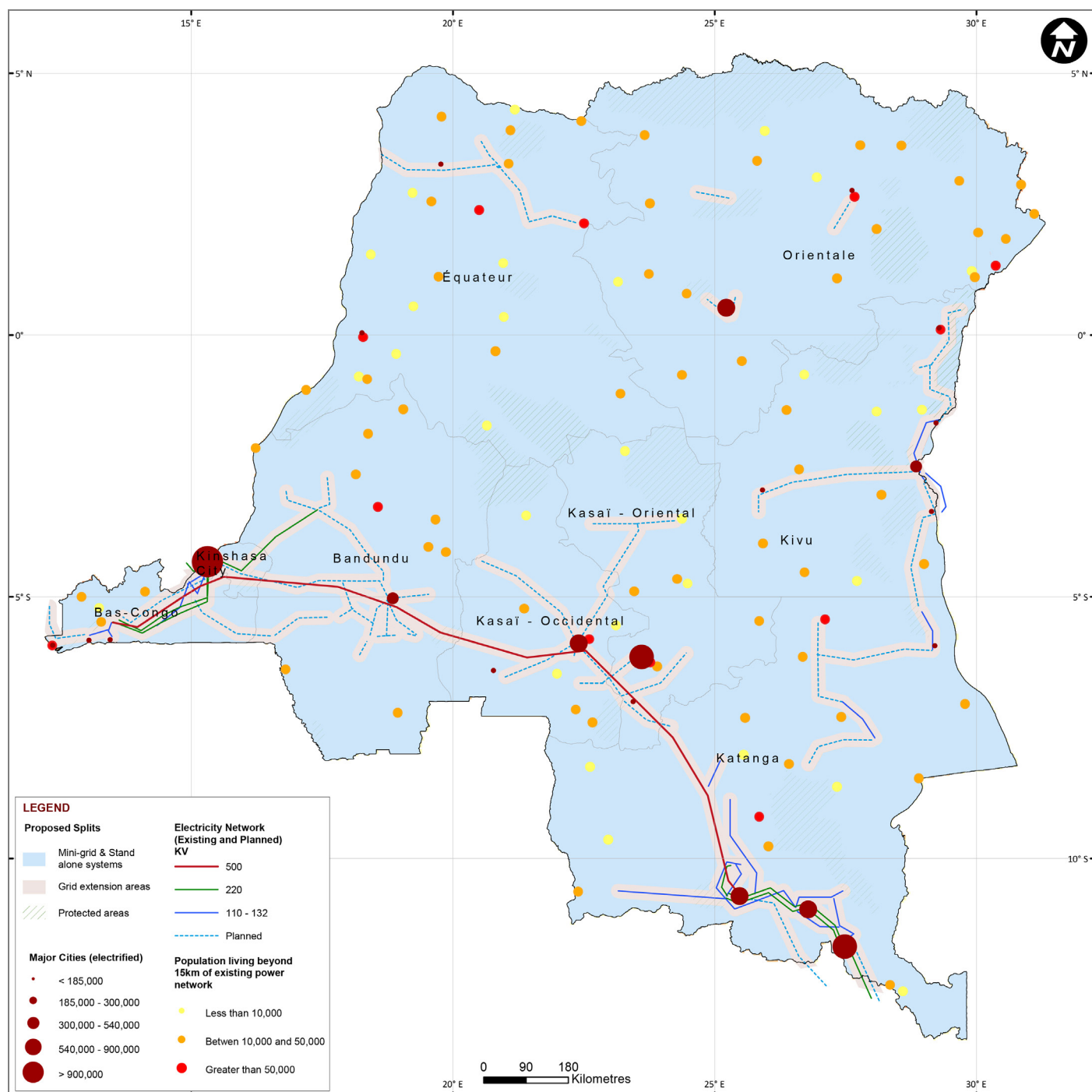
Table 1 continued

Province	Population living in grid areas (in million)	Population living in mini-grid and off-grid areas (in million)	Mini and off-grid market size (US\$ million)
Scenario 2. Existing and Planned Grid			
Bas-Uele	0.1	1.2	18.2
Equateur	-	1.6	24.3
Haut-Katanga	1.9	0.8	12.2
Haut-Lomami	0.3	1.4	21.3
Haut-Uele	0.1	2.0	30.4
Ituri	-	4.2	63.9
Kasai	0.7	2.2	33.5
Kasai-Central	1.7	1.7	25.8
Kasai-Oriental	0.9	1.9	28.9
Kinshasa	8.4	0.7	10.6
Kongo-Central	2.6	2.7	41.1
Kwango	0.5	1.7	25.8
Kwilu	3.2	2.4	36.5
Lomami	1.0	1.4	21.3
Lualaba	0.7	0.8	12.2
Mai-Ndombe	0.2	1.8	27.4
Maniema	0.4	2.0	30.4
Mongala	0.7	1.2	18.2
Nord-Kivu	2.5	4.4	66.9
Nord-Ubangi	0.3	1.0	15.2
Sankuru	0.5	1.5	22.8
Sud-Kivu	3.3	1.9	28.9
Sud-Ubangi	0.7	1.9	28.9
Tanganyika	0.5	1.3	19.8
Tshopo	0.8	1.9	28.9
Tshuapa	-	1.7	25.8
TOTAL	32.0	47	721

Source: Carbon Trust analysis, based on data from East View Geospatial 2015 and SNEL

The main cities across the country represent an obvious priority target for mini-grid solutions. This analysis identified and reviewed the main 170 population centres in the country, with a total population of about 31 million people. Of these, some 20 million people live in 29 towns situated within 15km of the power network. The remaining 141 towns (Table 2) with a total population of about ten million people can be seen as primary targets for electrification through modern mini-grid solutions. When taking into account the planned grid extensions, the number of towns beyond the grid falls to 102 (Figure 4) with a population of approximately 4.4 million people.

Figure 4: Power grid and the main population centres beyond the existing and planned grid



Source: MONUSCO, SNEL, Carbon Trust analysis

The 141 main population centres situated beyond the current grid represent a theoretical mini-grid market of 10 million people, worth US\$153 million per year.¹² This is a first estimation and assumes that the entire population of these towns could be connected to mini-grids. The list includes towns that are served already by local diesel or hydro mini-grids. This is the case of towns such as Kisangani, Mbandaka, Moanda, Mokambo, and Uvira served in part by SNEL, and of towns such as Tshikapa served by independent mini-grid companies such as EDC. Many of these existing local grids are outdated and not operational. Taking into account the planned grid extension the market size falls to US\$67 million per year across the 102 towns identified.

Hydro and solar powered mini-grids have the largest potential to accelerate electrification rates. According to the data on hydro sites provided by the DRC's Renewable Energy Atlas, 51 of the 141 towns identified above are located within 20km of a potential hydro site. These towns, included in Table 2, have a total population of 2.7 million. The major one, Tshikapa is already being served by EDC through a hydro mini-grid, while others are being served by diesel mini-grids. These sites and towns could be primary targets for electrification through hydro powered mini-grids. An additional five towns located within 15km of the power grid are also within 20km of potential hydro sites. These sites, if developed, could supply power to existing communities and export any excess power to the grid.¹³

Table 2. Towns beyond grid proximity that are suitable candidates for mini-grids. (Towns highlighted in green are situated within 20km of a hydro site).

Province	Town	Population (2015)	Distance to nearest hydro site (KM)	Distance to nearest electricity transmission grid (KM)
Bas-Uele	Buta	74,000	18	685
	Aketi	56,000	26	748
	Bondo	26,000	18	853
	Bambesa*	21,000	20	660
	Poko	15,000	127	568
	Ango	12,000	18	706
Equateur	Mbandaka*	418,000	79	377
	Basankusu*	38,000	51	555
	Lukolela	21,000	10	254
	Isangi	16,000	94	295
	Bikoro	10,000	104	294
	Bomongo	7,000	21	551
	Bolomba	6,000	25	475
	Ingende	5,000	14	369
Haut-Katanga	Pweto	35,000	307	124
	Mokambo*	32,000	126	48
	Sakania*	14,000	152	68
	Mitwaba*	6,000	255	133
Haut-Lomami	Bukama*	97,000	172	61
	Mulongo	82,000	165	103
	Kaniama	74,000	163	19
	Kipamba	43,000	166	145
	Malemba-Nkulu*	40,000	168	134
	Kabongo	20,000	51	106
	Kole	6,000	128	51

12 World Bank Global Consumption Database. The data is from 2010 in USD. Nominal 2010-2016 GDP growth rates from the IMF were applied to calculate a 2016 approximation.

13 NB. A number of additional towns lie within 20 to 60km of a hydro site, but have not been short-listed for this exercise.

Haut-Uele	Isiro	235,000	66	501
	Watsa	43,000	19	505
	Dungu	38,000	1	584
	Wamba	25,000	17	422
	Niangara	19,000	13	602
Ituri	Bunia*	367,000	56	346
	Kituku	61,000	40	309
	Aru	42,000	2	524
	Mongbwalu*	42,000	34	403
	Djugu*	38,000	27	406
	Mahagi	26,000	4	476
	Irumu	15,000	26	321
Kasal	Tshikapa*	583,000	9	53
	Mweka	75,000	29	129
	Luebo	42,000	45	97
	Dekese	4,000	3	288
Kasal-Central	Kananga	1,145,000	38	15
	Kalonji	92,000	16	24
	Demba	29,000	43	54
	Mankanza	25,000	39	98
	Luiza	21,000	5	104
	Kazumba	6,000	5	42
	Dimbelenge	5,000	26	83
Kasal-Oriental	Tshilenge	107,000	98	80
	Miabi	73,000	55	53
	Katanda	39,000	114	84
Kongo-Central	Moanda*	118,000	468	81
	Kinzau-Vuete	24,000	365	20
	Luozi	18,000	285	53
	Seke-Banza	8,000	372	40
Kwango	Kenge	58,000	11	21
	Kasongo-Lunda	31,000	50	184
	Kahemba	25,000	8	192
	Popokabaka	17,000	16	119
	Feshi	10,000	11	129
Kwilu	Idiofa	81,000	73	58
	Bulungu	75,000	15	44
	Mangai	59,000	6	144
	Dibaya Lubue	51,000	34	153
	Masi-Manimba	42,000	8	16
	Gungu	32,000	25	27
	Bagata	26,000	4	34
Lomami	Mwene-Ditu	272,000	67	17
	Kabinda	201,000	142	154
	Lubao	35,000	102	241
Lualaba	Lubudi	30,000	130	53
	Dilolo	25,000	306	83
	Sandoa	14,000	263	110
	Kapanga	3,000	119	169

Mal-Ndombe	Ilebo	108,000	42	128
	Inongo	63,000	16	193
	Nioki	57,000	0	75
	Mushie	56,000	79	61
	Kutu	51,000	6	110
	Bolobo	43,000	46	180
	Oshwe	30,000	28	203
	Kiri	19,000	7	280
Maniema	Kindu*	215,000	2	332
	Kasongo*	75,000	11	259
	Kalima	66,000	21	246
	Punia*	25,000	4	285
	Kibombo	24,000	10	363
	Kabambare	14,000	3	150
	Lubutu	11,000	15	278
Mongala	Bumba	142,000	7	828
	Lisala	108,000	6	758
	Binga	89,000	97	720
	Bongandanga	5,000	61	653
Nord-Kivu	Butembo*	263,000	32	176
	Beni	129,000	9	224
	Katwa	82,000	13	190
	Rutshuru	76,000	129	60
	Kirumba	48,000	120	58
	Kayna	47,000	86	111
	Kanyabayonga	41,000	96	101
	Lubero	38,000	45	151
	Walikale	13,000	31	106
	Masisi	9,000	74	28
Nord-Ubangi	Gbadolite	68,000	35	900
	Businga	44,000	22	836
	Bosobolo	18,000	8	870
	Yakoma	16,000	2	972
	Mobayi-Mbongo	7,000	71	942
Sankuru	Lodja	84,000	184	295
	Lusambo	45,000	60	163
	Luhatahata	24,000	149	245
	Lomela	13,000	157	430
	Katako-Kombe	10,000	176	347
	Lubefu	3,000	165	254
Sud-Kivu	Shabunda	28,000	8	169
	Walungu	20,000	12	24
	Kamituga	18,000	15	95
	Fizi	17,000	11	100
Sud-Ubangi	Gemena	181,000	46	765
	Zongo	45,000	18	845
	Libenge	34,000	88	773
	Budjala	29,000	27	694
	Bokungu	11,000	31	748
	Kungu	11,000	7	699

Tanganyika	Kongolo	80,000	20	177
	Manono*	76,000	174	27
	Kabalo	75,000	80	117
	Moba*	75,000	185	133
	Nyunzu	57,000	91	126
	Lukula	43,000	109	124
Tshopo	Kisangani*	1,085,000	87	470
	Basoko	70,000	72	667
	Yangambi	57,000	24	576
	Opala	22,000	19	519
	Bafwasende	20,000	88	358
	Ubundu	19,000	18	411
	Yahuma	7,000	36	719
Tshuapa	Boende*	47,000	45	506
	Ikela	21,000	107	547
	Monkoto	12,000	9	402
	Befale	5,000	21	568
Total		141	10,070,000	

NB A number of these population centres have existing or decommissioned generation and distribution infrastructure serving, when operational, a small number of users. These are emboldened and marked with an asterisk (*).

Source: Carbon Trust analysis, based on data from UNDP Renewable Energy Atlas and MONUSCO

3.4 RENEWABLE ENERGY POTENTIAL FOR MINI-GRIDS

HYDRO

The DRC has 100GW of hydro potential (the greatest in Africa), of which only 2.5GW have been developed. Of this potential, 40GW are concentrated in the Inga Falls area, 140 miles southwest of Kinshasa. Two dams (Inga 1 and Inga 2) with a capacity of 351MW and 1,424MW were completed in 1972 and 1982. A third dam (Inga 3) with a potential of 4,500MW is at the developmental phase. Other existing major plants include Nseke (248.4MW), Nzilo (108MW), Zongo 1 (75MW), Mwadingusha (68MW), Ruzizi 1 and 2 (29.8MW and 44MW) and Koni (42MW). Most of these assets were built more than forty years ago and are running well below capacity due to lack of maintenance.

Hydro resources have significant potential to power mini-grids across the country. Several existing isolated mini-grids are hydro powered, such as the *Electricité du Congo* (EDC) grid in the city of Tshikapa (1.5MW), the Virunga SARL grids in Mutwanga (0.4MW) and Matebe (12.6MW), the *Société d'énergie du Kasai* (Enerka) grid in Mbuji-Mayi (18.48MW) and the *Société des Mines d'Or de Kilo-Moto* (SOKIMO) grid in Bunia and Mongbwalu (11MW). SNEL also operates two hydro mini-grids in the cities of Kindu and Kisangani. Nevertheless, most of the potential remains untapped.

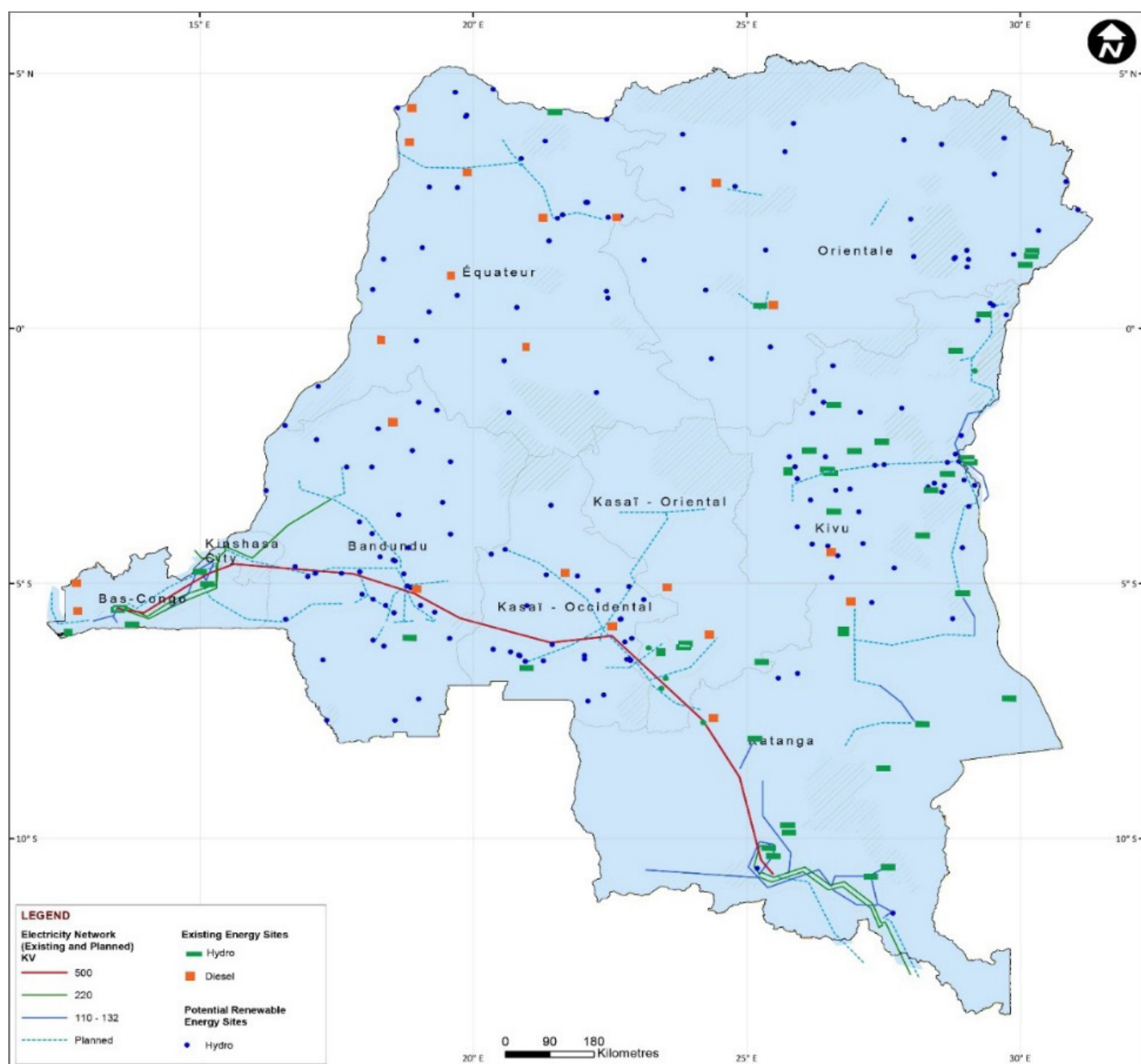
One hundred eighty-three (183) small hydro sites with a combined theoretical capacity of 1,110MW have been identified across 19 provinces. The United Nations Development Program (UNDP) produced a Renewable Energy Atlas in 2014 that identified 317 potential small hydro sites. Although data on location and estimated potential is incomplete, 183 sites across the country with a total potential of 1.1 GW were identified. Fifty-seven (57) sites with a potential of 165MW are located within 15km of the existing power network, and could contribute to develop the capacity and distribution network of the main grid. Beyond the 15km buffer, 126 sites with a potential of 945MW have been identified that could contribute to the development of hydro-based mini grids.

Table 3. Number of hydro sites and potential identified in the RE Atlas

PROVINCE	Potential within 15km buffer of existing network		Potential beyond 15km buffer of existing network		Total (Mw)
	Number of Sites	Potential (Mw)	Number of Sites	Potential (Mw)	
Bas-Uele			5	3.9	4
Equateur			7	156.0	156
Haut-Katanga	1	0.2			0
Haut-Lomami			2	0.3	0
Haut-Uele			5	62.3	62
Ituri			10	12.1	12
Kasai	1		13	10.1	10
Kasai-Central	4	16.8	11	6.7	23
Kwango	4	27.0	11	15.9	43
Kwilu	5	31.8	19	12.5	44
Lualaba	1	0.2			0
Mai-Ndombe			11	2.3	2
Maniema			21	371.5	371
Mongala			8	2.0	2
Nord-Kivu			5	15.9	16
Nord-Ubangi			8	36.4	36
Sud-Kivu	4	16.6	11	301.4	318
Sud-Ubangi			3	4.0	4
Tanganyika			2	0.3	0
Tshopo			5	0.0	0
Tshuapa			6	4.0	4
TOTAL	20	92.5	163	1,017	1,110

Source: UNDP RE Atlas, Carbon Trust analysis

Figure 5. Existing hydro and diesel sites and potential hydro sites



Source: UNDP RE Atlas, AfDB, SNEL, Carbon Trust analysis

BIOMASS

DRC has significant biomass resources, however it has experienced slow but steady deforestation over the last three decades. The FAO estimates that tropical rainforests cover 67% of the country's surface area, or 152,889,400 hectares (2014). This corresponds to 19.5 billion tonnes of living carbon stock, although other estimates suggest up to double this figure. However approximately two thirds of DRCs forests are primary forests, which need conserving as one of the most biodiverse habitats on Earth. Despite this significant resource, deforestation rates have remained consistently around 0.2% per year since the 1990s.¹⁴ While a lower percentage than South American rainforests, this corresponds to over 300,000 hectares every year.

¹⁴ FAO, The State of Forests in the Amazon Basin, Congo Basin and Southeast Asia, 2011

Domestic demand for traditional biomass as the primary source of energy is a primary cause of deforestation. Nationally, 95% of the population relies on traditional biomass for cooking.¹⁵ This biomass included mainly firewood and waste biomass in rural areas and charcoal in urban areas. Most fuelwood is burned in inefficient traditional three-stone cooking fires, leaving significant potential for the dissemination of efficient cook stoves. Significant deforestation is also caused by farming, mining, industrial activity and illegal logging. The DRC is host to a number of programmes tackling this issue, including the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) and the World Bank's Forest Improvement Programme.

DRC has solid potential for energy production from forestry and agricultural waste and methane, although no comprehensive studies exist. The DRC Renewable Energy Atlas provides high level estimates for land cover, distribution of crops, estimated energy from agricultural residue, livestock and biogas potential from livestock waste. On methane potential, Lake Kivu has an estimated 50 billion m³ of methane reserves. Agricultural waste has potential as well, with an estimated 25 million hectares of cultivated arable land in 2013 (FAO). Manioc is the primary crop, with maize, cassava, plantain and sugarcane also grown. Agriculture is generally dominated by subsistence production and characterised by low crop productivity, low diversification and limited participation of formal private businesses. Livestock waste is a further potential source of energy. A 2010 CIAT survey in Kivu, which has a population of approximately one million, showed that 25% of households had sufficient livestock for implementing a biogas digester.¹⁶ Utilisation of these sources however, is limited by poor distribution channels, a lack of existing waste collection mechanisms, a lack of technical expertise and low average household income relative to technology costs.

Despite the significant potential of biomass for power production, only three biomass projects have been identified. The SNV pilots a mini-grid COOP in Gemena, powered by four small diesel engines running on palm oil and providing electricity to 72 households (430 users). The Binga Crop Company – CCB (*Compagnie des Cultures de Binga*) runs a biomass power station fuelled by palm oil by-products in the city of Binga and finally the Kwilu-Ngongo Sugar Company (*Sucrierie Kwilu-Ngongo*) runs a 9MW biomass power station running on sugar bagasse in the city of Kwilu-Ngongo.

SOLAR

Solar energy is abundant in DRC with most potential in the south.¹⁷ Average daily irradiation ranges from 3.5 to 5.5 kWh/m². In the provinces with the highest irradiance such as Kwilu, Lomami, Haut-Lomami, Kasai-Oriental, Lualaba, Tanganyika and Haut-Katanga the average daily solar irradiance reaches 5kWh/m²/day and up to 6.75kWh/m².

Solar energy has not been tapped to supply the main grid, but offers significant potential to power mini-grids over the next few years. The main existing solar project is a 1MW hybrid plant developed by ENERKAC and powering SNEL's Kananga mini-grid in the Kasai Central province.¹⁸ The DFID Essor programme aims at promoting up to 33 solar mini-grids over the next five years. Each mini-grid is expected to provide electricity to between 100k and 300k people with an installed capacity of 3MW to 10MW. Candidate cities for electrification in the first phase of the programme include Bumba, Gemena, Isiro, Gandajika, and Ilebo.

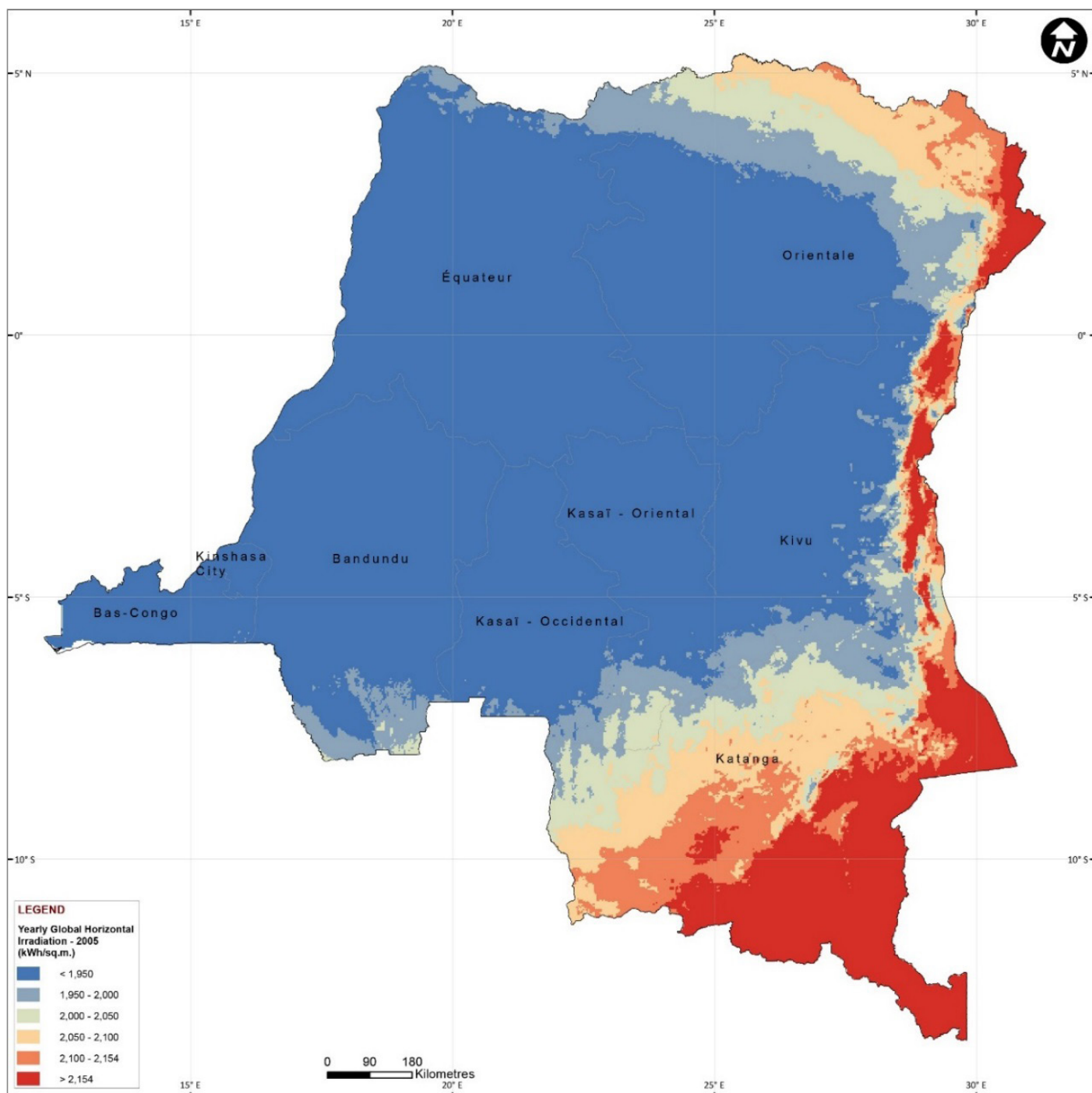
15 IEA, World Energy Outlook 2016 IEA

16 Diagnostic Survey of Livestock Production in South Kivu/DR Congo CIAT 2010

17 UN, SNV, SEforALL, 2014, Atlas des énergies renouvelables

18 Enerkac website

Figure 6. Yearly global horizontal irradiation



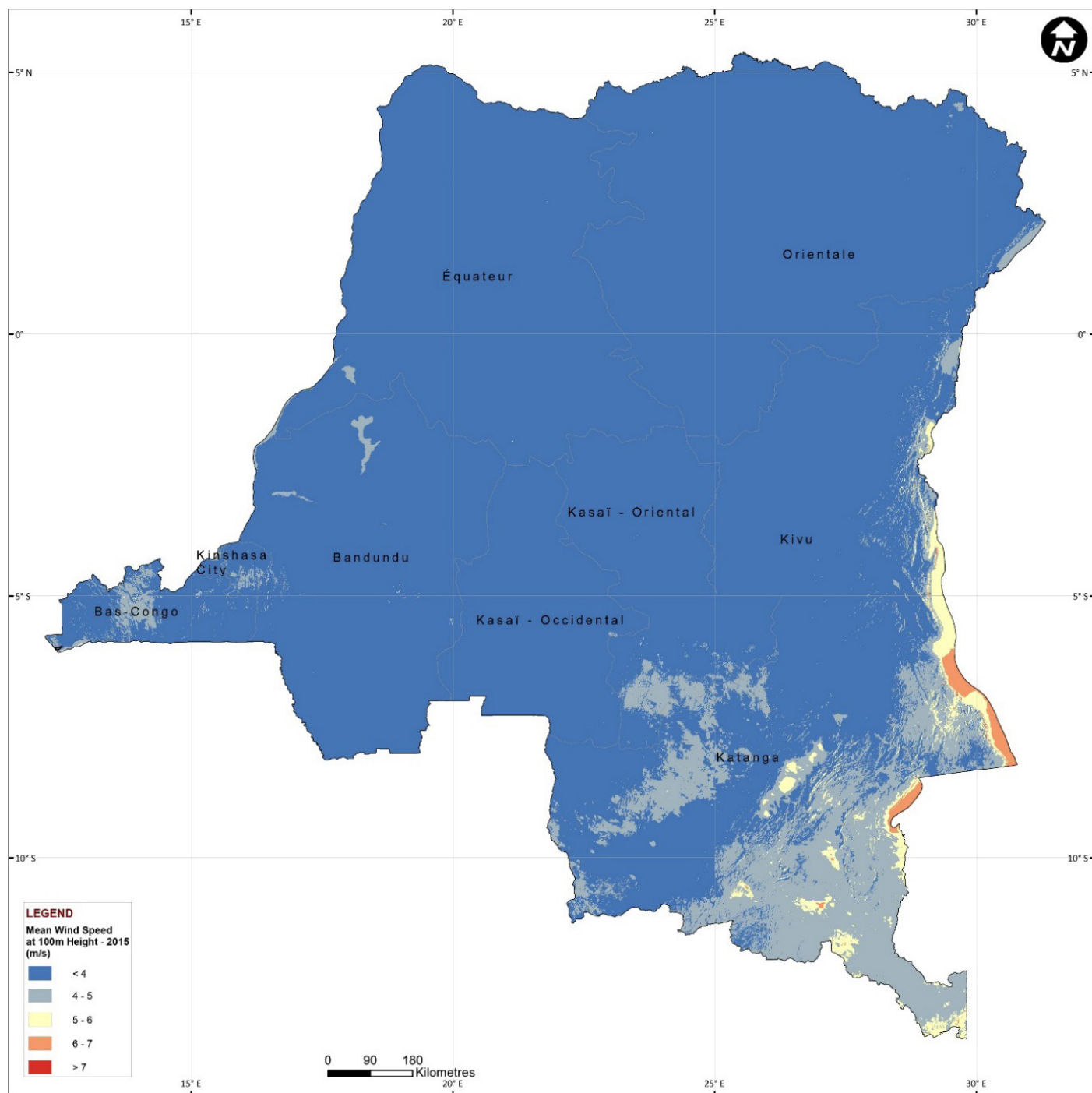
Source: DTU/IRENA.

OTHER RESOURCES

Wind potential is generally low. Wind resources have not been thoroughly assessed. Nevertheless, given the limited development of the grid and the availability of other energy sources wind is not considered an energy source with significant potential in the DRC. Existing high level estimates indicate wind speeds across the country of less than 4m/s although in the provinces of Katanga and Kasaï Oriental average wind speed can reach 6m/s. Existing wind turbines have only been used for water pumping.

Geothermal potential is high in the east of the country across the East African Rift. Significant geothermal potential has been identified in the Katanga and Kongo Central provinces but remains untapped.

Figure 7. Mean wind speed in DRC



Source: DTU/IRENA.

4. OVERVIEW OF THE ENERGY SECTOR

4.1 CURRENT CONTEXT AND OVERVIEW OF RESPONSIBILITIES

The electricity sector in DRC is characterised by low electrification rates and an underdeveloped and dysfunctional grid. While accurate energy access surveys do not exist, it is estimated that the electrification rate stands at around 9%.¹⁹ In other words, out of a population of 65.7 million, only 7.2 million have access to electricity. A significant portion of electricity consumers are connected illegally or to informal grids, with the national utility SNEL accounting for only 500,000 registered household connections. Total installed capacity amounts to 2.61 GW but only 1.13 GW are available as more than half of the existing hydro plants run under 50% capacity due to aging infrastructure and lack of maintenance.²⁰

SNEL has a long track record of operational and financial underperformance. SNEL reports that 95% of customers are unmetered. Together with a high rate of illegal connections and extremely low average electricity tariffs of 7c\$/kWh, amongst the lowest in Africa, they have suffered from continuous operating losses which amounted to US\$300 million in 2014. To address these performance problems and provide management and technical advisory services to SNEL, Manitoba Hydro International was recruited in 2015 with World Bank funding. This has included the preparation of a near-term recovery plan approved in 2016, which will require significant external funding to be implemented.

The Ministry of Energy and Hydraulic Resources (MERH) is the main authority in the electricity sector. In addition to overseeing SNEL, its responsibilities include planning, policy, and program development and oversight. Within the Ministry, the Unit for the Management and Coordination of the Ministry's projects (UCM) is in charge of supervising, administering and coordinating MERH's electricity and water projects. Its responsibilities include identifying renewable energy sites, selecting and preparing medium power plant projects for Public-Private Partnerships (PPP), analysing the regulations for the project's realisation and coordinating donor financing. The National Energy Commission (CNE) collects data and carries out research on the Energy Minister's request to inform energy policy. The National Investment Promotion Agency (ANAPI) promotes and facilitates investment opportunities including those in the energy sector.

The Electricity Law 2014 opened the power sector up to private operators. The Law removed SNEL's monopoly status and laid the foundations of a new legal framework to promote public-private partnerships and private investments. However, three years later, no procedures and guidelines to obtain concessions, leases, or management contracts have been developed. Despite the incomplete legal framework, some independent power companies have implemented pilot projects, building or rehabilitating plants and mini-grids and operating generation and distribution ventures. EDC has 10,000 customers in Tshikapa, Virunga SARL has 5,000 clients in Mutwanga and Matebe and Enerkac supplies the city of Kananga. These old pilot projects have benefited from sizable grant funding from the EU-Africa Infrastructure Trust Fund (EU-AITF), the World Bank, the Commonwealth Development Corporation (CDC), the Howard G. Buffet foundation and the Development Bank of South Africa (DBSA).

The 2014 Electricity Law also reviewed the institutional framework, creating new agencies and transferring power to the provincial authorities. The Law foresees the creation of two new agencies, the Electricity Regulation Authority (ARE) and the National Agency for the Electrification of Rural and Peri-urban areas (ANSER), but neither are operational yet. ARE's foreseen main responsibilities include resolving stakeholder disputes, ensuring fair competition, supporting the tendering of power projects and ensuring that tariffs submitted by operators follow specific rules and guidelines reflecting the cost structure of the project. ANSER's main responsibility will be to promote planning and financing of rural and peri-urban electrification projects. The Law also transfers power to provincial governments, such as the ultimate responsibility of granting concessions for most generation and distribution projects.

¹⁹ ICF/USAID, 2017

²⁰ UN, SNV, SEforALL, 2014, Atlas des énergies renouvelables

4.2 POWER NETWORK AND INFRASTRUCTURE

Hydro is the main source of electricity, although only a small fraction of the potential has been developed. Hydro accounts for 2,563MW out of a total of 2,609MW of installed generation capacity. Nevertheless, only 1.13GW are actually available. SNEL operates most hydro plants in the country, including Inga 1 (351MW), Inga 2 (1424MW), Zongo 1 (75MW), Sanga (11.5MW), Mpozo (2.2MW) Nseke (248.4MW), Nzilo (108MW), Mwandingusha (68MW), Koni (42.1MW) and Ruzizi 1 (29.8MW). SINELAC owns and operates the 44MW Ruzizi 2 hydro plant. Other operators include private power producers, mini-grid operators and mining companies such as EDC, Virunga, Hydroforce and SOKIMO.

The total hydro potential, estimated at 100GW, would make the country, if developed, a continental powerhouse. The Grand Inga project has a potential of 40GW with an estimated generation cost of 3 cents per kWh, making it one of the cheapest possible sources of electricity in Africa. Some 4,800MW, corresponding to the Inga 3 hydro project, are currently at the development phase. South Africa and DRC have already signed a PPA for 2,500MW of Inga 3's capacity.²¹

The power transmission network is underdeveloped and fragmented, leaving most of the country in the dark. Despite being the biggest country in Africa, the DRC has only 4,600km of HV transmission lines. The transmission network is fragmented into three regional grids. The western grid covers the Central Congo and Kinshasa provinces, the eastern grid covers North Kivu and South Kivu provinces and the southern grid covers the Haut-Katanga and Lualaba provinces. The western and southern grids are connected through the Inga-Kolwezi link, a 1,700km 500kV transmission line connecting the Inga hydro plants to Katanga's mining district.

A sizeable informal electricity sector coexists alongside formal electricity providers. SNEL owns and operates most of the existing transmission and distribution network, but it has only 500,000 domestic customers, including those served through two hydro and nine diesel mini-grids. The actual number of users could, nevertheless, be significantly higher given that an estimated three to five households informally connect to each formal customer. This practice is favoured by the fact that about 95 percent of SNEL customers are unmetered and are charged a flat monthly fee. In several towns, power is supplied by few formal independent power companies such as EDC in Tshikapa, Virunga SARL in Mutwanga and Matebe, Enerka in Mbuji-Mayi, but also by mining companies such as SOKIMO (connecting local communities as part of community engagement initiatives) and faith-based and nongovernmental organizations (NGOs). Nevertheless, in many others such as the city of Gemena with 300,000 inhabitants, most of the electrified population gains access to electricity through the informal sector.

4.3 SUPPORT FOR RENEWABLE ENERGY

Large hydro projects have attracted the majority of funding to the energy sector. Multiple large hydro projects are at the development and construction stages and have attracted significant funding. The African Development Bank (AfDB) and the World Bank (WB) have provided a US\$377 million grant for the rehabilitation of Inga 1 and Inga 2, a US\$68 million grant for the development of the Inga 3 hydro plant, a US\$106.5 million technical assistance (TA) grant for the creation of the Grand Inga Development Authority and other medium scale hydro projects.²² The EU-AITF has provided grants worth €3 million and €11 million for the rehabilitation of the Ruzizi 1 and Ruzizi 2 hydro plants. Additional funds were provided by KfW, AFD and EIB. The 147MW Ruzizi 3 hydro plant, with a required investment of US\$652 million has received funding from AfDB, EIB, WB, EU, AFD, and KfW.²³ The China's Export-Import (EXIM) bank has provided US\$360 million in credit for the development of the 150MW Zongo 2 hydro plant to be built by SINOHYDRO. India's EXIM bank has provided lines of credit worth US\$168 million, US\$82 million and US\$109.9 million for the development of the 64MW Katende hydro plant and associated transmission and distribution lines. SINOHYDRO Corp. and China Railway Group Ltd. have committed US\$660 million to the construction of the 240MW Busanga hydro plant in Katanga province.

21 IHA, 2015, Democratic Republic of the Congo

22 IHA, 2015, Democratic Republic of the Congo

23 AfDB, Multinational Ruzizi III regional hydropower plant appraisal report

A few smaller scale hydro projects have come on-line in recent years promoted by mini-grid operators and IPPs.

Randgold commissioned the 22MW Nzoro 2 and 10.8MW Ambarau (Kibali 1) hydro plants in 2014 and 2017 and plans to commission the 10MW Azambi (Kibali 2) hydro plant during Q3 of 2018 to supply power to the Kibali gold mine. Virunga SARL commissioned the 12.6MW Matebe hydro plant in 2015 to supply electricity to the surrounding area and to supply Goma in the future. The project has received funding from the EU and the Howard G. Buffett foundation. The government commissioned the 9.3MW Kakobola plant in 2016 to supply electricity to Kikwit, Gungu and Idiofa, a project that received a US\$76.5 million loan from India's EXIM bank. Hydroforce owns and operates a 1MW hydro plant supplying electricity to the city of Kananga through SNEL's grid. EDC plans to commission the 10MW Lugundi 2 hydro plant to supply additional connections in Tshikapa and Enerkac plans to develop the 7.5MW Tshibuyia hydro plant.

The UNDP produced the 2014 Renewable Energy Atlas mapping the country's potential renewable energy sites.

The RE Atlas, completed with support from SNV, reviews the potential of renewable energy in the country, with a focus on hydro. The Atlas identifies 317 potential hydro sites and estimates the power potential of 156 sites with a combined capacity of 1.5GW. The Atlas includes also geographic coordinates for 195 sites.

4.4 OFF-GRID DEVELOPMENTS AND SUPPORT FOR ENERGY ACCESS

The MERH's Modern Villages programme aims to electrify 100 villages using hydro GMGs, but implementation is slow.

The Ministry aims to electrify target villages with hydro powered mini-grids. The Ngula and Kimbau villages in the old Bandundu province have been electrified under this programme.²⁴ The MERH has identified an additional seven villages to be electrified, namely the villages of Muluma, Mukoso, Fatundu, Kipuka, Mundundu, Kiefu and Mongobebe.

The opening up of the power generation and distribution sectors to private operators has been a remarkable achievement of the 2014 Electricity Law.

Several independent mini-grids have come on-line in relation to the development of the electricity law. Virunga SARL operates the 400 kW Mutwanga and 12.6MW Matebe hydro plants serving 5,000 customers. EDC rehabilitated the 1.5MW Lugundi hydro plant and supplies electricity to 10,000 clients in the city of Tshikapa. The company plans to build the 10MW Lugundi 2 hydro plant to serve an additional 10,000²⁵ clients. Enerkac has developed a 1MW hybrid production plant to supply power to SNEL's Kananga mini-grid. In addition, SNV is implementing a pilot mini-grid project in Gemena. The project is promoting a local cooperative to operate a local mini grid powered by four diesel engines adapted to run on palm oil that will supply electricity to 72 households.

These projects have benefited from significant donor support. The EU financed 80% of the 400kW Virunga hydro plant in Mutwanga and provided US\$2.5 million in TA for the 12.6MW hydro plant in Matebe. The latter was financed by the Howard G. Buffett foundation.²⁶ In 2016, the CDC invested US\$2.5 million in debt in Virunga for the expansion of Matebe's plant distribution grid and is expected to invest a further US\$6.5 million in debt for the construction of additional mini-grids in Lubero and Beni or Rutshuru.²⁷ *Energie du Nord Kivu* has received support from the WB and the DBSA for their mini-grid project.

Mining companies such as the *Société des mines d'or de Kilo-Moto (SOKIMO)* and *Société Minière de Bakwanga (MIBA)* own hydro plants and inject excess energy in local grids. SOKIMO, the government-owned gold mining company, has developed the 11MW Budana hydro plant through its subsidiary and distributes electricity to the city of Bunia and Mongbwalu. *The Société d'énergie du Kasai (Enerka)* operates MIBA's 18.48MW Tshiala hydro site, comprising three hydro plants, namely the 1.4MW Tshiala 1, 7MW Lubilanji 1 and 10.08MW Lubilanji 2 hydro plants. It also distributes electricity to 1,700 clients in the city of Mbuji-Mayi in the Kasai Oriental province.²⁸ This site was operated by Hydroforce up to 2012.

²⁴ UN, SNV, SEforALL, 2014, Atlas des énergies renouvelables

²⁵ DFID Eссор, 2016, Access to Electricity Solar powered mini-grids in the DRC

²⁶ Meeting with European Delegation in DRC, 2017

²⁷ CDC Group, 2016, Press release: CDC investment brings electricity to Eastern

²⁸ Marge, 2016, Privately Run mini-grids

Additional green mini-grid projects are at the development stage. ENK plans to build and operate distribution grids in the cities of Beni and Butembo and a transport line between them to electrify 20,000 to 40,000 new clients. These grids will be powered by the 23MW Taliha and 2.3MW Ivugha hydro plants.²⁹ Enerdeal and Congo Energy are planning a 1MW solar mini-grid with 3MWh of battery storage capacity in the city of Manono, in the old Katanga province to supply the local population and SMEs.³⁰

Existing SNEL mini-grids offer additional opportunities for privatisation and rehabilitation. SNEL operates multiple 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.^{31 32 33} These mini-grids face serious operational problems due to lack of maintenance and the high price of diesel.

DFID and the World Bank are committing significant funding to further development of mini-grids over the next five years. DFID's £35 million Eссор programme plans to support the construction of 33 solar GMGs by 2021 through the "Access to Electricity" work stream. The programme aims to support projects to reach financial close and facilitate the tendering process. Funding is expected to be sourced from private investors and DFIs through a combination of financial instruments (grants, loans and equity). The projects are expected to be tendered out in groups, with the first bundle of three projects having a capacity of 3-10MW expected to be tendered in Q1 of 2018. These solar projects are expected to benefit from 15 to 20 year concessions. The cities of Bumba, Gemena, Isiro, Gandajika and Ilebo with populations between 124,000 and 260,000 people, solar irradiation between 5.27 kWh/m²/day and 6.2 kWh/m²/day and energy demands between 0.45MW and 5MW have been identified as priority targets. The WB's Energy Access & Services Expansion (EASE) programme, with a budget of US\$147 million, aims to electrify provincial capitals using GMGs. In addition, it aims to rehabilitate the Mobayi hydro plant and the Gbadolite grid. The programme will also support the creation of a Credit Support Facility (CSF), administered by a financial institution, and a Rural Electrification Fund (REF), administered by UCM and ANSER. These will provide much needed capital in the form of lines of credit, subsidies and grants for private rural electrification projects. There are four energy access projects that are most likely to receive funding, namely: (i) EDC's Tshikapa project to subsidize new client connection costs, (ii) Virunga SARLS's project to build additional hydro plants in the North Kivu province and subsidize connection costs, (iii) ENK's project to build the Beni and Butembo grids, and (iv) Enerkac's project for their Kananga hybrid plant.

Some incentives to the import of generation equipment were adopted in 2015. Import duties and VAT on equipment, tools and spare parts destined exclusively for the production of electricity have been removed for a period of four years. Projects not benefiting from the above can still benefit from tax and duty exonerations under the general investment code through the ANAPI.

4.5 CHALLENGES TO INCREASE THE UPTAKE OF GREEN MINI-GRIDS

Several factors render DRC a country with significant potential for green mini-grid development. The country is large, electrification rates are still low, energy demand is higher than supply and the hydro, solar and biomass energy potentials are significant. The government has reformed the electricity sector opening the sector up to private operators and transferring powers to the provinces. Donors such as the WB, AfDB, DFID and the EU are providing significant funding for the development of the sector.

However, DRC's political and business climate seriously reduce this potential. Armed conflicts in the north and the east of the country still lead to significant population displacements.³⁴ The November 2016 elections have been rescheduled for late 2017, causing additional political uncertainty and instability. DRC ranks 184 out of 190 economies included in the

29 DFID Eссор, 2016, Access to Electricity Solar powered mini-grids in the DRC

30 Enerdeal, 2016

31 SNEL, 2017, Rural Electrification Department

32 ReliefWeb, 2002, DRC: ICRC helps ensure safe water and electricity for Kisangani

33 SNEL, 2017, Rural Electrification Department

34 CIA World Factbook

World Bank Group's 2017 Doing Business Report, and 156 out of 176 on its anti-corruption indicator. Low salaries in the public sector are one reason for mass corruption.³⁵ Access to financing, inadequate supply of infrastructure and tax rates are also important concerns for business executives.³⁶ In addition, the visa requirements are lengthy and burdensome, discouraging business travel and prospective investments.

The energy sector faces additional problems with a weak and non-operational institutional framework, insufficient capacity and lack of information and data. The ARE and ANSER were created by decree but are not operational yet. The responsibilities of some public stakeholders overlap, as for example for SENEN and ANSER. There is a lack of administrative capacity and skilled labour capable of maintaining and operating mini-grids. Information and data is hard to find or is inconsistent.

35 Transparency International, 2013, Overview of corruption and anti-corruption in the DRC

36 World Economic Forum, 2016

5. REGULATORY FRAMEWORK FOR MINI-GRIDS

5.1 REGULATORY AND POLICY ENVIRONMENT: MAIN TAKEAWAYS

Table 4. Summary of the DRC's regulatory and policy environment

	Enabling Factors for the development of clean energy mini-grids	Limiting Factors for the development of clean energy mini-grids
Planning and institutional setting	<ul style="list-style-type: none"> Private sector is allowed to operate in the energy sector. Some private sector led mini-grids are operational. The 2014 Energy Law aims to foster private investment and streamline administrative processes by transferring responsibilities to provincial governments. 	<ul style="list-style-type: none"> Complex institutional setting, with multiple agencies involved in planning and delivery including at the provincial and central government levels. Limited planning capabilities hamper development of nation-wide electrification strategies.
Data availability	<ul style="list-style-type: none"> A Renewable Energy Atlas for DRC was produced in 2014 by UNDP and is currently being updated. The Atlas is available in PDF format online. 	<ul style="list-style-type: none"> The information contained in the RE Atlas is not made available in any GIS-friendly format. Many ministries and agencies do not have a website and relevant sector information is not available online.
Licensing	<ul style="list-style-type: none"> Private operators can build and operate mini-grids, subject to a government concession. 	<ul style="list-style-type: none"> According to the electricity law 2014 all transmission and distribution activities require a concession, which in the case of local projects are granted by the provincial authorities. No provisions are made to streamline the installation of small rural mini-grids. Concessions must be object of public tenders, limiting the ability of new entrants to deploy small-mini grids in rural areas.
Tariffs	<ul style="list-style-type: none"> Mini-grid operators can propose tariffs that guarantee an appropriate return, but these are subject to government approval. Existing mini-grids are charging tariffs that are significantly higher (32 to 48 c\$/kWh) than those of the national utility (7 c\$/kWh). 	
Subsidies and incentives	<ul style="list-style-type: none"> Import duties and Valued Added Tax (VAT) have been lifted for generation equipment including renewable generation. 	<ul style="list-style-type: none"> No specific incentives for mini-grid projects exist.
Power purchase agreements	<ul style="list-style-type: none"> There is limited experience with PPAs for small scale plants. Hydroforce and Enerkac sell electricity to the SNEL in Kananga. 	<ul style="list-style-type: none"> Standard PPAs and provisions for green generation projects do not exist.
Arrival of the grid	<ul style="list-style-type: none"> Mini-grids are subject to government concessions of up to 30 years. Most of the country is not covered by the national grid and will remain so for the foreseeable future. 	<ul style="list-style-type: none"> No provisions exist specifically protecting mini-grids from the arrival of the main grid.

	Enabling Factors for the development of clean energy mini-grids	Limiting Factors for the development of clean energy mini-grids
Technical rules	<ul style="list-style-type: none"> There are general norms and standards to be respected for any electricity project. 	<ul style="list-style-type: none"> The general norms and standards are appropriate for utility-scale mini-grids, but are too stringent and limit the potential activities of modern mini-grid companies targeting rural areas.
Mobile services	<ul style="list-style-type: none"> Mobile money service is available through various operators. 	<ul style="list-style-type: none"> Mobile coverage must be strengthened.

5.2 THE MINI-GRID POLICY AND REGULATORY ENVIRONMENT

PLANNING AND INSTITUTIONAL SETTING

The 2014 Electricity Law was designed with the objective of fostering private investment in the electricity sector. The 2014 law opened the door for the private sector to operate in all segments of the electricity sector. SNEL remains the main player in the power sector accounting for the majority of the country's generation capacity and its three legacy grids. But several other companies operate generation and distribution facilities across the country. Virunga operates two hydro plants in the communities of Mutwanga and Matebe. SOKIMO developed the Budana hydro plant in the cities of Bunia and Mongbwalu. Enerka operates the Tshiala hydro plant and supplies electricity to the city of Mbuji-Mayi. Enerkac has developed a solar/diesel plant in Kananga. And, EDC has rehabilitated and operates the Lugundi 1 hydro plant in the city of Tshikapa.

The institutional setting remains relatively complex involving multiple parties. According to the 2014 Law, the electricity sector involves both central and provincial governments. MERH is responsible for the sector's oversight, including overseeing SNEL, the national utility. In addition, the Law mandates the creation of two national agencies, ARE, the electricity sector regulator, and ANSER, a rural electrification agency. Neither of these two agencies are operational, but they are expected to play a significant role in the development of mini-grids. ARE will have the responsibility to draft the specifications for generation and distribution projects to be tendered and to review and authorise new electricity tariffs proposed by any operator in the sector. ANSER will promote and finance rural and peri-urban electrification. Concessions for generation and distribution projects are ultimately granted by the provincial governments, unless projects cover two or more provinces, in which case concessions are granted by the central government. Nevertheless, the central government agencies are always to be involved in the design and implementation of the tendering process. Other relevant agencies include the National Energy Commission (CNE), which advises the Ministry of Energy and the National Investment Promotion Agency (ANAPI) with the mandate to promote and facilitate investments in the country.

The country lacks a nation-wide 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 limited technical and financial capabilities. Current electrification plans are either related to big generation projects such as Inga 3 and Ruzizi 3 or aim at the development of local grids. The WB-funded EASE programme and the DFID-funded Essor programme, for instance, aim at promoting the electrification of all provincial capitals and other major population centres through local hydro and hybrid mini grids.

DATA AVAILABILITY

Limited data exists and is made available to potential project developers. Limited data exists and is made available on-line to potential project developers, regarding DRC, the electricity sector, stakeholders and relevant regulations. The Renewable Energy Atlas was completed in 2014 by UNDP, the MERH and SNV and is currently being updated. The 2014 Atlas is available for download in PDF format on the UNDP website. Nevertheless, raw data is not provided, limiting its potential uses. The only relevant law or regulation on the electricity sector available online is the 2014 law through the Leganet website. The MERH and other public organisations 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 centres) would be extremely useful.

LICENCING

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. The Law requires that power distributors of any scale operating in the public domain obtain a concession, lasting up to 30 years, through a tender process to be coordinated by ARE. The ultimate responsibility in granting the concession for most power projects has been transferred to the provincial governments. 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 to promote small scale rural mini-grids. Given the contribution 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.

There is a significant informal electricity sector providing services to population centres. Despite sometimes stringent regulations, a wide range of parties is providing energy services across the country, oftentimes through informal networks escaping government oversight. Energy service providers include, in addition to private companies described above, mining companies involved in community outreach projects, as well as faith-based and non-governmental organizations (NGOs). In a city like Gemena with 300,000 inhabitants, most of the electrified population gains access to electricity 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 are at only 7c\$/kWh, but mini-grids are not bound by this low threshold. Developers can propose tariffs that reflect the cost structure incurred by the operator, following the guidelines and rules elaborated by the regulator. Tariffs must be approved by the MERH and the Ministry of Economy after having been reviewed by the regulator. SNEL reportedly applies tariffs ranging from 32 to 40 c\$/kWh for electricity from their diesel mini-grids and EDC applies a tariff of 48c\$/kWh at the Tshikapa mini-grid. Independent power producers such as Hydroforce and Enerkac in Kananga sell their electricity to the local grid for 31 c\$/kWh and 39 c\$/kWh respectively.

SUBSIDIES AND INCENTIVES

Support to mini-grids has mostly been provided by international donors and foundations. A rural electrification agency and a rural electrification fund are foreseen by the Electricity Law but they do not yet exist. Meanwhile, existing mini-grid developers have benefitted from grants and loans provided by donors and foundations through multi-country facilities. Two new programmes funded by DFID (Essor) and the WB (EASE) are expected to provide additional funding to mini-grid projects over the next five years.

In the absence of other incentives, the government has removed import duties and VAT on generation equipment. Import duties and VAT on equipment, tools and spare parts destined exclusively for the production of electricity were lifted in 2015 for a duration of four years. Projects not benefiting from the above can still benefit from tax and duties exonerations under the general investment code through the ANAPI.

POWER PURCHASE AGREEMENTS (PPA)

Standard PPAs for small renewable energy projects do not exist. Nevertheless, some PPAs have been signed between SNEL and independent producers. Hydroforce and Enerkac, for instance, are selling to SNEL the electricity that they produce in Kananga.

ARRIVAL OF THE GRID

The law does not foresee the case where the main grid reaches mini-grids. The concession contracts can have a duration of up to 30 years, which should provide some security to mini-grid operators. The 2014 Law does not include any provisions on the arrival of the grid. The size of the country, the grid's limited reach and limited investments in transmission, nevertheless, are factors that limit the possibility of the national utility encroaching on mini-grid concessions.

TECHNICAL RULES

Mini-grid projects follow the general technical specifications for electricity projects. The technical specifications must be included in documents for any tender and any installation must respect the general norms and standards in the country. The specifications are appropriate for utility scale mini-grids but are too stringent and limit the potential activities of modern mini-grid companies targeting rural areas with their own ready-to-deploy infrastructure.

MOBILE SERVICES

Mobile phone ownership is common, multiple mobile services providers exist but PAYG services are not well developed. 55.7 % of the population owns at least one SIM card, while only 11% of the population has an account at a financial institution. There are five mobile service providers in DRC, including Airtel, Vodacom, Tigo, Orange and Africell. Airtel Money, Vodacom M-Pesa, Tigo Cash and Orange Money can be used to store or transfer money to other people and pay bills. One off-grid company, BBOX, provides PAYG services. The GSM network needs to be strengthened for mobile money services to spread.³⁷

5.3 ENERGY SECTOR POLICY AND REGULATORY FRAMEWORK

NATIONAL SEforALL-DRC GAP ANALYSIS, August 2013

https://www.SEforALLafrica.org/fileadmin/uploads/SEforALL/Documents/Country_RAGAs/Democratic_Republic_of_Congo_FR_Released.pdf

https://www.SEforALL-africa.org/fileadmin/uploads/SEforALL/Documents/Abidjan_workshop_2016/6_KABASELE_RDC.pdf

The National SEforALL-DRC Gap Analysis assesses the current country situation and the gaps to be bridged to achieve the 2030 objectives. These include a 100% electrification rate for a projected population of 143 million people. It defines the programmes that need to be implemented to meet the targets and estimates the costs related to these endeavours. Currently, the DRC has a Draft Action Agenda that has not yet been formally adopted by the government. If adopted an Investment Prospectus will be produced to bridge the gaps.

LAW N°14/011 of June the 17th, 2014

<http://leganet.cd/Legislation/Droit%20economique/Energie/Loi.14.011.17.06.2014.htm>

The 2014 Electricity Law opens the electricity sector up to private operators and foresees the creation of an electricity regulator and a rural electrification agency. It also grants the operators the freedom to set their tariffs subject to the regulator's approval.

37 GSMA, 2013, Mobile Money in the Democratic Republic of Congo

DECREE N°16/013 of April the 21st, 2016

The decree creates ARE, the regulator of the electricity sector and defines its mission, responsibilities, structure, financing, etc.

DECREE N°16/014 of April the 21st, 2016

The decree creates ANSER, the agency for the promotion of electrification and energy services in rural and peri-urban areas. It defines its mission, responsibilities, structure, financing etc.

A catalogue of other policies, including the main administrative and public laws, labour and company laws, can be found at <http://www.leganet.cd/index.htm> and <http://www.journalofficiel.cd/jordc/index.php>

5.4 INVESTMENT INCENTIVE POLICIES

DECREE N° 09/33 of August the 8th, 2009

<http://www.leganet.cd/Legislation/Droit%20economique/AidesPubliques/D.09.33.08.08.2009.htm>

The decree creates the National Agency for Investment Promotion – ANAPI (*Agence Nationale pour la promotion des investissements*) responsible for the promotion of investments and for the improvement of the business climate in DRC. Investment incentives under the general investment code are subject to ANAPI approval.

LAW N° 004/2002 of February the 21st, 2002

<http://www.leganet.cd/Legislation/Droit%20economique/Code%20d%27investissements.htm>

The Law establishes the new investment code in DRC. It defines conditions, rules and general incentives regarding investments made in the country.

LAW N° 13/005 of February the 11th, 2014

<http://www.leganet.cd/Legislation/Dfiscal/Loi13005.11.02.2014.htm>

The Law defines the regulatory framework of public-private partnerships (PPPs). It lays down the special provisions as well the regimes for PPPs.

DECREE N°15/009 of April the 28th, 2015

<https://investindrc.cd/fr/centre-d-informations/autres-textes-legaux?task=document.viewdoc&id=148>

The decree sets a special tax and duties regime for electricity production, import and export.

5.5 RECOMMENDATIONS

The DRC has made progress towards stimulating the market for mini-grids. Despite the low current rate of rural electrification, green energy mini-grids are seen as an opportunity to increase energy access and alleviate poverty. This opportunity is reflected in the ambitious targets set out in the SEforALL initiative.

A number of initiatives could contribute to the development and growth of clean mini-grids. There is a need to develop a single, coherent national rural electrification plan. Combined with greater availability of Geographic Information System (GIS) datasets, this would facilitate transparent and efficient electricity sector development. Accordingly, we offer the following, non-exhaustive, high-level policy recommendations to promote GMGs and private operators:

Policy and national electrification planning

- Eliminate responsibility overlaps for rural electrification and renewable energies;

- Improve the coordination between public bodies;
- Formally recognise the importance of mini-grids to the future development of the energy sector in policies, sector strategies and visions;
- Create a legal framework specific to GMGs;
- Streamline and standardise Environmental and Social Impact Assessments for GMGs to reduce compliance costs;
- Develop a simple, fast and transparent licensing process for mini-grids as well as the respective concession terms;
- Develop a transparent planning process to provide clarity over the current and future boundary between grid and off-grid areas;
- Promote longer-term, GIS-based electrification planning, including the regular publication of grid extension plans and schedules;
- Update and make GIS datasets freely available, including data on population and the grid network; and
- Consider creating fiscal incentives for GMGs to attract local and foreign investment.

Capacity and market development

- Promote capacity development of potential local mini-grid developers;
- Ensure all data contained in the RE Atlas developed by UNDP is made openly and freely available (including GIS data), as well as being updated at suitable intervals; and
- Support the development of mobile payment coverage and solutions.

Financing

- Increase the sustainability of SNEL by, amongst others, increasing the national electricity tariff. Sustainable profitability of SNEL is needed to effectively roll out access to energy programs; and
- Consider financing mechanisms to reduce the cost of access to electrification for poor communities, such as subsidising connection costs through a levy on grid tariffs.

The GMGs Market Development Programme could support the mini-grid sector in DRC through a number of initiatives. Of primary consideration to the programme is supporting the government in its transition towards implementation of GMGs and solar technologies as part of the national (and rural) electrification strategy. This includes policy and institutional support such as the development of a hydro and solar master plan, development and dissemination of GIS-based data, knowledge transfer and capacity development for financiers and supply chains. A number of potential support initiatives include:

- The review and improvement of the existing regulatory framework for mini-grids to reduce the requirements on small mini-grid projects;
- The development of GIS-based spatial planning processes, including working with local authorities to make more GIS data available; financing the refresh and open-source publication of existing GIS datasets;
- A series of capacity building programmes for cooperatives and mini-grids operators;
- The development of a comprehensive mobile and mobile money services coverage map for DRC (mobile money coverage is growing annually, so updates would be necessary for this resource to remain useful); and
- Work with financial institutions and other stakeholders to reduce investment risk.

6. MAIN STAKEHOLDERS

6.1 GOVERNMENT AND AGENCIES

The ministries in DRC and their responsibilities are listed in Order n° 15/015 of March the 21st 2015. The list of ministers was announced by the Prime Minister Samy Badibanga on December 12, 2016.³⁸

MINISTRY OF ENERGY AND HYDRAULIC RESSOURCES (MERH - MINISTÈRE DE L'ENERGIE ET DES RESSOURCES HYDRAULIQUES)

Contact: Mr. Pierre Anatole MATUSILA, Minister
Mr. Camille KABASELE DIKANGALA, Head of the Electricity Department

The MERH is responsible for the elaboration of the national energy strategy and the development of the production, transport and distribution infrastructure for water and electricity.

Other relevant ministries include:

- Ministry of Rural Development (*Ministère du Développement Rural*), Minister Martine NTUMBA BUKASA (Mrs.)
- Ministry of Environment and Sustainable Development (*Ministère de l'Environnement et Développement Durable*), Minister Atis KABONGO KALONJI (Mr.)
- Ministry of National Economy (*Ministère de l'Economie Nationale*), Minister Bahati LUKWEBE (Mr.)
- Ministry of Public Health (*Ministère de la Santé Publique*), Minister Ilunga KALENGA (Mr.)
- Ministry of Decentralisation and Customary Affairs (*Ministère de la Décentralisation et Affaires Coutumières*), Minister Montana MPUKU AUTAIN (Mr.)
- Ministry of Spatial and Urban Planning and Housing (*Ministère de l'Aménagement du Territoire, Urbanisme et Habitat*), Minister Zachée RUGABISHA (Mr.)
- Ministry of Industry (*Ministère de l'Industrie*), Minister Marcel ILUNGA LEHU (Mr.)

STATE PROVINCES

A non-exhaustive list of the governors of DRC's provinces can be found on the following website: <http://www.radiookapi.net/2016/03/26/actualite/politique/rdc-liste-de-nouveaux-gouverneurs-de-province-elus>

Since the establishment of the 2014 Electricity Law, the provinces have the ultimate responsibility of granting concessions for most energy projects.

NATIONAL ENERGY COMMISSION (CNE - COMMISSION NATIONALE DE L'ENERGIE)

Contact: Mr. Jean Pierre BEYOKO LOKU, Permanent Secretary

The CNE was created in 1981 by Order n°21/022 of the 14th of February of 1981. It performs studies and advises on the energy sector reporting to the Minister of Energy.

NATIONAL AGENCY FOR INVESTMENT PROMOTION (ANAPI - AGENCE NATIONALE POUR LA PROMOTION DES INVESTISSEMENTS)

Link: <https://www.investindrc.cd/>

38 Radio Okapi, 2016, RDC: Samy Badibanga publie son gouvernement

The agency is responsible for the promotion of investments and for the improvement of the business climate in DRC. It also provides support to investors to create a company in the country and information regarding investment incentives and legal regimes such as concessions.

UNIT FOR THE MANAGEMENT AND COORDINATION OF THE MINISTRY'S PROJECTS (UCM - UNITÉ DE COORDINATION ET DE MANAGEMENT DES PROJETS DU MINISTÈRE)

Contact: Mr. Maximilien Munga, Head
Email: info@ucmenergie-rdc.com
Link: <http://ucmenergie-rdc.com/>

Created by ministerial order n° CAB/MIN-ERH/058/2015 of October the 15th 2015, it is in charge of supervising, administrating and coordinating MERH's electricity and water projects. Its responsibilities include identifying renewable energy sites, selecting and preparing medium power plant projects for public-private partnerships, analysing the regulations for the project's realisation and coordinating donor financing.

ELECTRICITY SECTOR REGULATION AUTHORITY (ARE - AUTORITÉ DE RÉGULATION DU SECTEUR DE L'ÉLECTRICITÉ)

Created by decree n°16/013 of April the 21st of 2016, ARE's responsibilities are to: promote and ensure fair competition in the electricity sector; ensure the respect of all laws, norms and standards in the electricity sector by each stakeholder; and to resolve disputes and support provinces in drafting the documents for their tenders.

PREPARATORY COMMITTEE OF THE ARE (CPARE - COMITÉ PRÉPARATOIRE DE L'ARE)

Contact: M. Antoine KALONJI, coordinator
Email: antokalonji@yahoo.fr

The CPARE is a committee responsible for operationalising the ARE. Its tasks are, amongst others, to create ARE's processes and legal documents; establish the organisational structure; and hire initial personnel.

AGENCY FOR NATIONAL ELECTRIFICATION AND RURAL AND PERI-URBAN ENERGY SERVICES (ANSER - AGENCE NATIONALE DE L'ELECTRIFICATION ET DES SERVICES ENERGÉTIQUES EN MILIEU RURAL ET PÉRIURBAIN)

Created by decree n°16/014 of April the 21st of 2016, ANSER's mission is to promote and finance the electrification of rural and peri-urban areas. Its main responsibilities are to identify the national energy potential; elaborate a national electrification plan for rural and peri-urban areas to be integrated in the national electrification plan; search for financing for the various projects in the rural and peri-urban electrification programme; monitor progress with donors; and serve as an intermediary between operators and the state for the electrification programme. It is also responsible for soliciting state financing for rural projects.

PREPARATORY COMMITTEE OF THE ANSER (CPANSER - COMITÉ PRÉPARATOIRE DE L'ANSER)

Contact: Mr. Bienvenu MATENDA, coordinator
Email: matendabienvendu@gmail.com

The CPANSER is a committee responsible for operationalising the ANSER. Its tasks are amongst others to create ANSER's processes and legal documents; establish the organisational structure; and hire initial personnel.

NATIONAL SERVICE FOR NEW ENERGY (SENEN - SERVICE NATIONAL DES ENERGIES NOUVELLES)

Part of the Ministry for Rural Development, the SENEN is responsible for rural electrification projects in coordination with the Ministry of Energy and Hydraulic Resources.³⁹

39 Lighting Africa, 2012, Policy Report Note Democratic Republic of Congo

6.2 PROJECT DEVELOPERS AND MINI-GRID COMPANIES

NATIONAL ELECTRICITY UTILITY – SNEL (*SOCIÉTÉ NATIONALE D'ÉLECTRICITÉ*)

Contact: Mr. Lambert ENGWANDA, Rural Electrification Department

Email: engwandamong@gmail.com

Link: <http://www.snel.cd/>

SNEL is the state utility and main operator in the electricity sector. It is present in all the electricity segments and operates most of the country's assets. It also operates a large number of mini-grids, most of which are diesel powered.

INTERNATIONAL ELECTRICITY COMPANY OF THE GREAT LAKES COUNTRIES - SINELAC (*SOCIÉTÉ INTERNATIONALE D'ÉLECTRICITÉ DES PAYS DES GRANDS LACS*)

Link: <http://www.sinelac.org/>

SINELAC is the result of an international cooperation between DRC, Burundi and Rwanda. It owns and operates the 44MW Ruzizi 2 hydro plant and sells electricity to member countries' national grids.

VIRUNGA SARL

Contact: Mr. Ephrem BABOLA, Manager

Link: <https://virunga.org>

Virunga SARL reports to the Virunga National Park and the Virunga foundation. It developed the Mutwanga and Matebe hydro mini-grids in order to provide electricity to local communities. It plans to develop six new grids in the future.

COMPANY OF THE KILO-MOTO GOLD MINES (*SOKIMO - SOCIÉTÉ DES MINES D'OR DE KILO-MOTO*)

Link: <http://mines-rdc.cd/mines/main/main>

Sokimo is a state-owned gold mining company active in the Haut-Uélé province. It operates hydro plants for its own energy needs and injects the excess energy into a mini-grid in the city of Bunia and Mongbwalu.

HYDROFORCE / INFORINDUS

Contact: Mr. Pierre OUDART, Owner

Email: inforindus.rdc@gmail.com

Link: <http://www.inforindus.com>

Hydroforce/Inforindus is a project developer active in the water and electricity sectors. In addition to delivering energy installations for private companies, it operates a small hydro plant in Kananga selling electricity to SNEL and was also operating MIBA's Tshiala hydro site up to 2012.

STS

Link: <http://www.sts-rdc.com>

STS is a project developer in the electricity sector. Its subsidiaries Electricité Du Congo and Nord-Kivu Energy are operating in the mini-grid sector.

CONGO ELECTRICITY (*EDC - ÉLECTRICITÉ DU CONGO*)

Link: <http://www.edc-rdc.com>

EDC is a renewable energy project developer created by STS and Safricas (<http://www.safricas.com/>). It operates a hydro powered GMG in the city of Tshikapa.

NORD-KIVU ENERGY (ENK - ENERGIE DU NORD-KIVU)

ENK is a PPP between STS and the Nord-Kivu province developing the Taliha and Ivuha hydro plants, as well as the transport and distribution lines between and in the cities of Beni and Butembo.

ENERKAC

Link: <https://www.enerkac.com>

Enerkac, owned by Megatron Federal, STAR Group SARL and Kasai Central province owns and operates a 1MW solar and 2.25MW diesel hybrid plant in the city of Kananga in the Kasai Central province. The plant sells power to SNEL.

ENERDEAL

Link: <http://www.enerdeal.com>

Enerdeal is an on-grid and off-grid solar project developer. It recently partnered with the Group Forrest through its Congo Energy subsidiary to build a solar-diesel hybrid mini-grid in the Katanga region.

KASAI ENERGY COMPANY (ENERKA - SOCIÉTÉ D'ÉNERGIE DU KASAI)

Link: <http://enerka.org/>

Enerka is a private generator and distributor commercialising the electricity produced in MIBA's Tshiala hydro site to the city of Mbuji-Mayi.

6.3 BILATERAL AND MULTILATERAL DONOR ORGANISATIONS

RECONSTRUCTION CREDIT INSTITUTE (KfW - KREDITANSTALT FÜR WIEDERAUFBAU)

Contact: Mrs. Cathy MBUNGANI, Contact point

Link: <https://www.kfw-entwicklungsbank.de/International-financing/KfW-Development-Bank/Local-presence/Subsahara-Africa/Congo-D.R./>

On behalf of the German federal government, KfW supports long-term peace and reconstruction processes, for example by improving the water supply and basic sanitation, develops the financial sector and stimulates local business in DRC. It has provided funds for the Ruzizi 1, 2 and 3 projects and will build hydro plants to supply electricity to 19 REGIDESO water stations and the surrounding population using funds allocated by the German Federal Ministry of Economic Cooperation and Development.

WORLD BANK (WB)

Contact: Mr. Jose Francisco PEREZ CACERES, Energy Specialist

Email: jperezcaceres@worldbank.org

Link: <http://www.worldbank.org/en/country/drc>

The World Bank portfolio in the DRC consists of 29 active projects representing a total of US\$3.8 billion. This includes regional projects and projects under the Great Lakes Initiative. Projects in the power sector include the connection of the cities of Beni and Butembo and the Taliha hydro power plant in the North Kivu province, the rehabilitation of the Katanga-Inga T-line, the construction of a second Inga-Kinshasa T-line, the rehabilitation of some hydro groups at Inga 1 and Inga 2 plants, the restructuring of SNEL and the rehabilitation and reinforcement of SNEL's medium voltage/low voltage network in Kinshasa. In late 2013 and 2014, the African Development Bank - AfDB and the World Bank announced a combined US\$106.5 million initiative to create the Grand Inga Development Authority, to prepare the Inga 3 tender and other medium-size projects. In July 2016, the World Bank suspended its funding following the government of DRC's decision to follow a different strategic direction.

EU-AFRICA INFRASTRUCTURE TRUST FUND (EU-AITF)

Link: <http://www.eu-africa-infrastructure-tf.net>

The EU-AITF provides TA, grants and interest rate subsidies to energy, transport, water and ICT projects in SSA. It has provided grants for the Ruzizi 1 and Ruzizi 2 hydro plants and committed an additional grant for the Ruzizi 3 hydro plant project.

FRENCH DEVELOPMENT AGENCY (AFD – AGENCE FRANÇAISE DE DÉVELOPPEMENT)

Link: <http://www.afd.fr/home/pays-d-intervention-afd/afrique-sub-saharienne/pays-afrique/republique-democratique-du-congo>

The AFD follows DRC's governmental strategy of contributing to improved infrastructure, education, health, water and electricity access, housing and employment. It has provided funding for the Ruzizi 1, 2 and 3 hydro plants.

EUROPEAN INVESTMENT BANK (EIB)

Link: <http://www.eib.org/projects/regions/acp/index.htm>

The EIB's objective in Central Africa is to help generate long-term economic growth led by the private sector and reduce poverty. They have provided funds for the Ruzizi 1, 2 and 3 hydro plants.

DEVELOPMENT BANK OF SOUTH AFRICA (DBSA)

Link: <http://www.dbsa.org>

The DBSA has provided support for the rehabilitation of the Inga 2 plant and the reinforcement of SNEL's grid in Kinshasa as well as for the project connecting the cities of Beni and Butembo to the Taliha and Ivugha hydro plants in the North Kivu province.

UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)

Contact: Mr. Idesbald CHINAMULA, Programme Coordinator

Email: idesbald.chinamula@undp.org

Link: <http://www.cd.undp.org/content/rdc/en/home.html>

UNDP is promoting the use of renewable energies through the creation of the Renewable Energy Atlas that has identified potential renewable energy production sites all over the country. The Atlas was a joint effort with the SNV and the Ministry of Energy and MERH.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

Link: <http://www.unido.org/africa/offices/congo-democratic-republic-of-the.html>

UNIDO's mission is to promote and accelerate Inclusive and Sustainable Industrial Development (ISID) in developing countries and economies in transition. UNIDO has been working with provincial and district authorities to set up a one-stop shop to improve the local business and investment environment. However current instability has meant that future funds will be redirected from government support to project support only. This may provide a longer-term opportunity to support GMGs.

UK'S DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID)

Link: <https://www.gov.uk/government/world/organisations/dfid-drc>

DFID leads the UK's work to promote international development and poverty alleviation. DFID's Eссор programme focuses on business environment reform and anti-corruption. In DRC, it will support the construction of 33 solar GMGs up to 2021 through the "Access to Electricity" workstream by providing a one-stop shop tendering process for these projects. The CDC

runs the DFID Impact Programme to improve the access to affordable goods and services and promote income-generating opportunities. In addition, DFID funded the £50 million ELAN RDC programme to promote sustainable and inclusive economic development through private sector support.

AFRICAN DEVELOPMENT BANK (AFDB)

Contact: Mr. Sylvain MALIKO, Resident Representative

Email: s.maliko@afdb.org

Link: <https://www.afdb.org/en/countries/central-africa/democratic-republic-of-congo/>

AfDB's focus in DRC has been in providing TA for better governance and capacity and project financing for hydro projects. It has financed projects improving the electricity sector's governance through the "PAGASE" programme, funded the reinforcement and rehabilitation of the Inga 1 and Inga 2 plants, and transport and distribution lines through the "PMEDE" programme. It also provided US\$138 million in loans and grants for the development of the 147MW Ruzizi 3 hydro plant whose electricity will be partly fed to the EAPP. In late 2013 and 2014, the AfDB and the WB announced a joint US\$106.5 million TA project (US\$73.1 million from the World Bank) to create of the Grand Inga Development Authority, to prepare the Inga 3 tender and other medium-sized projects.

NETHERLANDS DEVELOPMENT ORGANISATION (SNV - *STICHTING NEDERLANDSE VRIJWILLIGERS*)

Contact: Mr. Piet VISSER, Project Manager

Email: pvisser@snv.org

Link: <http://www.snv.org/country/dr-congo>

The Dutch NGO SNV includes renewable energy as one of its key sectors of intervention in DRC. SNV tested a cooperative model for the production and distribution of electricity to a small neighbourhood of Gemena using palm oil. SNV also collaborated with UNDP to develop the Renewable Energy Atlas for DRC, which includes all known potential micro-hydro sites, and provides high level policy recommendations regarding the development of these sites.

INTERNATIONAL COMMITTEE OF THE RED CROSS (ICRC)

Link: <https://www.icrc.org/en/where-we-work/africa/democratic-republic-congo>

The ICRC has repaired the 18 MW Tshopo hydro plant to provide electricity to the city of Kisangani and its water treatment plant in Eastern DRC.

6.4 OTHER RELEVANT ORGANISATIONS AND INITIATIVES

HOWARD G. BUFFETT FOUNDATION

Link: <http://www.thehowardgbuffettfoundation.org/>

The foundation provided vital financing for the 12.6MW Matebe hydro plant in Virunga.

7. ANNEX. OBJECTIVES, SCOPE AND METHODOLOGY OF THE MARKET ASSESSMENT

7.1 OBJECTIVES OF THE MARKET ASSESSMENT

The objective of the GMG Africa Market Development Programme is to support the scale-up of investments in commercially viable GMG projects through a broad range of interventions to improve the enabling environment. The project seeks to remove or reduce market barriers at regional scale and strengthen the ecosystem for the emergence of a thriving GMG sector in Sub-Saharan Africa (SSA) contributing significantly to the objectives of the SEforALL initiative. The Market Intelligence business line supports activities that foster the ability of project developers, investors and public entities in identifying market opportunities for GMGs, facilitating a coherent national approach and supporting the linkages between central authorities, local/national businesses, investors and communities with demand for power.

7.2 SCOPE OF THE MARKET ASSESSMENT

This report is one of five country reports that together form part of the third deliverable for this project. All published deliverables will be available through the African Development Bank and other dissemination channels. As written in the original terms of reference, the project had three main deliverables:

D1 - An evaluation of the methodologies and best practices available for assessing GMG potential; D1 will analyse the methodologies currently utilised to assess the GMG potential with top-down approaches. The assessment will include data requirements, software requirement, robustness, handling of data paucity, quality of outputs, facility of use, openness of the system, interoperability with other planning tools, cost and any other specific strength or weakness. The Output of the D1 will be a report accompanied by an executive summary and a presentation or infographics.

D2 - Creation or choice of an opportunity assessment methodology in order to generate comparable data across countries, to the extent that is possible. On the basis of the methodological analysis made in D1, the consultant will present a methodology able to generate comparable data across countries. The methodology shall generate quality outputs, be robust, scalable, preferably based on open source or commonly used software and need only limited training. The output of the D2 will be a methodological paper or report and a presentation. If any new software tool will be developed to implement this methodology, it will have to be disseminated as open source.

D3 - The publication of country-level analysis on mini-grid market opportunities, initially focussing on at least five countries in SSA that are prioritising GMGs, generated with the above methodology. AfDB will provide the country list and will support the consultant to access country institutions, notably the SEforALL focal points, and national sources of data to apply the methodology. The D3 Output will be a report with the assessment for the five countries.

7.3 METHODOLOGY

This methodology was developed during the second phase of the Green Mini Grids Market Development Program - Market Intelligence business line, which is also available via the African Development Bank.

This analysis, whose results are given in section 2, considers the potential for mini-grids by segmenting the countries into two areas, grid and off-grid areas. This split is based on the distance of 15km from the power network. The planned power network for up to 2025 has been used. The GIS sources used in this analysis are detailed below.

POPULATION DENSITY

Source: World Pop, LandScan Global Population Database

POPULATION CENTRES

Source: MONUSCO

EXISTING AND PLANNED POWER GRID

Source: WB, SNEL

PROTECTED AREAS

Source: The World Database on Protected Areas, 2014

IDENTIFIED RENEWABLE SOURCES AND PROJECTS

Source: UNDP RE Atlas of DRC 2014

MEAN AVERAGE WIND SPEED

Source: DTU/IRENA, 2005

ANNUAL GLOBAL HORIZONTAL IRRADIATION

Source: DTU/IRENA, 2015

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