INCREASING ACCESS TO ELECTRICITY IN THE DEMOCRATIC REPUBLIC OF CONGO

OPPORTUNITIES AND CHALLENGES

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CONTENTS

LIST OF MAPS

LIST OF BOXES

LIST OF FIGURES

LIST OF TABLES

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INTRODUCTION

Photo : © Nuru

INTRODUCTION

The report explores the current state of the electricity sector in the DRC, including opportunities and challenges, and presents a set of recommendations, focusing on principles and priorities to proceed with future power sector development. It defines how these principles can be implemented in planning the sector development and identifies some of the investments required to move towards the goal of universal access to electricity. The note could contribute to the definition of a short and medium-term roadmap for the government and for donors.

The report builds upon the national dialogue on the future of DRC's power sector called 'Assises de l'Electricite' and which took place in Kinshasa in May 2018 under the Patronage of the Prime Minister. This forum gave the opportunity to private and public stakeholders from all the provinces to exchange ideas and experiences about the future of the DRC power sector and define the elements of a roadmap for the sector.

1. **The main priority for the Democratic Republic of Congo's power sector is to increase access to electricity.** The Democratic Republic of Congo is a large country with 10 million households of which 1.6 million have access to electricity. This makes it the third largest population in the world without access to electricity. If electrification efforts follow the same pace as during the last decade, 84 million people – or 80% of total population – will still live without electricity in the DRC by 2030.
2. **The well-distributed potential of both hydro and solar resources remains mainly untapped, as power sector development has focused on a few large hydropower plants over the last decades.** While these large hydropower facilities provide a clear majority of the electricity today, this strategy has resulted in (i) stagnant rate of population access to electricity and limited improvement in service reliability, and (ii) an estimated unmet demand of 5,000 GWh in 2018. In its latest design, the Inga 3 project would provide important export revenues for the government of DRC but is not a least-cost solution for expanding access to electricity in the country.
3. **The power sector development strategy must consider the very weak governance and high fragility context and focus on solutions adapted to this risky environment.** The DRC is the size of Western Europe with approximately as many paved roads as Luxemburg. Conflicts and guerillas still rage in several provinces causing high security risks and large population movements that make demand for electricity unpredictable. DRC's population is among the poorest in the world, often unable to afford the cost of connection to the grid. Technical solutions adapted to such a context include small and mid-sized hydro, solar and hybrid plants located near or within population centers, and a significant penetration of off-grid systems.
4. **The investment needs of the sector vastly exceed the government's fiscal capacity, and major efforts to attract private capital and operators are needed.** Providing all households of the 26 provincial capitals of DRC access to grid electricity through a mix of mid-sized hydro and solar power plants would cost approximately USD 10.5 billion in CAPEX. This would raise the access rate to about a third of the population, at a cost equivalent to 30% of GDP. While the USD 3.4 billion required in transmission and distribution networks could be taken up by public investment – at an annual cost of 5% of government budget from now to 2030. The remainder for generation activities would need to be commercially financed. The government needs to offer favorable investment conditions and create a transparent and stable regulatory environment.

5 **Supporting human capital development is critical to efficiently enforce policies and regulation, and to meet the employment needs of the sector.** At both central and provincial levels, public institutions do not have the capacity to screen, negotiate, secure and supervise public-private partnerships. An operational independent and well-resourced regulatory agency is a priority and will require significant capacity building. In addition, the education and training of engineers and technicians is essential to meet the need for technical skills from SNEL and other power sector players operating in the DRC.

6. **Off grid solar offers modular solutions to rapidly expand access at lower cost. The government can leverage a significant scale-up by improving the business environment and providing affordable financing.** Equipping

the remaining two third of the population with Tier 2 access to electricity through solar home systems comes with a much lower price tag, estimated at about USD 3.3 billion. Only a few private operators both local and international - have started to get into the DRC market. Government can help scale-up private investments by operationalizing the regulator and the rural electrification agency, reducing tax barriers, subsidizing hefty connection costs and easing access to finance.

7. **SNEL, the national utility, remains a critical contributor to electricity access, in particular in Kinshasa, but is caught in a vicious cycle of mounting commercial losses, deteriorating assets and mounting debt.** Courageous political decisions to adjust electricity tariffs and eliminate existing and accumulating arrears, as well as to complete the recovery plan of the utility are required to restore the utility's financial health and strengthen its position in a liberalized sector.

FOUR PRIORITY AREAS TO INCREASE ACCESS TO ELECTRICITY IN THE SHORT UN

1. STRENGTHEN THE INSTITUTIONAL AND REGULATORY FRAMEWORK TO ALLOW AN EFFECTIVE LIBERALIZATION OF THE DRC POWER SECTOR

Challenge: The 2014 liberalization law, the decentralization law, the law on public utilities' transformation, the State disengagement law and their respective secondary legislation have not been effectively enforced with the required institutional support to create an environment fostering both public and private sector investment.

Guiding principle: Enhancing collaboration and technical support of central authorities and provincial ministries of energy to (i) better align electrification strategies with local specificities, including opportunities, challenges and needs and (ii) transparently apply a robust set of regulations to allow the sector growth.

Top priority actions:

- Operationalize the energy regulator and the rural electrification agency to implement secondary regulation of the 2014 Liberalization Law and accelerate rural access (roadmap, human and financial resources, tools, technical assistance technique);
- Strengthen the government financial and technical capacity (at both central and provincial levels) to screen, negotiate, secure and supervise public-private partnerships following transparent and fair processes;
- Organize knowledge transfer on renewable energy and battery storage to train decision-makers and future technicians and engineers;
- Encourage data collection, in particular via household surveys such as the Multi-tier Framework.

Order of magnitude: USD 1 million per year for ARE and ANSER functioning, USD 3 million for technical assistance targeting the Ministry of Energy and 5 key provinces.

2. SCALE UP DECENTRALIZED RENEWABLE ENERGY SOLUTIONS AND ISOLATED GRID INVESTMENTS

Challenge: The high degree of the country's fragility – which includes weak governance, conflict and security issues, poor transport infrastructure, lack of public financial capacity – has been ignored in past power system development. The centralized grid expansion model based on large and centralized generation assets has therefore failed to increase access to electricity in the DRC.

Guiding principle: Adjusting the least cost planning to including country risks, regional specificities and supporting an electrification strategy articulated around distributed renewables solutions prioritizing mid-size hydro and solar technologies closer to demand centers.

Top priority actions:

- Invest in resources' assessment and preliminary project preparatory studies at a government level to reduce early stage capital investment required of private sector (prefeasibility studies for isolated grids in main provincial capital cities);
- Launch least cost planning of the sector, focusing particularly on major non-grid connected demand centers along the South-West backbone;
- Launch auctions for isolated grids in priority provincial capitals.

Order of magnitude: USD 4 million per provincial capital city

3. REMOVE VERY HIGH BARRIERS TO DOING BUSINESS THAT CURRENTLY CONSTRAIN PRIVATE SECTOR DEVELOPMENT

Challenges: Current policies do not offer favorable investment conditions and remain ambiguous about issues such as ownership, and concessions. Affordable financing mechanisms to consumers and operators in a context of low end-user purchasing power, high costs of capital and weak commercial banking sector are not available. However, the utility SNEL is in no position to single handedly address the access deficit challenge and private operators are needed to help scale up decentralized supply options.

Guiding principle: Creating an enabling environment to support private sector participation in the development of isolated grids and standalone systems in the DRC.

Top priority actions:

- Waive import taxes on off grid solutions;
- Adopt international quality standards of off grid products;
- Set up mechanisms to support CAPEX financing through more attractive commercial credit terms;
- Support human capacity development through the education and training of engineers and technicians.

Order of magnitude: USD 200 million

4. SUPPORT THE UTILITY'S RECOVERY

Challenges: Low commercial performance, mismanagement, and unsustainable indebtedness have prevented SNEL to keep up with galloping electricity demand. Latest attempts to implement the board-approved recovery plan have not delivered expected results mostly because of weak leadership, unrealistic objectives and skills gap on specific key functions.

Guiding principle: Transforming SNEL to become a more client-centered and results-oriented player in a liberalized sector.

Top priority actions:

- Rehabilitate and modernize Kinshasa's distribution network;
- Secure SNEL's commercial revenues through investments in commercial department, and assess the opportunity of a pilot to outsource billing and collection services to a private operator (starting for instance with Kinshasa);

- Increase in imports in the short or medium term from neighboring countries including Zambia, especially to address unmet demand from the mining sector located in the South;
- Launch feasibility studies for the rehabilitation of critical hydropower plants close to major demand centers (Nzilo, Zongo 1);
- Provide external support to SNEL in the form of a service contract or management contract to intensify recovery on key functions (commercial, finance, IT).

Order of magnitude: Technical assistance and related investments for the recovery of the commercial, finance and IT functions: USD 10 million per year; rehabilitation of Kinshasa's LV network: USD 450 million.

1

DATA SCARCITY AND UNPREDICTABILITY OF ELECTRICITY DEMAND MAKE POWER SECTOR PLANNING CHALLENGING

Photo : © Nuru SARL

1. DATA SCARCITY AND UNPREDICTABILITY OF ELECTRICITY DEMAND MAKE POWER SECTOR PLANNING CHALLENGING

1.1. A CONTRASTED AND CONSTRAINED DEMAND

The geographic size and topography of the DRC have led to pockets of electricity demand. With an estimated area of 2,345,000km^2, DRC is the second largest country in Africa. DRC has a very low population density[1] and a landmass that covers the size of Western Europe. The country is split into 26 provinces (see Map 1), some of which are of similar size to Senegal and Lebanon. Rainforests cover 55% of national territory, second only to Brazil in size. Biomass, such as firewood and charcoal[2], accounts for approximately 90% of the country's total energy consumption and is used primarily for households. But in addition to significant agro-processing potential widespread on the entire territory, important mineral reserves, in particular cobalt, copper and coltan, are mined in the Southern provinces of Haut-Katanga, Haut-Lomami, Lualaba, and the three Kasai provinces and in the East and require electricity.

MAP 1 • The 26 provinces of DRC

Source: World Bank, authors

Average annual electricity consumption per capita is the second lowest in Sub-Saharan Africa, and half the regional average at 94 kWh per capita (Figure 2).[3] Total electricity consumption in 2015 was 7,266 GWh (up from 4,533 GWh in 2000) (Figure 1). The economy is becoming more energy intensive, with total power consumption growing at a compound annual growth rate (CAGR) of 3% between 2000 and 2015, compared with an average growth in GDP per capita of 1.5%.

Industry accounts for the largest share of electricity consumption, representing 55 % of DRC demand, followed by 35% for residential and 10% for other commercial uses and services (Figure 1). Industrial and residential electricity consumption levels have doubled since 2000 (respectively +111%, and +105% between 2000 and 2015) while commercial and public services consumption has been cut in half (–48%). Residential electricity consumption grew at 5% per year, a little over the average population growth rate of 3.3%.

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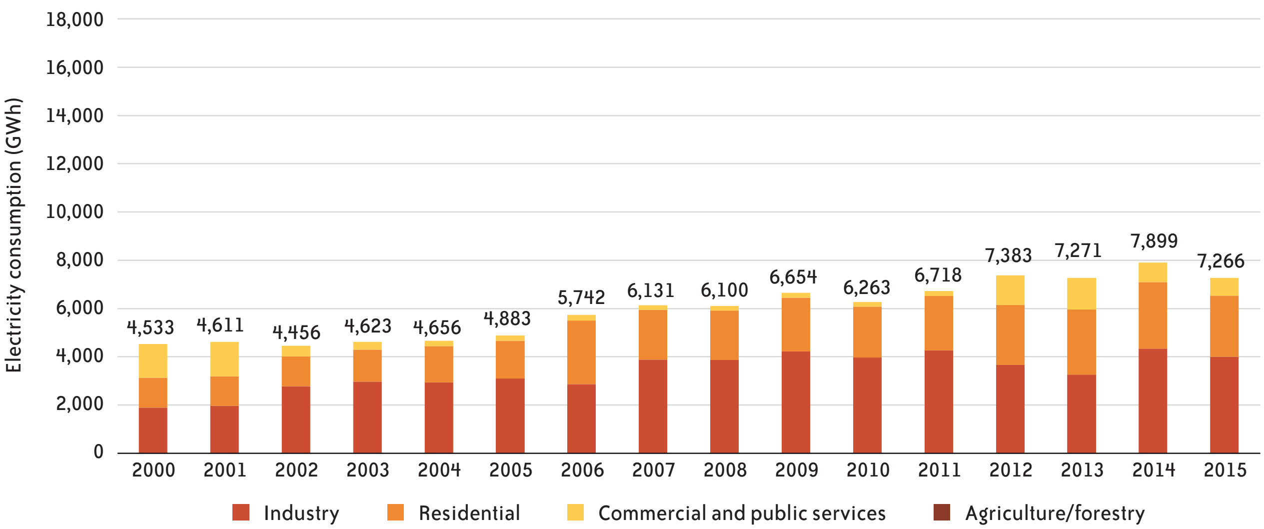
[1] World Bank 2018.

[2] AECOM/EDF study reports that 92% of cooking in DRC uses biomass, three quarters of which is in the form of firewood, and 79% in urban households, two thirds of which is charcoal.

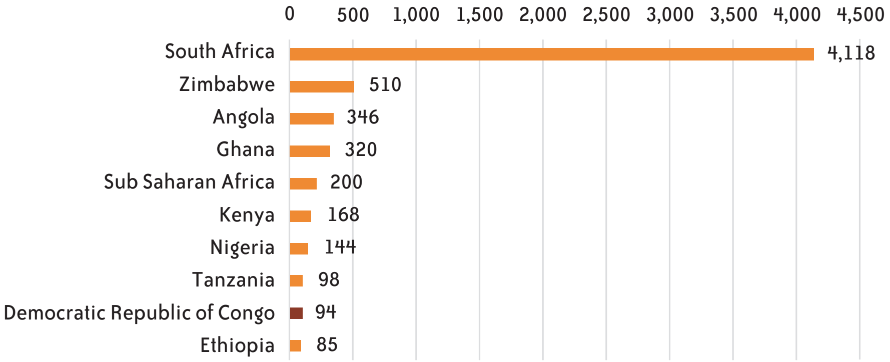
[3] Hafner and others, (2018), *Energy in Africa – Challenges and Opportunities*, Springer Open. Note that this average hides significant differences across cities and rural/urban areas.

FIGURE 1 • Electricity consumption by sector since 2000 (GWh)



Source: IEA, World Energy Statistics, 2017

FIGURE 2 • Electricity consumption per capita across Sub Saharan Africa (kWh/person)



Source: IEA, World Energy Statistics, 2017 and World Bank, World Development Indicator database

Industrial consumption comes mostly from the extractive industry. The extractive industry accounted for 20% of the DRC's economic growth in real terms in 2015[4] and 97.5% of exports. It requires large quantities of fuel and electricity for extraction and conversion of metallic ores. Formal mining is mainly located in the provinces of Kasai Central and Kasai Oriental, in the Haut-Katanga and Lualaba, but also in the North-Eastern regions of Haut-Uele and Ituri (Map 2). Industries such as food processing, textiles, metallurgy and the light chemical industry located around large cities such as Kinshasa, consumes only a small amount of electricity. As does industry linked to raw material deposits, such as limestone for cement works.

Residential demand displays large disparities in average demand between urban and rural populations. Residential electricity consumers are concentrated in Kinshasa and a few other large cities in the South or along the Eastern border with Rwanda and Uganda. Average annual demand per capita in Kinshasa is estimated at around 380 kWh, compared with around 330 kWh in Southern cities and 290 kWh in Eastern cities. Outside of a few cities, other areas have far less electricity demand due to sparse population. Bas-Uele, for example, is as sparsely populated as Russia (Map 3). Subsistence farming with low revenues constrains the residential demand of rural households, which is estimated to be closer to 35 kWh per annum.

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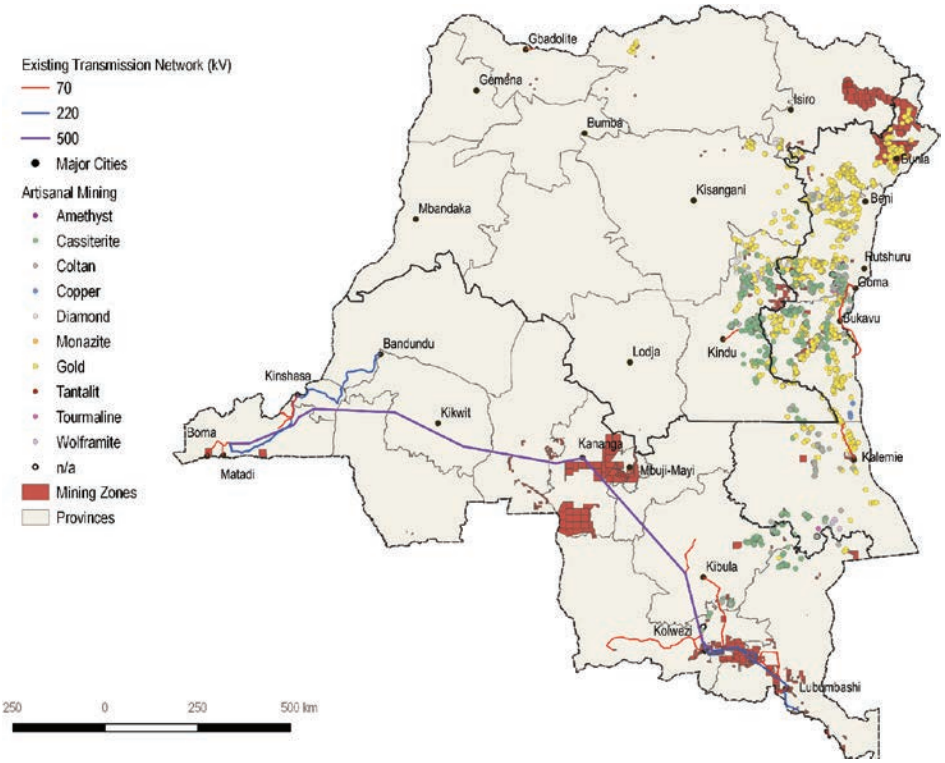
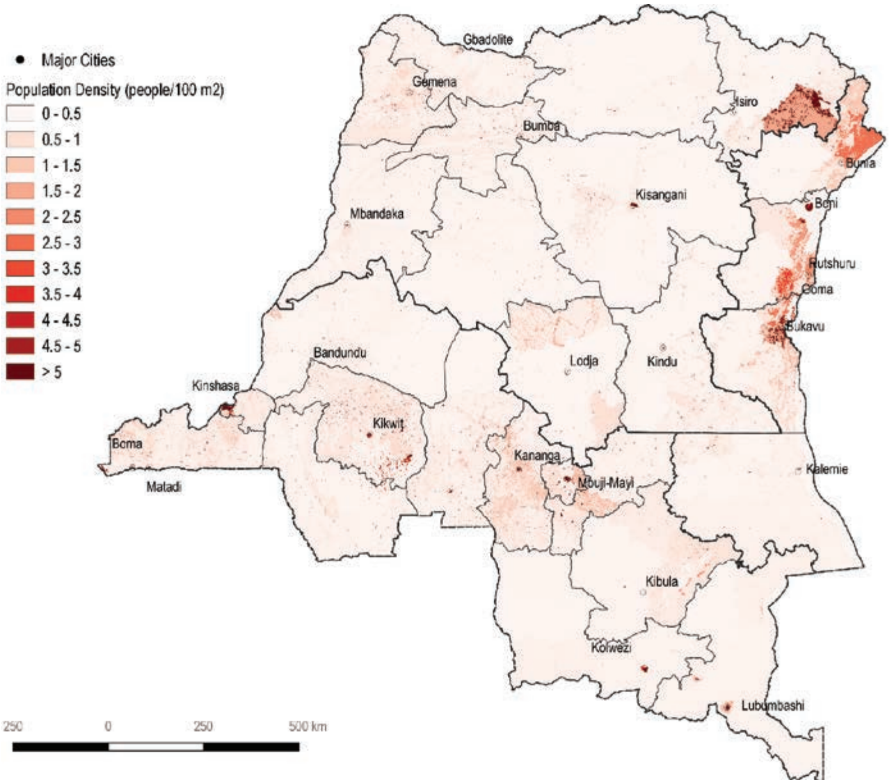
[4] EITI, https://eiti.org/democratic-republic-of-congo#contribution-of-the-extractive-industry-to-the-economy.

MAP 2 • Location of mines and artisanal isolated grids



Source: CICOS, IPIS, World Bank, authors

MAP 3 • Population density in the DRC, 2015



Source: Worldpop

All segments of electricity demand are severely constrained by supply. Most demand in the residential sector is unmet, partly because DRC has one of the largest deficits in electricity access in the world and high geographical disparities (see chapter 2 for information about access). So is industrial demand. Mines in the South, for example, rely on a combination of domestic power, imported electricity through the DRC-Zambia interconnector (a 220 kV line between Kasumbalesa and Luano), and self-generation using diesel transported over long distances by barges on the large rivers, trucks and two-wheelers. Less than half of this known demand from the South is currently met, constraining the sector's output[5].

1.2. THE CHALLENGES OF A RAPIDLY RISING DEMAND

The pace of electrification has been very slow, challenged by high birth and poverty rates. DRC has one of the highest fertility rates in the world (after Niger and Somalia)[6] and DRC residents are some of the poorest in the world, with 91 percent of the population living on less than $3.10 per day in 2012 (2011 PPP) (Map 4). Other countries in the region with similar urbanization levels such as Nigeria, Senegal, and Benin have poverty rates of 76.5 percent, 66.3 percent, and 75.6 percent respectively. If electrification efforts follow the same pace as during the last decade, 84 million people – which represent 80% of total population - will still live without electricity in the DRC by 2030.

Rapid urbanization creates high-density demand pockets which present the opportunity to economically expand and densify electricity grid access. 34 million people, 43% of population, live in urban areas[7] and this number is increasing by 4.5% a year. Around one fourth of this population lives in six urban centers: Kinshasa, Lubumbashi, Mbuji-Mayi, Goma, Kananga and Kisangani. With around 1 million people a year moving to cities every year[8], there is an opportunity to quickly and cost-effectively connect new customers.

Both residential and industrial demand are forecast to grow rapidly. Residential electricity demand is expected to grow from an estimated 3,000 GWh, at a CAGR of 11% to reach 11,000 GWh by 2030. The total current demand from mines is estimated at around 7,000 GWh in 2018 and is projected to grow to around 11,000 GWh by 2030, or a CAGR of 4%.

If this rising demand is not met with an increase in supply and improvements to electricity infrastructure, it will lead to further deterioration of electricity service. In Kinshasa, while 60% of the population has access to electricity, service quality and reliability is very poor. This is due mainly to the saturation of the Kinshasa distribution grid and capacity limitations for Inga 1 and 2 power plants. Power injected into the network is currently limited to about 500 MW, whereas peak demand is estimated at 1000 MW[9]. To cope with this deficit, SNEL[10] conducts a daily load shedding program and triggers overloaded equipment (Figure 3). In April 2018, the SNEL monthly activity report indicated that there were 3,130 disruptions in the Kinshasa distribution grid resulting in power outages for customers. Two thirds of these power outages were due to load shedding, while the second cause was system overload. In addition, preventive deballasting of about twenty lines also happens when it rains to limit electrical risks.

Poor electricity quality and frequent outages cause major problems for industries and services that depend on electricity. One in two firms identify electricity as a major constraint to growth and nearly nine out of ten firms experience outages. In addition, 60% of firms own a generator, due to unreliable electricity, compared with an average of 43% in the rest of sub-Saharan Africa. Most firms, as well as high to medium income residential consumers, have to invest in expensive back-up generators, usually fueled with diesel or gasoline, which adds significant costs to businesses. Frequent and prolonged power outages can result in major economic losses and make it difficult for industry to deliver on time and to scale up operations. It may also dissuade entrepreneurs from embarking on industrial activities.[11]

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[5] *Chambre des Mines*.

[6] 6.1 births per women in 2016, WDI.

[7] WDI 2016.

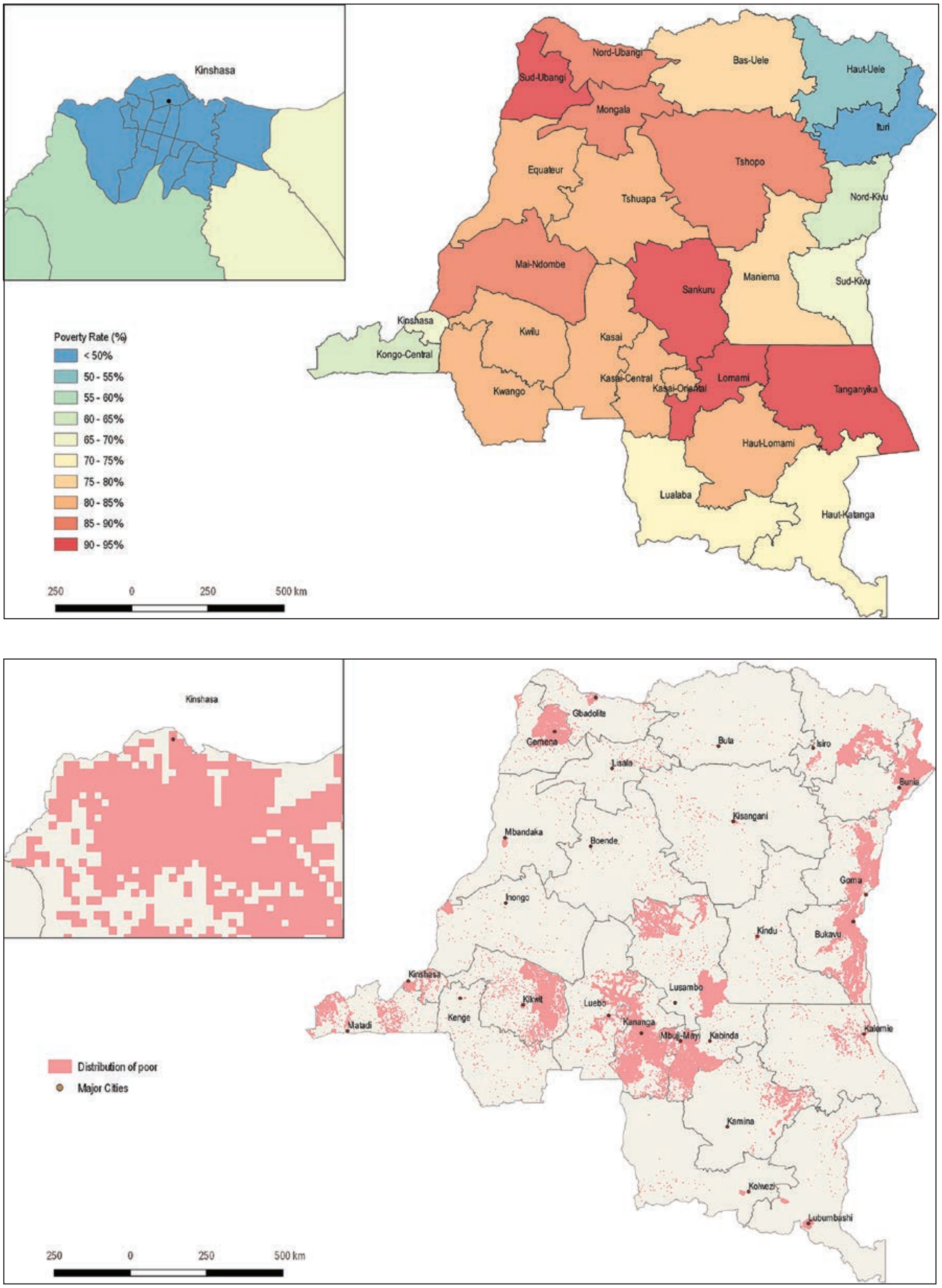
[8] World Bank, 2018. *Democratic Republic of Congo Urbanization Review: Productive and Inclusive Cities for an Emerging Congo*. Directions in Development—Environment and Sustainable Development; Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/28931.

[9] Master Plan of the city-province of Kinshasa - Horizon 2016 – 2030 (June 2016).

[10] SNEL is a public company governed by Law # 78/002 of January 6, 1978 which became a Limited Liability Company ("SARL") in 2009. In 2014, it became a Limited Company ("Société Anonyme"– SA) with the Congolese State as sole shareholder.

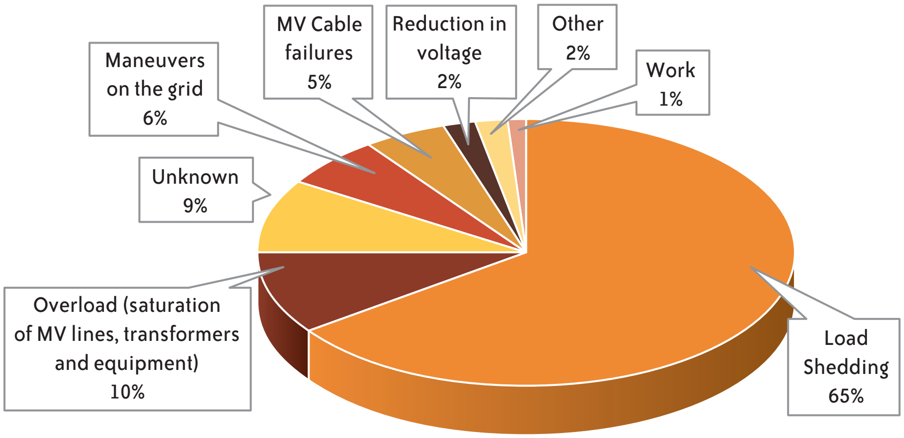
[11] Hafner and others, (2018).

MAP 4 • Poverty rates and number of poor across DRC



Source: World Bank

FIGURE 3 • Kinshasa's distribution grid: causes of power outages for a typical month (%)



Source: SNEL – Kinshasa Monthly Activity Report April 2018

1.3. PLANNING IN A CONTEXT OF DEEP UNCERTAINTY

The DRC suffers from a lack of information about all aspects of power demand, which magnifies the challenge of planning. The mere scale of the DRC and accessibility challenges make information gathering complicated and costly. The last and only population census was conducted in 1984[12]. Lack of census data prevents a reliable understanding of population dynamics. Information on population size, distribution and income level is inaccurate and varies significantly across sources. Even the total population of DRC varies by more than 11 million people from one source to another[13]. Furthermore, given that most sectors of the economy operate informally, there is very limited data on potential productive uses, trade, and incomes and thus very little data on which to base demand estimates or forecasts. Few SNEL residential customers are metered, so their consumption must be estimated. And due to the lack of a detailed household energy survey, there is no information available regarding the spending of unconnected households on alternative sources of energy, such as candles, kerosene, and batteries.

Unpredictable and large-scale movements in population also make forecasting power demand difficult. Ongoing conflicts have displaced more than 4.5 million people – mainly in the Kivus and Tanganyika in the east, central Kasai and most recently in northeast Ituri[14]. Goma's region has the fastest urban population growth (average annual growth of above 10 percent since 1984) driven by civil conflict. Many displaced people find themselves in urban slums where more than 75% of urban populations live.[15] In slums it is more challenging to provide reliable and safe electricity.

In the industrial sector, current and future power demand from mining also fluctuates with mineral markets. Mining sites remain mostly informal and artisanal; informal trade of minerals – gold in particular – along the Eastern border is widespread[16]. Even the size and power demands from legal mines located in the North-Eastern part of the country are unknown. Demand from the mining sector is by nature difficult to predict as it is proportional to mining output, which fluctuates with international markets for minerals.

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[12] http://ins-rdc.org/?q=content/*deuxieme*-recensement-general-de-la-population-et-de-l%E2%80%99habitat.
[13] Comparing 2015 data from WorldPop and Annuaire Statistique for example.
[14] https://news.un.org/en/story/2018/03/1004542.
[15] WDI, 2014.
[16] World Bank 2018.

To better understand present and future electricity demand in the DRC, a concerted effort by public agencies and donors, under the leadership of the Ministry of Energy and Hydraulic Resources to collect better data will be needed, as will a flexible approach to quickly factor evolving demand growth. The SE4ALL Multi-Tier Framework Electricity Access survey, which is currently under planning, will survey households in Kinshasa and Gbadolite to provide a better understanding of the level and quality of electricity service currently supplied as well as consumer satisfaction. Limited household surveys will be conducted in 9 provincial capitals as part the prefeasibility studies for the electrification of new provincial capitals supported by the World Bank. Further surveys will be needed to get a more accurate picture for planning at the national and regional level. Enhancing collaboration between central and local governments for data gathering can also help move forward with planning at a subnational level, as can the use of GIS data. For power suppliers, this uncertainty about demand implies building uncertainty into infrastructure design and implementing demand-side programs such as energy efficiency measures (minimum energy performance requirements – MEPs – for lighting, key energy consuming appliances and industrial equipment) to slow power demand growth.

2

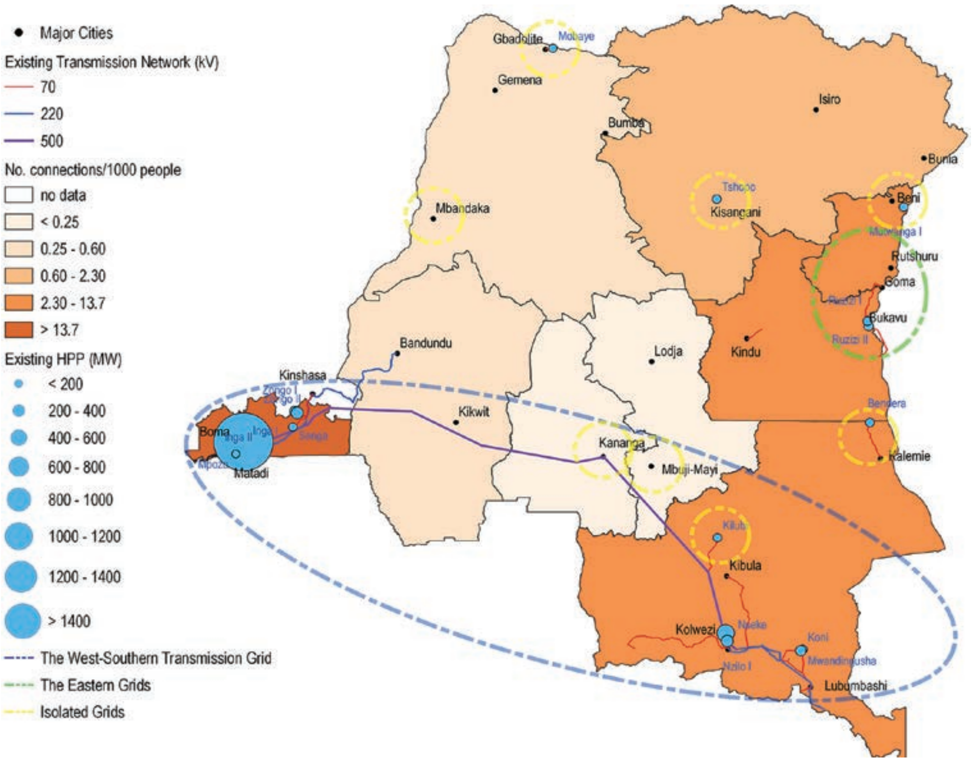
SHIFTING POWER SECTOR PLANNING TO A REGIONAL LEVEL

2. SHIFTING POWER SECTOR PLANNING TO A REGIONAL LEVEL

2.1. AN AGING SUPPLY DOMINATED BY ONE MAIN INTERCONNECTED GRID

Power sector planning led at a national level encouraged the development of large production centers with one main interconnected grid (Map 5). The West-Southern transmission grid, operated by SNEL[17], serves the capital Kinshasa and the major urban and mining centers of the former provinces of Bas Congo and Katanga. It is made up of high voltage lines with a length of 6,937 km (including 1,827 km of very high-voltage direct current lines (HVDC). It is interconnected with Congo Brazzaville and Zambia (with respective transit capacities of 150 MW and 500 MW). It concentrates 2,490 MW of generation capacity that is 90% of the country's generation capacity. On a different scale, a secondary interconnected grid operated by SNEL, the Eastern transmission grid, covers the Kivu provinces and is interconnected with Rwanda and Burundi. The DRC power system also includes a few isolated grids operated by SNEL and half a dozen private operators[18]. These isolated grids are developed around hydroelectric power plants (HPP), with installed capacities ranging from 2 to 20 MW[19], and gensets – when operational - of the order of a few MW as in Kananga and Mbandaka. In addition to the power plants operated by SNEL, around 150 MW of hydroelectric and thermal power plants are operated by private operators, such as Virunga in Matebe, Hydroforce in Mbuji-Mayi, EDC in Tshikapa, SINELAC in Bukavu, or Randgold in Kibali.

MAP 5 • Current state of the DRC power system development



Source: SNEL, World Bank, authors

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[17] This network represents around 97% of its activity (SNEL)

[18] For example, Electricite Du Congo (Tshikapa), SOCODEE (Goma), VIRUNGA SARL (Rutshuru), Energie du Nord Kivu (Butembo-Beni), SOKIMO (Bunia), SICOHYDRO (Busanga).

[19] For example, the supply of Kalemie through Bendera, Kamina through Kilubi, Gbadolite through Mobayi Mbongo, Kisangani through Tshopo and Mbuji Mayi through Tsahala.

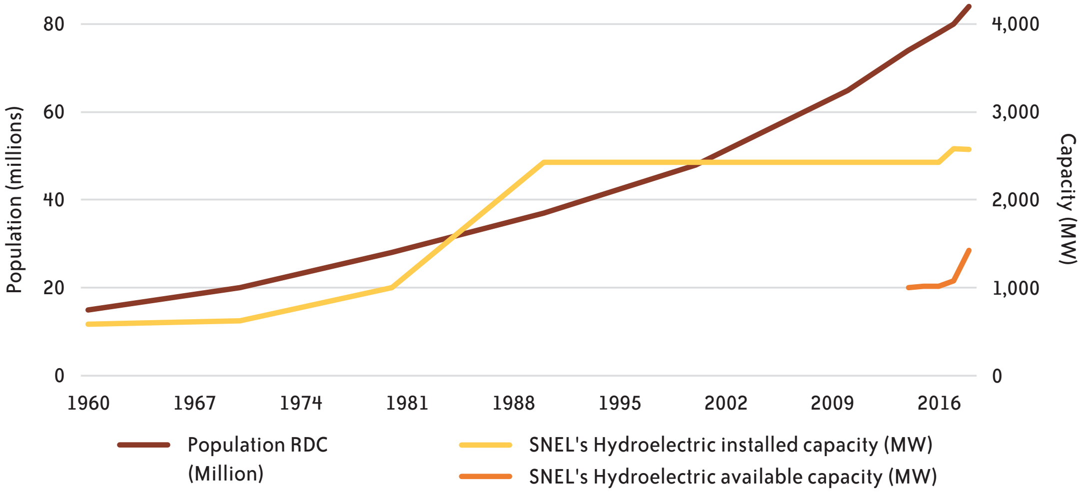
Expansion of DRC's transmission network has historically been driven by the mining sector and the associated urbanization around Kolwezi and Lubumbashi. The Southern part of the West-Southern backbone was developed in the 1950s with the progressive commissioning of the Koni (42 MW), Nzilo (108 MW) and Nseke (260 MW) hydroelectric facilities. The Western part of the grid relied on the hydroelectric production of Zongo 1 (75 MW) and Inga 1 (351 MW) to supply Kinshasa and the former province of Bas Congo. The commissioning of the Inga 2 hydroelectric plant (1,424 MW) in 1982, which alone still accounts for more than 50% of the country's generation capacity, was followed by the construction of a 500 kV DC line of 1,774 km between Inga and Kolwezi, allowing the interconnection of the West and South grids and the transfer of energy to Kolwezi to cope with growing mining demand.

SNEL installed capacity has not significantly increased between 1990 and 2017 (Figure 4). Today SNEL's power generation facilities consist of 15 hydroelectric power plants representing 2,579 MW of installed capacity (Table 1), 33 thermal units with an installed capacity of 318 MW and a solar power plant of 1MW in Manono (commissioned in March 2018). Zongo 2 HPP has added 150 MW to the installed capacity in 2018 but its generation is currently limited[20]. Before Zongo, the last SNEL commissioned power plant was Mobayi Mbongo HPP in 1990. Since that time, the population has more than doubled. Moreover, during this period, the gradual deterioration of facilities has decreased available generation to 1440 MW[21], or 55% of installed capacity. Thus, since 1990, the actual available capacity per capita has been divided almost by 5.

Non-cost recovery tariffs, low collection rate and mismanagement have prevented proper maintenance and investment in rehabilitation – which result today in about 55% of generation capacity available in the DRC. While hydro facilities have an average age of 43 years, 29 HPP representing 49% of the total installed capacity have never been rehabilitated since their commissioning (Figure 5). SNEL estimates the cost of rehabilitation of these 29 generators between $800 and $ 1 billion. It has already identified sources of funding for US$ 600 million. SNEL also indicated, that as of March 2020, only 46% of the 31 MW of thermal generators spread in the territory, so 14 MW, were available (Table 1). Beyond the lack of maintenance, the unavailability is also explained by the difficulties of supply of fuel and oil and the looting that accompanied the political instability during wars and the remaining localized conflicts of the last two decades.

A rehabilitation campaign initiated in 2010 sought to first maintain and then improve a dozen hydro generators. These generators were located in the power stations of Ruzizi (1 × 8.6 MW), Nseke (3 × 65 MW), Tshopo (1 × 7 MW),

FIGURE 4 • SNEL's Hydropower installed capacity 1990–2018



Source: SNEL

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[20] Pending the commissioning planned in 2020 of the new 220 kV Zongo2-Kinsuka line and the Kinsuka electrical substation located in Kinshasa, Zongo 2 is connected to Zongo 1. The 70 kV lines from Zongo 1 do not allow to dispatch the generation capacity (225 MW) of the two hydro power stations.

[21] "Les Assises sur le secteur de l'Electricite de la RDC" Kinshasa-May 2018.

TABLE 1 • SNEL's hydropower generation portfolio, 2020

Regions	Hydro Power Stations	Installed Capacity of the power plant (MW)	Generators	Installed Capacity (MW)	Year of commissioning	Year of the last rehabilitation*	Funding still to find	Estimation of the cost of the rehabilitation (USD M)	Capacity available February 2018 (MW)
WEST	INGA 1	351.0	G11	58.5	1972	2017			0
			G12	58.5	1972	2013			0
			G13	58.5	1973	NR	X	35	55
			G14	58.5	1974	2017			58.5
			G15	58.5	1974	2016			58.5
			G16	58.5	1974	NR	X	35	55
WEST	INGA 2	1424.0	G21	178	1981	2017			140
			G22	178	1981	2018			145
			G23	178	1981	NR		55.0	140
			G24	178	1981	NR		83.0	130
			G25	178	1981	NR		55.0	140
			G26	178	1982	NR		55.0	135
			G27	178	1982	2018			0
			G28	178	1982	2020			0
WEST	ZONGO 1	75.0	G1	13	1955	NR	X	37.5	13
			G2	13	1955	NR	X	37.5	0
			G3	13	1957	NR	X	37.5	0
			G4	18	1964	NR	X	37.5	18
			G5	18	1965	NR	X	37.5	0
WEST	SANGA	12.0	G1	2	1932	2018			0
			G2	2	1932	OG			0
			G3	2	1946	OG			0
			G4	2	1947	2018			0
			G5	2	1948	OG			0
			G6	2	1949	2017			0
SOUTH	NSEKE	260.0	G1	65	1956	OG			0
			G2	65	1956	2015			62.1
			G3	65	1957	2011			62.1
			G4	65	1957	2013			62.1
SOUTH	NZILO	108.0	G1	27	1952	NR		30.0	25
			G2	27	1953	NR		30.0	25
			G3	27	1954	NR		35.0	25
			G4	27	1954	NR		30.0	25

(*continues on page 18*)

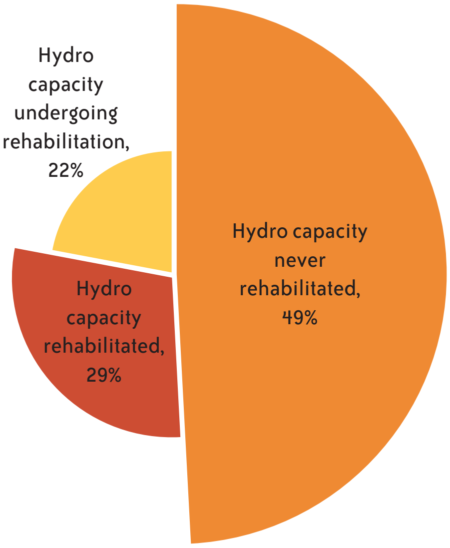
TABLE 1 • SNEL's hydropower generation portfolio, 2020 *(Continued)*

Regions	Hydro Power Stations	Installed Capacity of the power plant (MW)	Generators	Installed Capacity (MW)	Year of commissioning	Year of the last rehabilitation*	Funding still to find	Estimation of the cost of the rehabilitation (USD M)	Capacity available February 2018 (MW)
SOUTH	MWADINGUSHA	67.8	G1	10.8	1930	OG			0
			G2	10.8	1930	OG			0
			G3	10.8	1930	OG			0
			G4	11.8	1938	OG			0
			G5	11.8	1939	OG			0
			G6	11.8	1954	OG			0
SOUTH	KONI	42.1	G1	14.04	1951	2015			13
			G2	14.04	1950	NR		37.5	13
			G3	14.04	1950	OG			0
EAST	RUZIZI 1	29.8	G1	6.3	1958	NR	X	17	6
			G2	6.3	1959	NR	X	17	0
			G3	8.6	1972	NR	X	17	0
			G4	8.6	1972	2011			7
ISOLATED	TSHOPO	19.7	G1	7	1955	2013			0
			G2	6.15	1955	NR	X	20	6.15
			G3	6.5	1975	NR	X	20	6.5
ISOLATED	MOBAYI MBONGO	11.4	G1	3.79	1990	NR		8.4	0
			G2	3.79	1990	NR		8.4	3
			G3	3.79	1989	NR		8.4	0
ISOLATED	BENDERA	17.2	G1	8.6	1959	OG			0
			G2	8.6	1959	OG			0
ISOLATED	KILUBI	10.8	G1	3.6	1954	NR	X	8	3
			G2	3.6	1954	NR	X	8	0
			G3	3.6	1954	NR	X	8	0
ISOLATED	MPOZO	2.2	G1	1.1	1932	NR			0
			G2	1.1	1932	NR			0
	Sub TOTAL	**2429**		**2429**				**808.2**	**1431.95**
WEST	ZONGO 2	150.0	G1	50	2018				
			G2	50	2018				
			G3	50	2018				
	TOTAL	**2579**		**2579**					

*NR: Never Rehabilitated / OG: On going

Source: SNEL

FIGURE 5 • State of SNEL's hydropower plants, 2020

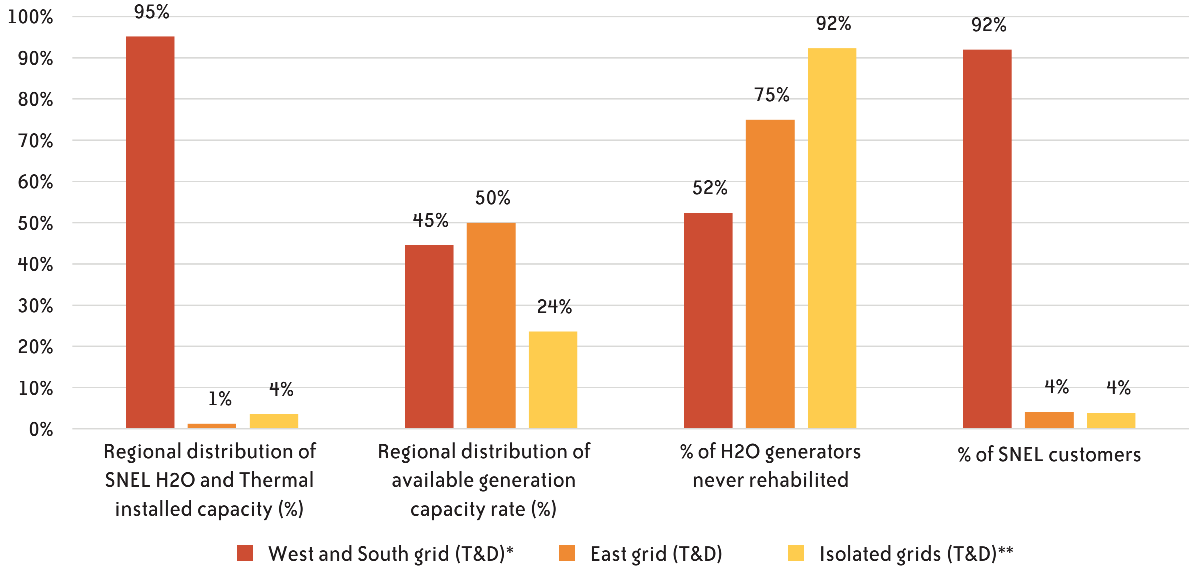


Source: SNEL

Koni (1 × 14 MW) and more recently Inga 1 (4 × 58.5 MW) and 2 (2 × 178 MW). The PMEDE[22] project financed by the World Bank was one of the main rehabilitation campaigns which notably financed the rehabilitation of units at Inga 1 and 2 (415 MW rehabilitated, so 23% of total installed capacity), and the construction of the second supply canal (+390 MW in the overall available capacity of the facilities). In total, average available electricity generation increased from 1,010 MW to 1,078 MW, or + 7% between 2016 and 2017. This immediately translated into a rise in electric energy generation of 0,6 TWh. The transmission network has also benefited from rehabilitations. The Inga-Kolwezi line has been reinforced to increase its transit capacity from 500 to 1000 MW to the southern transport network thanks to funding from multilateral and private (mainly mining) partners. A second line (400kV - operated at 220 kV in the first phase) Inga-Kinshasa was built and put into service in 2016 to bring more power to Kinshasa (1000 MW).

SNEL isolated grids are also progressively degrading and now run a significant risk of collapse if rehabilitation of generation and networks is not undertaken urgently. 92% of hydro generators connected to SNEL isolated grids have never been rehabilitated since their commissioning (Figure 6). During a World Bank survey in February 2018, several local operators of SNEL hydro power plants expressed concern about the high level of degradation of their plants, particularly for the isolated power stations of Bendera, Kilubi and Mobayi Mbongo[23], with average available generations of respectively 26,6%, 22,9% and 8,6% of the installed capacities.

FIGURE 6 • Comparison of the West-Southern, Eastern and Isolated grids



Source: SNEL - May 2018 (*without Zongo 2 / **With 28 MW thermal units)

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[22] Regional and Domestic Power Markets Development Project.

[23] The Mobayi-Mbongo Hydropower plant has come to a complete stop as of November 1, 2018. The last generation unit (one of 3) which was running, broke down. As of today, there is no more generation at the Mobayi-Mbongo Hydropower Plant.

Isolated systems which represent only 4% of the total installed capacity, 7% of the total length of distribution lines and supply around 4% of the SNEL's customers are nevertheless the only sources of access to electricity in several provinces. Distribution grids are also old and in need of rehabilitation. Without maintenance programs and rehabilitation works in the short term, they risk collapsing. Local operators noted that most of the grids were erected during the construction of the power stations that supply them and are in a state of obsolescence, particularly the distribution networks of Central Kasai, Oriental Kasai, Equateur and Bandundu provinces. This causes frequent equipment failure and deteriorates supply quality. Lack of funds for maintenance, cable theft and acts of vandalism continue to worsen the situation.

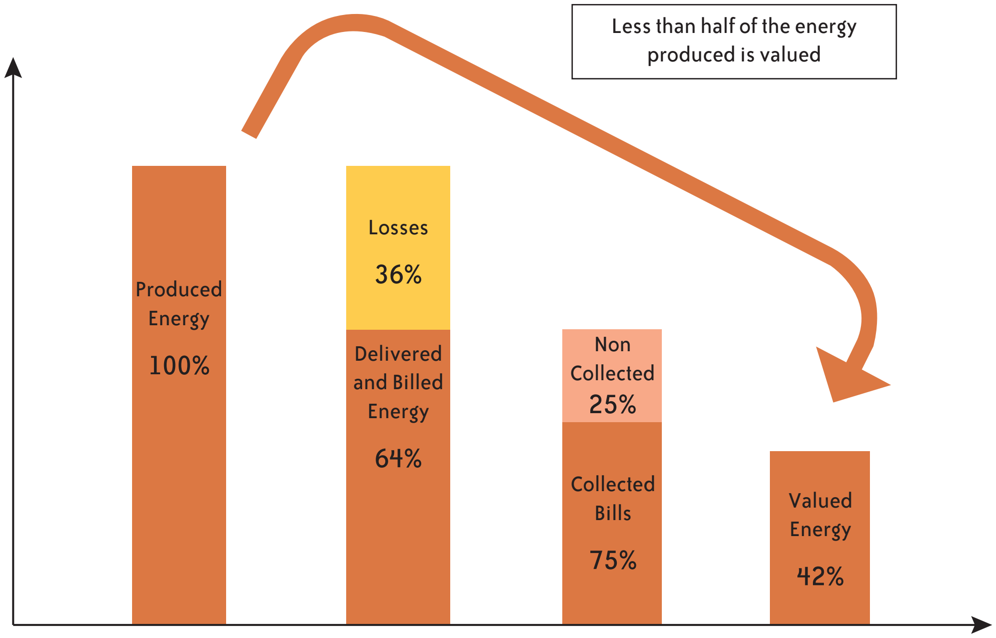
Other issues plaguing the DRC electricity system include technical and non-technical losses. Technical and non-technical losses represented 36% of total production in 2016. The first ones are due mainly to the obsolescence of certain equipment such as transformers and lines, how some equipment (such as Kinhasa's distribution network) are operated and increased loads (Figure 7) while the others to fraud and non-billing of consumption. In addition, SNEL failed to collect on 25% of the value invoiced. 8% of uncollected bills pertained to high voltage and medium voltage private customers, 55% to low voltage private customers and the rest pertained to the State (e.g. public buildings, ministries) and State-owned companies. Overall, less than half of the energy produced is monetized (Figure 7).

2.2. CENTRALIZED ELECTRIFICATION PLANNING HAS FAILED TO INCREASE ACCESS ACROSS THE TERRITORY AND THE POPULATION

Limited institutional capacity did not allow the design of a national electrification plan although it is a prerequisite for any program to be efficiently implemented. The last sector development policy note dates back to 2009. The enrollment of the DRC in the Sustainable Energy for All initiative in 2012 has not triggered the expected acceleration on electrification.

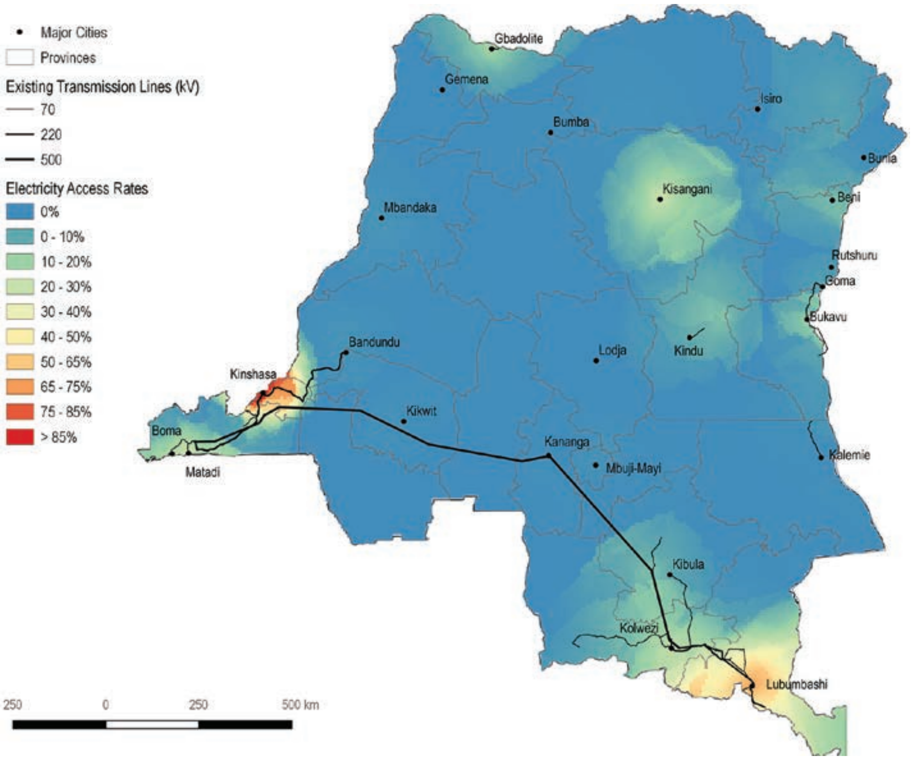
Poor sector governance, lack of planning, weak institutional framework and lack of government commitment have resulted in one of the largest deficit in electricity access in the world and high geographical disparities.

FIGURE 7 • Estimation of overall losses on SNEL's power system



Source: SNEL, authors

MAP 6 • Share of people with access to electricity in the DRC



Source: DHS 2013–2014

With 65 million people without access to electricity in 2016, the DRC has the third largest population without access in the world, after India and Ethiopia[24]. DRC's latest household survey (DHS 2013–14) available reported that 14% of its population had access to electricity, with significant geographic disparities ranging from 42% in urban areas to 0.4% in rural areas (Map 6). Large disparities exist also between cities. While 60% of Kinshasa's population have some access to electricity, several cities of more than 800 thousand population such as Kananga and Mbuji-Maye have less than 10% access. In 2017, an estimated 10% of the population were connected to the power grid, with significant regional disparities that partly reflect supply constraints, and partly economic disparities. While residential grid electricity access in the West is estimated at 30%, in the South it is closer to 10%, 5% in the East and 3% in the North-West[25].

This has also resulted in a very unequal electrification with one of the largest gaps in access rates by income group in the world. In the DRC, more than in other countries in large access-deficit countries in sub-Saharan Africa, electrification increases as overall household welfare rises (Figure 8). Ensuring the most vulnerable populations have affordable access to electricity, whether it's through grid connections or isolated systems is a key policy challenge that should be addressed in an electricity sector plan.

Three regions with specific demand and supply characteristics emerge and justify differentiated regional planning: i) The South-Western axis with strong supply system and high demand; ii) The Eastern region with weak / underdeveloped supply system and high demand; iii) The North Central region with weak supply system and relatively lower demand.

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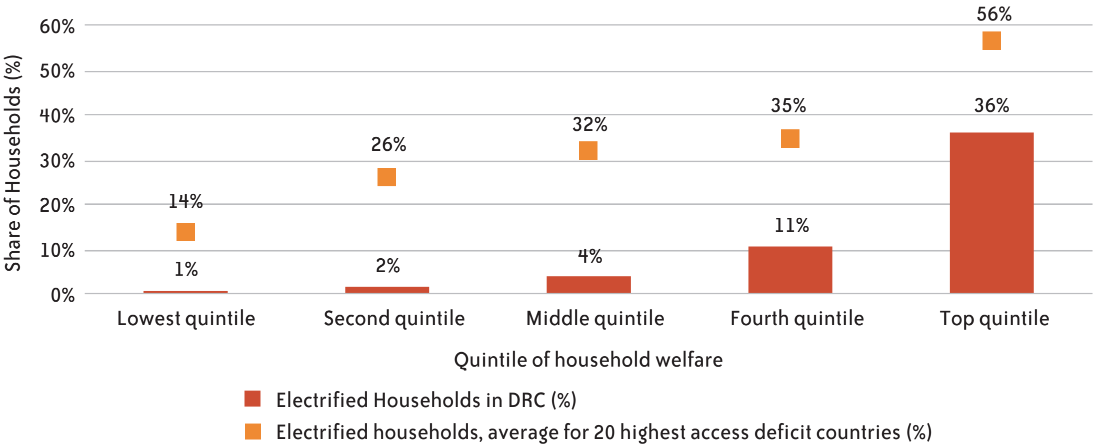
[24] World Bank, SDG7 Tracking Report 2018.

[25] EDS 2013-2014.

FIGURE 8 • Share of people with access to electricity by quintile of household welfare (2012)



Source: Global Micro Database, World Bank, latest year available (2012)

The decentralization law transferred de facto the planning function to the relevant subnational level (provinces and ETD[26]). No central authority nor the national utility SNEL currently have sufficient technical capacity to improve electricity service delivery through quality planning consistent across the entire DRC territory. Each provincial authority has a better understanding of the diversity of natural endowments, economic and social characteristics of its population. A stronger involvement of local governments in electricity sector central planning would enable local specificities to be better taken into consideration and to align it with spatial and urban planning at a provincial level. However, planning at a subnational level includes various challenges. Currently, provinces do not have the institutional and financial capacity to fully endorse this role, nor do they have the technical capability. The coordination among national and local government is critical but must go hand in hand with an allocation of funding[27].

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[26] Entité Territoriale Décentralisée or decentralized territorial entities.

[27] World Bank 2018

3

PARAMETERS OF A LEAST-COST PLANNING EXERCISE IN A CONSTRAINED ENVIRONMENT

Photo : © Juliette Besnard

3. PARAMETERS OF A LEAST-COST PLANNING EXERCISE IN A CONSTRAINED ENVIRONMENT

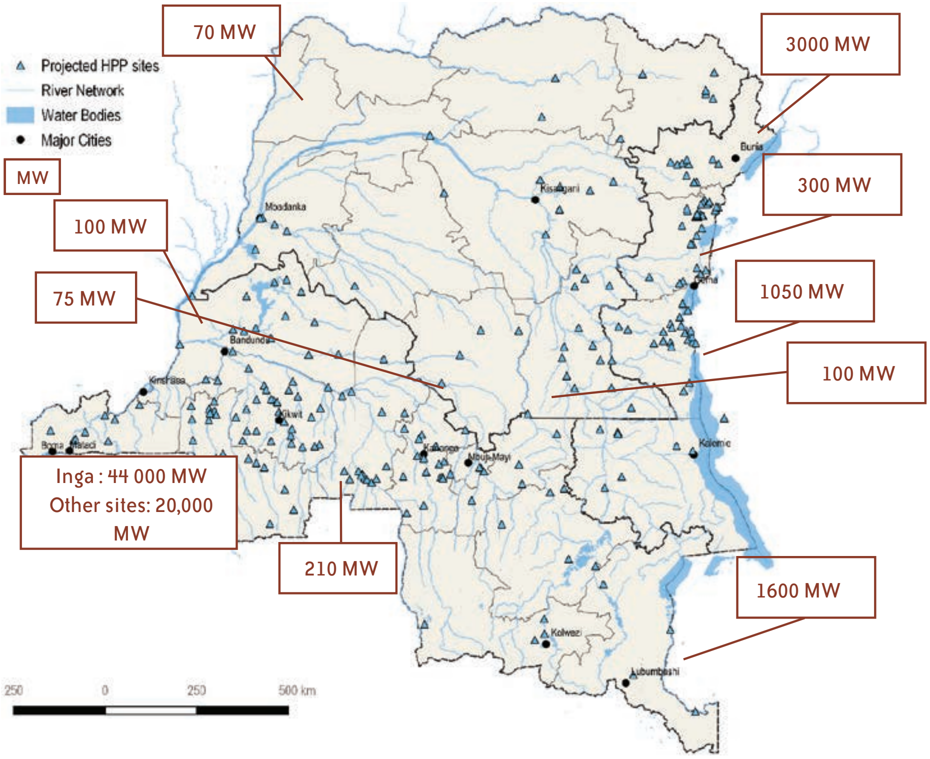
This chapter examines opportunities and constraints for power sector developments in the DRC. If planning identifies least-cost supply options considering demand, existing supply, latest market evolutions, and available resources, it should also recognize that in the DRC's context of fragility and deep uncertainty, a series of additional parameters must be considered during power sector planning.

3.1. ABUNDANT RENEWABLE ENERGY RESOURCES LOCATED CLOSE TO POTENTIAL DEMAND CLUSTERS

DRC has rich hydro resources distributed across the territory and some of this potential is in close proximity to extractive industries and population centers (Map 7**).** The DRC hydrological technical potential is estimated to be around 100 GW among which 70 GW have already been specifically localized and most of this potential (64 GW) being concentrated in Bas Congo Province.

Unique hydropower resources in the DRC have the potential to provide large competitive & flexible renewable energy but their development has been limited so far and exceedingly slow. According to a recent report by the

MAP 7 • Hydropower resource of DRC



Source: Resource Matters, SNEL, Study of Inga Hydroelectric Site Development and Associated Power Interconnections-Prefeasibility Study Report- Volume 2–AECOM and EDF–April 2012

International Renewable Energy Agency[28], hydropower remains the lowest-cost source of electricity worldwide, at 5 cUSD/kWh. Moreover, hydropower energy has the advantage to be flexible and to provide large-scale energy storage through reservoirs. In DRC, Inga being core to the hydropower potential of the country, efforts for developing generation over the last 8 years have mainly focused on this site; such focus was based on the facts that (i) levelized cost of energy for large development at Inga was expected to be in the order of 2 cUSD/kWh (see box below), (ii) Inga has the potential to meet part of DRC's electricity demand, and (iii) it could provide large opportunities to generate electricity export revenue. Unfortunately, the focus on expanding the Inga power plant has tended to delay the development of other hydropower sites, especially smaller ones.

A stronger focus on developing small and medium-sized HPP, closer to the electricity load is indispensable. In addition to new hydro sites, rehabilitation of hydro is actually the lowest cost option (estimated to be in the order of 2.5 cts / kwh) with potentially lesser environmental and social impacts and shorter project development time than new greenfield HPP. Existing hydro sites with the potential for rehabilitation are described in Chapter 2.

Vast land areas with high-quality solar resource are found in the three regions of DRC. The best potential is located where unmet demand is the highest along the Eastern border and in the Eastern half of the South-Western region (Map 8). Three categories of solar resource quality stand out in the DRC: (i) medium irradiation (around 1,810–1,830 kWh/m2)

BOX 1 • INGA 3: A LARGE & COMPLEX INFRASTRUCTURE PROJECT IN A FRAGILE & LOW CAPACITY CONTEXT

As first steps to the development of Inga site, Inga 1 and 2 projects have been commissioned respectively in 1974 and 1982 with an installed capacity of 350 & 1400 MW (which remain today as the core of electricity production in DRC). Since then, various studies have explored how to further tap in the large potential of Grand Inga (44,000 MW). Most recent study implemented by AECOM and EDF (2012) proposed a progressive development of the site with initial development of Inga 3 Low Head (LH) with installed capacity up to 4,800 MW at a levelized cost of energy originally estimated to be in the order of 2 cUSD/kWh, based upon European capital expenditures for similar projects and with the addition of a 20% physical contingency. This estimate did not include specific risks linked to the fragile situation of the country which would have increased the estimated cost or the transmission costs to end-users. Inga 3 low estimated levelized cost is also the result of the large hydrological potential of this site, which could potentially deliver a capacity factor much higher than in other HPPs since the plant would always be smaller than the actual volume of exploitable energy. On this basis and assuming the outright purchase of 2,500 MW by South Africa, tenders for the construction of Inga 3 were updated and submitted to the three Consortia previously prequalified. In June 2017, the two remaining Consortia led by ACS (Spain) and China Three Gorges Corporation (CTGC) were asked to submit a joint proposal. They signed an exclusive development agreement with the government of DRC in October 2018. However, little progress has been made to date, as South Africa's needs for such import is less pressing and questions remain on size and timing of this development. The cost of Inga 3 electricity to the final users will depend upon the cost of financing of the HPP, as well as the arrangements in sharing risks between the developer, the offtakers and the Government of the DRC. The final cost will exceed the figure above.

Based on the lessons learned from the past and considering the large unmet electricity needs of DRC, an option to jumpstart the development of Inga 3 should accommodate more explicitly the implications of a situation of fragility in the economic analysis of the HPP[29]. Inga 3 should also be designed to first and foremost satisfy DRC's pressing electricity needs, as opposed to be an export revenue generation project which will result in a larger set of risks to be mitigated, including governance challenges in the management of revenues. With this in mind, it is likely that the Inga 3 project would be of a much smaller size than what was anticipated in 2012, which would not prevent the possibility of extending its capacity in the future. In any case, before being able to start the construction of the future power plant of Inga 3, outright purchases to buy the electricity which will be produced must have been mobilized above. Finally, Inga 3 will also need to be part of broader power sector least cost planning for each of the three regions of DRC, and which will accommodate the need to not only minimize the cost of electricity generation but also the need to expand electricity transmission.

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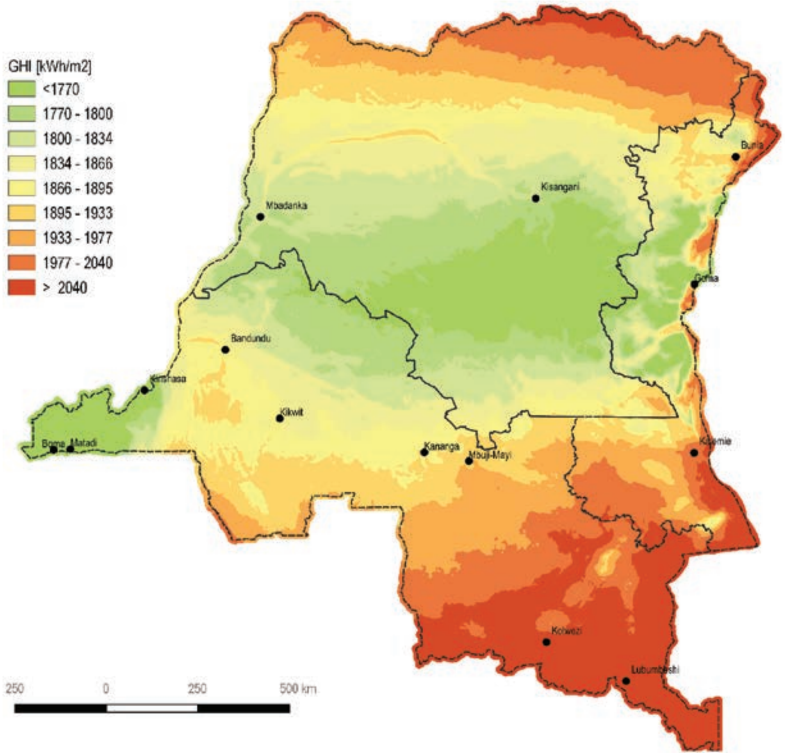
[28] *Renewable Power Generation Costs*, 2017.

[29] See Box 3 for an example in the case of South Sudan.

MAP 8 • Photovoltaic electricity potential (GHI, kWh/m^2)



Source: Solargis

in Goma, Kinshasa and Kisangani, equivalent to the quality in northern Morocco or eastern India, (ii) good irradiation (around 1,860–1,900 kWh/m2) in Bandundu or Kikwit, and (iii) exceptional irradiation in Kolwezi or Lubumbashi (more than 2,000 kWh/m2) which is equivalent to the best resources in the world like southern Spain or Arizona (USA).

With the rapid reduction in the cost of solar modules and batteries and a faster deployment rate than other forms of electricity generation, utility-scale solar (either grid-connected, or through isolated-grids) is set to become competitive in the DRC to offer rapid increase in generation capacity, particularly in the West-South where the resource is strongest. Back of the envelope calculations at current equipment costs produce price estimates that are lower than diesel, although not quite as low as hydro power (Table 2). A simple financial model for a 20 MWp solar PV power plant yields levelized tariffs ranging from 11.1 cUSD/kWh in Lubumbashi (12.2 cUSD/kWh with storage) where the solar resources is best, to 15.5 cUSD/kWh in Kindu, where it is weakest.

However, attaining low levelized cost of electricity for grid-connected solar PV in the DRC will depend on several factors, including the level of solar irradiation, CAPEX costs (EPC, transmission lines, development costs, land), cost of capital (debt and investors' equity), length of the Purchase Power Agreement (PPA) and the existence of fiscal incentives. Investors will particularly look at country risks (e.g. security, investment climate, investor protections), allocation of risks between the Government and the independent power producer (IPP), potential liquidity issue of the off taker (i.e. off taker bankability and creditworthiness) and the time and amount of money the IPP spend in development. In the DRC context, finding IPPs domestically and internationally could be a challenge. Access to concessional financing and guarantees complemented with key measures to improve business environment are needed to attract investments in the sector.

The mining sector, which is currently producing power through diesel gensets, could be an interesting partner for solar plants. The mining sector is already working in the country and is familiar with country risk. Moreover, they

TABLE 2 • Financial model for a 20 MWp installed capacity of solar PV

	Location	GHI (kWh/m² per year)	Cities with similar quality of solar resource	Capacity Factor	Storage	CAPEX total (kUSD/MW)	O&M (kUSD/MW)	Tariff (levelized) (cUSD/kWh)	Year 1 tariff with fixed 2% increase/ year cUSD/kWh
Low irradiation	Kindu	1779	Yaounde	16%	No	1,155	32	**15.3**	16
Medium irradiation	Goma/ Mbandaka	1838	Rabat	16%	No	1,155	32	**13.5**	14
	Kinshasa	1819	Tanger	17%	No	1,365	32	**13.4**	14
	Kisangani	1810	Accra	16%	No	1,365	32	**13.4**	14
High irradiation	Bandundu	1867	Casablanca	17%	No	1,365	32	**13**	13.5
	Isiro	1933	Nairobi	17%	No	1,155	32	**12.5**	13
Very high irradiation	Lubumbashi – w/o storage	2149	Niamey	20%	No	1,365	32	**11.1**	11.6
	Lubumbashi – with storage	2149	Niamey	20%	Yes (7MWh)	1,475	32	**12.2**	12.7

Source: World Bank

need power and are currently paying a much higher price for diesel. Contrary to terms of current deals between SNEL and the mines, any deal, would however need to carefully look at the balance of risks, debt structure and payment of development costs across the involved players.

This note acknowledges the importance of biomass as an key source of primary energy in DRC but considers its limitations as being too strong to constitute a significant response to the electricity access challenge. DRC has significant biomass resources, challenged by deforestation. FAO estimates tropical rainforests cover 67% of the country's surface area, two thirds of which are primary forests, which need conserving as one of the most biodiverse habitats on Earth. Traditional biomass is the mainstay of DRC's population for cooking purposes. DRC has solid potential for modern energy production from forestry and agricultural waste and methane, but no systematic comprehensive studies exists to date. SE4ALL and AfDB (2017) identified only three biomass projects: 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 (Sucrerie Kwilu-Ngongo) runs a 9MW biomass power station running on sugar bagasse in the city of Kwilu-Ngongo. The constraints to identify biomass resources that can be mobilized on a large scale and with sufficient supply consistency limit the potential for a scale-up proportionate to the broad electricity needs.

3.2. SCARCE INFRASTRUCTURE, FRAGILITY AND POOR GOVERNANCE MAY FAVOR SUPPLY OPTIONS THAT ARE NOT ALWAYS LEAST COST

Despite abundant renewable energy resources, the absence of transport infrastructure needed to support a large-scale infrastructure project substantially increases project costs. Transport infrastructure in DRC is in a very poor state. Road infrastructure density is among the lowest in the world, with 1km of paved road per 1000 km² of land, which is 16 times lower than the Low-income country average[30] (Map 9). DRC has approximately the same size of network of paved roads as Luxemburg, for a land area that is one thousand times larger. The cost of moving freight along the Congo

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[30] Damania et al (2015).

River— around 5 cents per ton-km—is only a third of the cost of moving freight by road (Foster and Benitez 2011) but would only support logistics for potential sites on the Congo and Kasai rivers.

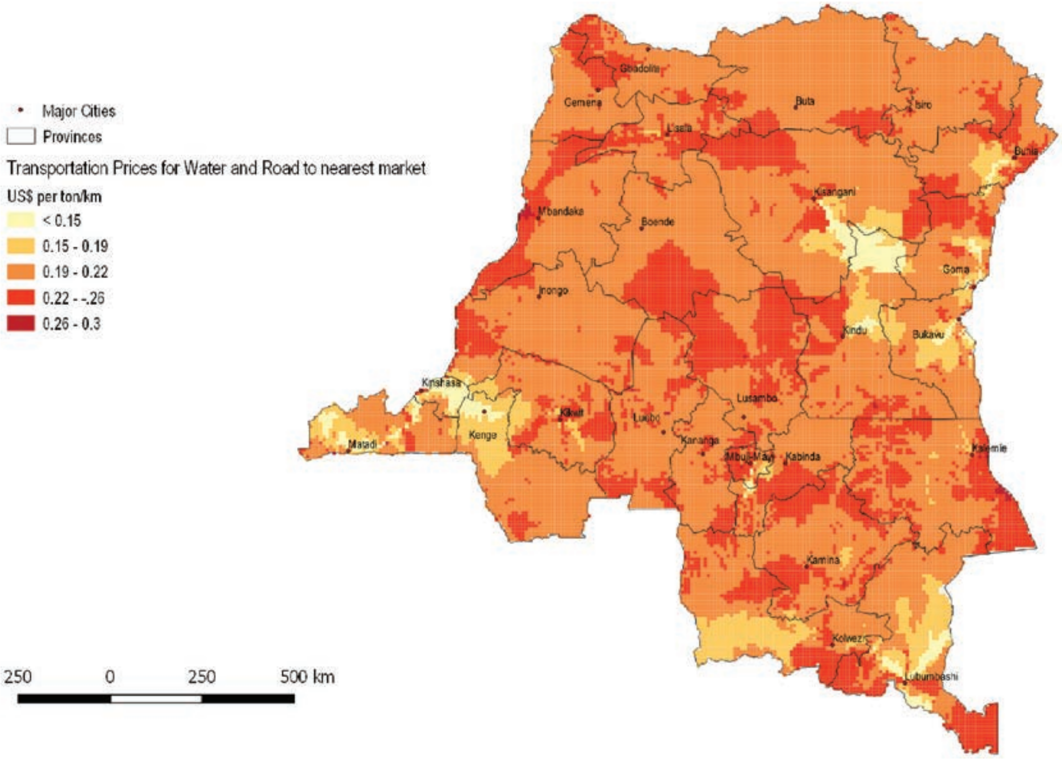
Moreover, very low levels of governance add a layer of risk to infrastructure development and should be taken into account when deciding which kind of investment to make. Despite efforts to strengthen national institutions and some improvements, the quality of governance as measured by the Bank's Worldwide Governance Indicators (WGI) in the DRC is very low compared to the regional average. The DRC scores in the lowest 10 percentiles across all six key governance dimensions (Figure 9). Similarly, the Doing Business report for 2017 ranked DRC 182nd out of 190 participating countries. Governance weaknesses continue to impact negatively the business climate and hinder private sector development and the country's ability to attract investors. Large and complex infrastructure projects are particularly vulnerable to these governance issues.

Although traditional planning tends to prioritize "scale-efficient solutions" like large-scale centralized infrastructure, in the DRC it is also important to include risks associated with security issues, which are experienced across the country, but particularly on the Eastern border (*Map 10*). The risks of damages, destructions, delays or even cancellations should therefore be recognized and internalized into the power sector planning in order to better inform decision-making and favor alternatives which are more flexible or incremental (Bazilian and Chattopadhyay, 2015).

3.3. ADAPTING POWER SYSTEM PLANNING TO A CONTEXT OF DEEP UNCERTAINTY

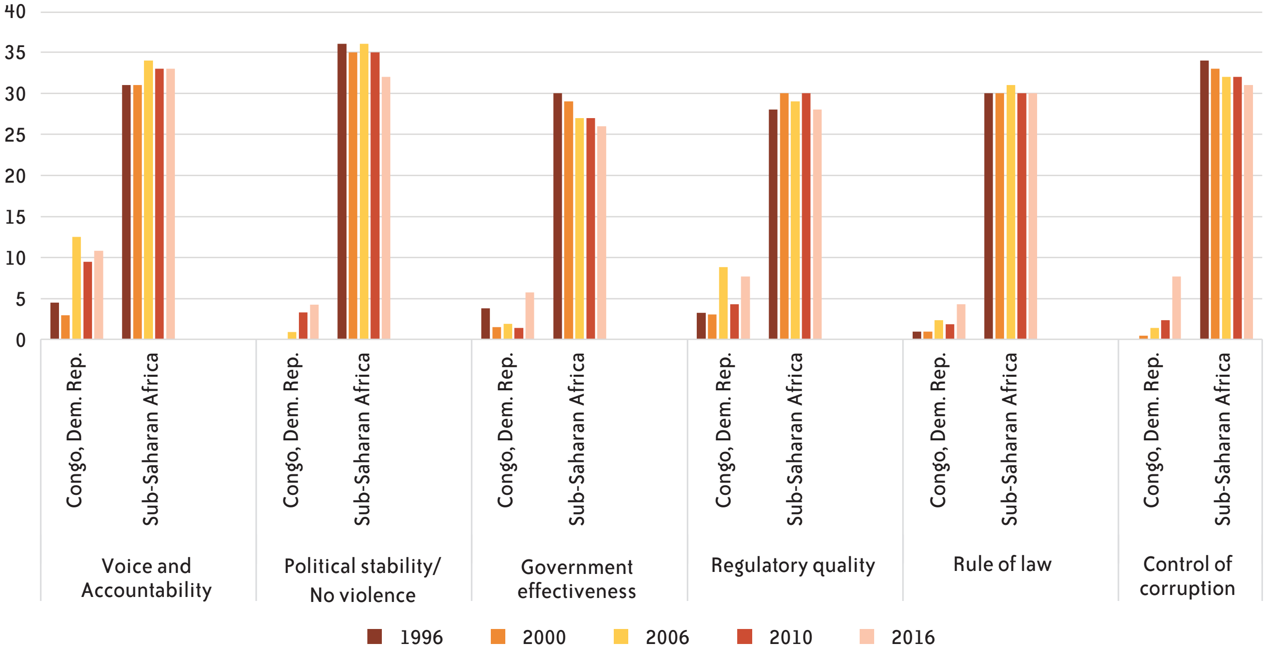
The energy potential of a region and the prioritization of power supply solutions must be evaluated not only in relation to estimated demand and, availability of renewable resources, but also along with the expected development and construction constraints, costs of capital, risks of violence and logistical complexity. In regions with high demand density close to the existing grid infrastructure, national grid improvements and extensions may be the

MAP 9 • Transport costs per kilometer to the nearest market (US$ per ton)



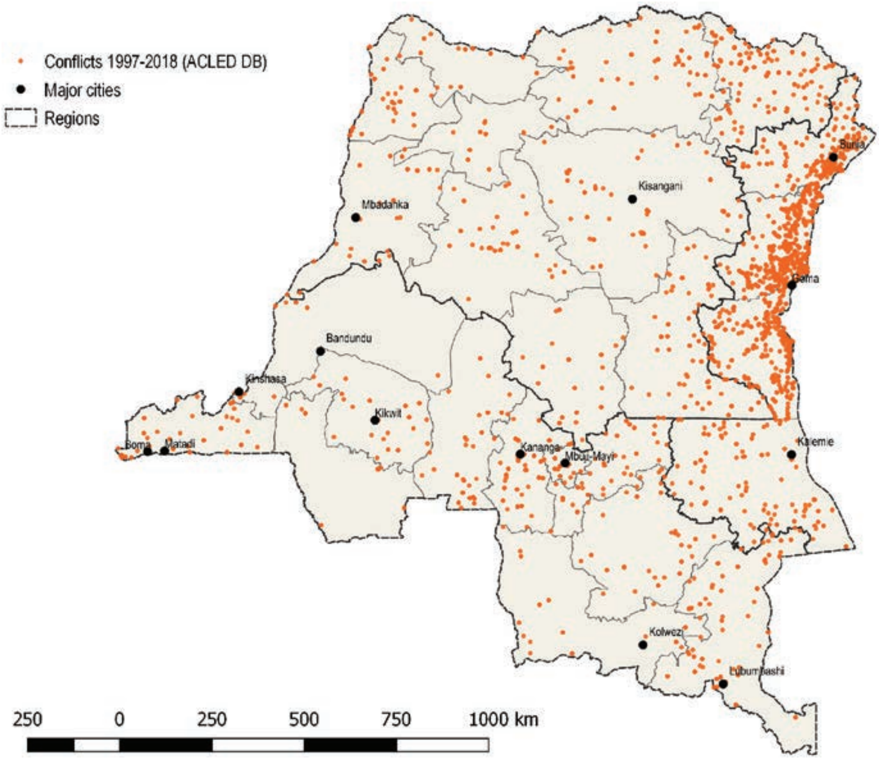
Source: Damania (2015)

FIGURE 9 • Governance indicators: DRC v. Sub-Saharan Africa Average (percentile rank - 0 to 100)



Source: World Bank 2018

MAP 10 • Location of conflicts between 1997 and 2018



Source: ACLED, authors

BOX 2 • FRAGILITY AND CONFLICT IN DRC

Fragility in the DRC is often associated with recurrent cycles of violent conflict in the country's eastern provinces. However, as the current political tensions show, structural and conjectural drivers of fragility affect the country's East and West alike:

- Central to the fragility analysis is the nature of the DRC's political system, which is characterized by deeply ingrained neopatrimonialism and has blurred the boundaries between the public and private spheres and deeply affected the nature of state institutions. Badly required reforms needed for economic and political stability have ground to a halt or been blocked, as they may threaten powerful players' interests.
- The Congolese undiversified economy is vulnerable to external shocks. Following the 2002 peace agreement, the economy started to grow again, driven by the revival of the mining industry. Between 2010 and 2015, the growth rate averaged 7.7 percent per year. However, this remarkable economic performance has not been used for diversification, and very few investments have been made in sectors such as transportation, energy, or agriculture, which would allow the economy to move away from its reliance on the extractive industry, which is prone to elite capture.
- A strong sense of frustration and helplessness reinforces the perception that violence is a legitimate strategy. The DRC's social fabric has progressively disintegrated since the later years of the Mobutu reign and was further damaged by the two Congo wars. The weakness of the security and justice sectors and the resulting impunity have also fuelled the lack of trust in State institutions and a sense that taking up arms is necessary to protect one's community and solve conflicts.

Recent developments—such as electoral tensions—are of a conjectural nature and have not addressed the deeper structural causes of fragility.

The eastern provinces are still vulnerable to relatively small and fragmented but numerous armed groups and recurrent violent events and clashes. At present, some 160-armed groups are active throughout the country; they are mostly small, local self-defense groups of around three hundred combatants and use local grievances to mobilize fighters and gain access to fertile land or other resources. Today, a rising polarization can be observed over the delayed organization of elections. Since 2016, the rising tensions in Kinshasa have been accompanied by a resurgence of sub-national conflicts throughout the country. Insurgents in North and South Kivu, and the Kasai region all have exploited the deteriorating political climate to justify their actions. For now, these dynamics appear isolated, but they are increasing in frequency and point to the risks of prolonged unrest. Humanitarian consequences have been considerable, as reflected in the large number of new internally displaced persons and refugees.

Source: World Bank

most appropriate option. In less populated areas, farther from the grid, or in areas with a high degree of uncertainty (including security), isolated grids[31] and off-grid individual technologies such as solar home systems tend to be more suitable (*Figure 10*).

These factors may act at the margin to sway a recommended solution towards solar power plants and distributed energy systems rather than large hydropower projects and long transmission lines. Even though building a large hydropower plant could be the least cost option in a context of certainty, it may not be the case anymore if risk-adjusted costs (including for instance additional financing costs, procurement costs) are taken into account. Solar facilities have lower structural engineering requirements than other renewable energy sources, even with the addition of storage. They can be built near urban electricity loads thereby reducing transmission costs. They are modular so can be adapted

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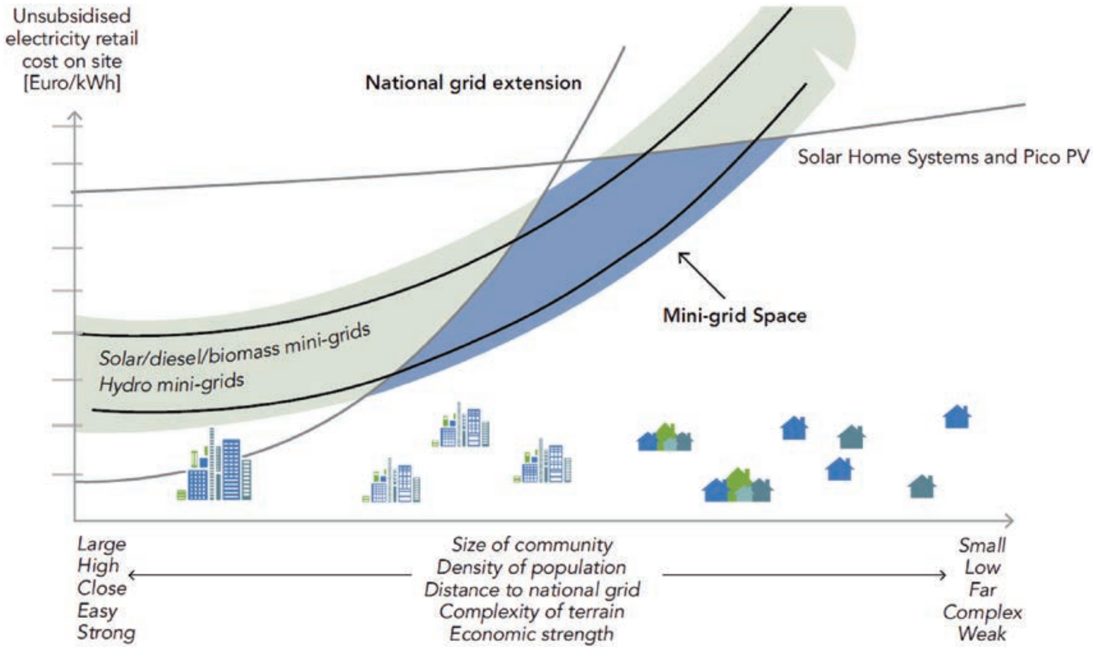
[31] *An isolated grid (or mini grid) is a set of electricity generators and possibly energy storage systems interconnected to a distribution network that supplies electricity to a localized group of customers and operates independently from the national transmission grid.*

FIGURE 10 • Opportunities for supply options in an environment of certainty



Source: Inensus

to existing demand and then scaled up as demand grows. Furthermore, maintenance on solar power plants is also less costly and complex.

However, all viable power supply options will suffer from the degraded culture of performance and chronic under-funding of maintenance in the DRC. While some planning can be done based on existing information, the government and sector stakeholders should endeavor to create more information to better estimate demand.

Traditional methodology of power sector planning is therefore inappropriate. Planning in infrastructure development cannot ignore inherent risks related to fragile and conflict-affected environments. Three categories of uncertainty are identified (Bazilian and Chattopadhyay, 2015): difficulty in predicting load demand as seen in Chapter 1, uncertainty on the project development and construction stages (delays, cancellation), and uncertainty on day-to-day operations during the lifetime of the investment (sabotage, attack)[32]. Centralized systems which benefit from economies of scale would not always be the most relevant option.

New assumptions are required to better reflect the impacts of fragility on investment prioritization. In future planning efforts in DRC, least cost planning will need to consider the impact of a context of fragility on several variables. These assumptions should include:

i) The lesser availability of debt than in a non-fragile context.
ii) A much higher expected return on private equity than in a non-fragile context (with WACC equaling 20 to 25%).
iii) Probabilities of delays in project start dates and commissioning dates, especially for larger generation projects (>100MW).
iv) The probability of full cancelation of generation projects.
v) Probability of permanent damage due to lack of operation and maintenance, or vandalism in associated high voltage transmission lines.

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[32] Bazilian and Chattopadhyay, (2015) *Considering power system planning in fragile and conflict states.*

Including risks associated to fragility in least cost planning exercises will likely result in several changes in the development priorities of the sector's infrastructure compared to previous efforts in DRC. Those changes will likely result in:

i) Larger total system cost of development than expected without taking into account fragility;

ii) Fewer large HPPs (>100MW);

iii) A more diversified electricity supply mix with small and mid-size HPP, small solar plants with storage and small diesel plants located near the loads;

iv) Lower total high voltage transmission capital expenditure, but a higher generation capital expenditure;

v) Higher volume of energy being unserved by the grid, justifying a stronger emphasis on off-grid options.

Based on lessons learned from past international engagements in the DRC power sector, preparation of large complex projects (such as Inga 3) requires more attention and devoted resources to reduce the amount of guesswork and mitigate implementation risks. In addition, clear commitments on strategic directions for the project should be secured upfront from the ultimate decision-making authority. Partners must retain enough leverage to ensure proper structuring of contracts and enforcement of legal covenants and to address project and contract management failings.

At the implementation stage, building in-house transactional and technical capacity within the national decision-making institutions is essential to be able to efficiently oversee complex transactional and strategic support performed by consultants. Incentives toward prompt implementation must drive project suppliers. The bulk of suppliers' profit should be associated to the on-time commissioning of equipment. Exit and transparency clauses should be included into owner's engineer contracts with the corresponding enforcement mechanisms to address contractors' poor performance and lack of professionalism.

BOX 3 • POWER SYSTEM PLANNING IN FCV STATES: A CASE STUDY (FROM BAZILIAN AND CHATTOPADHYAY, 2015)

Traditional methods of energy planning are likely to provide results that may be inappropriate in fragile and conflict-prone countries. The risks of violence and damage, or significant delays and cancellations in infrastructure development, are rife in these states. Bazilian and Chattopadhyay (2015) find striking differences comparing the results of two least cost planning exercises that take, or do not take, these factors into account for the case of South Soudan.

As of June 2015, South Sudan had no backbone transmission and less than 30 MW of installed diesel capacity serving pockets of loads in towns. It had one of the lowest electrification rates in the world of under 10%, and long-term power demand was expected to grow to 2,500 MW by 2045. A report prepared by Hatch (2015) developed a traditional long-term least cost capacity expansion plan that does not consider the risks associated with raising capital in a fragile environment. Primarily focused on developing a series of relatively large-scale hydro projects (including Shukoli HPP – 1100MW – and Bedden HPP – 520 MW), it would require $5.35 billion in new generation investment. In addition to the large projects, the generation investment plan also foresees $910 million in new transmission infrastructure to evacuate power from the proposed generation projects.

Bazilian and Chattopadhyay (2015) develop a transmission constrained generation expansion model that minimizes total system costs subject to a set of technical and financial constraints. They integrate the financing costs for debt and equity and constraints that might be associated with both (e.g., a debt cap) *endogenously* in a least-cost planning model, making the following assumptions:

1. A 60:40 debt/equity financing for all generation projects that would require $3.21 billion in debt to support a total of $5.35 billion in new investment over 2015–2045;
2. Return on equity of 25% reflecting high risk and a cost of debt of 7%; and
3. A debt ceiling of $2.4 billion, or 25% below unconstrained level. All other things being equal, the debt ceiling would increase the cost of capital-intensive hydro projects relative to that of new diesel plants.
4. All hydro projects face a potential delay in start year. There is a 45% chance of a timely start, 45% chance of a delay by up to 3 years and a 10% chance of the project being cancelled;
5. There is also a 10% chance for all years of all big projects (>100 MW) and associated 220/400 kV lines to be damaged permanently.

The table below compares the results of the conventional least-cost scenario with the 'modified least-cost plan'. The constraints have a substantial impact on system costs raising it by $1.38 billion or 18% primarily because of the additional diesel generation cost of $1.07 billion that the latter entails. The fragile scenario adds 443 MW additional (or, nearly double the solar capacity) compared to the traditional least-cost scenario. The variability of solar generation explains the worsening of the reliability of the system with higher expected unserved energy. Generation investment is curtailed by the debt ceiling and by the related increase in cost of (equity) financing. The most significant difference is in the mix of new capacity addition: Capital intensive and uncertain hydro projects reduce from 1,922 MW in the least-cost to 339 MW, diesel capacity nearly doubles, mostly in the town/city areas. Solar also goes up significantly.

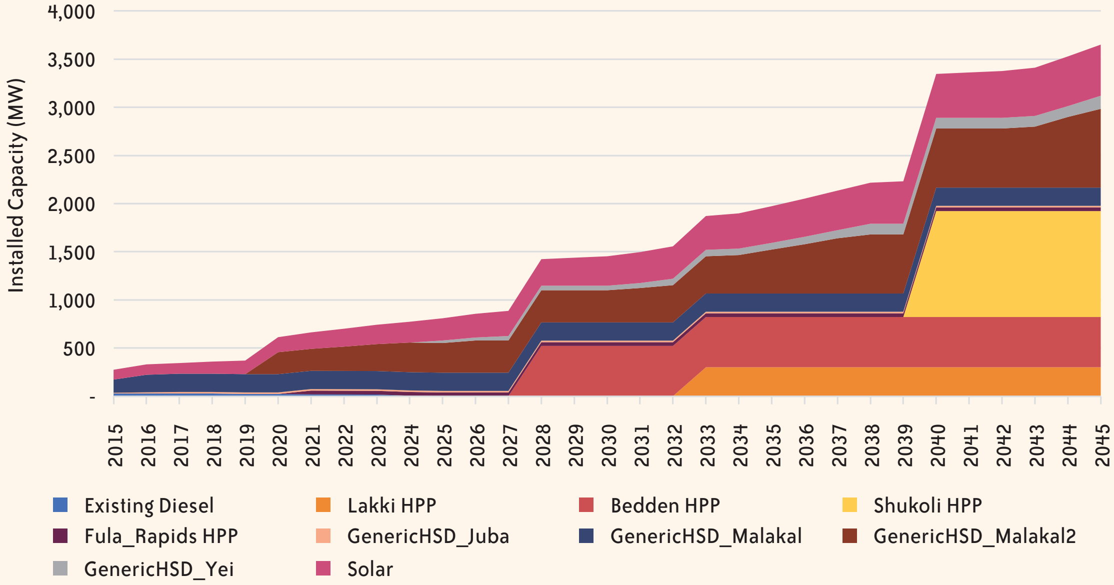
Parameter	Traditional least-cost	Modified least-cost with fragile-filter
Discounted system cost (2015–45) in $million*	7,592	8,971
Expected unserved energy (2015–2045) % of total energy	0.76%	1.23%
Generation investment ($b)	5.35	4.08
Hydro (MW)	1,922	339
New Diesel (MW)	1,198	2,354

*Note: This includes annualized capital costs for all new generation projects, fuel costs, and costs of unserved energy (but does not include transmission investment costs).

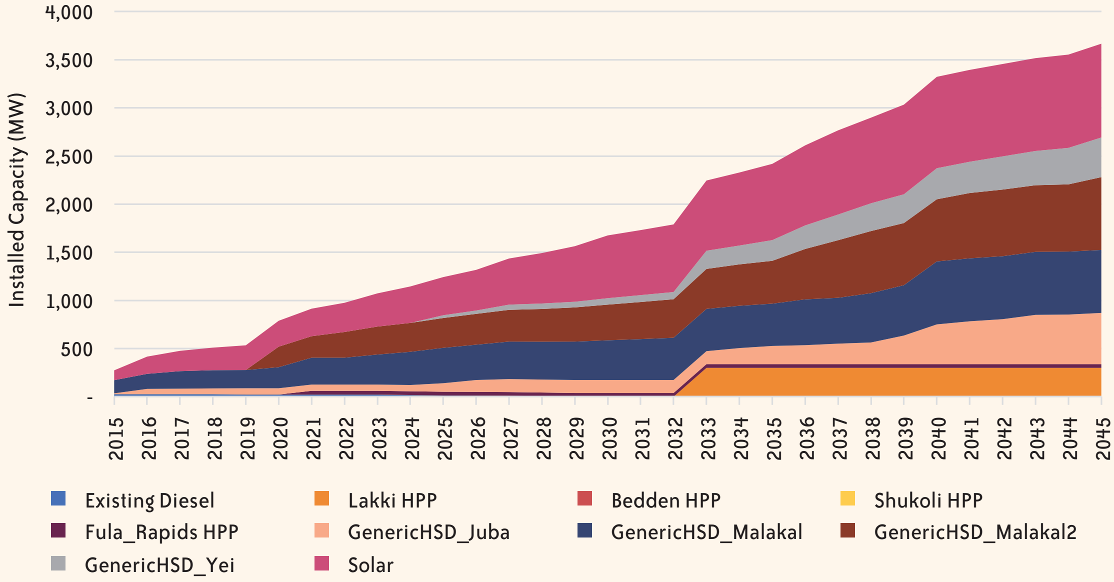
BOX 3 • POWER SYSTEM PLANNING IN FCV STATES: A CASE STUDY (FROM BAZILIAN AND CHATTOPADHYAY, 2015) (*Continued*)

The graphs below show the capacity development profiles for the least-cost (left) and modified least-cost (right) scenarios. The original capacity plan is lumpier reflecting large hydro projects being added creating significant surpluses, followed by little capacity addition, whereas the fragile scenario is characterized by much more gradual capacity addition over the years. Solar and diesel complement each other with diesel providing the baseload (and some load following) role and solar helping to contain the amount of expensive fuel. As the mega hydro projects are not considered in the fragile scenario, the transmission extension to these projects are also not needed lowering the amount of capital from $910 million to $376 million. The authors did not explore the role that may be played by storage, or very small appliances like Solar Home Systems with battery. As such, the power grid in the illustrative case study (right hand side) continues to be a significant part of the supply with distributed solar and diesel generation augmenting the main grid.

Least-cost capacity expansion plan



Capacity plan considering fragile environment



Source: Bazilian and Chattopadhyay, 2015

4

TOWARDS A FRAGILITY-ADAPTED REGIONAL POWER SYSTEM PLAN

Photo : © Iongwa Mashangao and Malango Washikala

4. TOWARDS A FRAGILITY-ADAPTED REGIONAL POWER SYSTEM PLAN

This chapter discusses the challenges, opportunities and priorities for the power sector in each of the three regions (South-West, East, North-Center). The proposals outlined in the chapter take into account regional specificities. In the South-Western region, for example, where more than half of the population lives within the existing grid area and the demand density is higher, investments could be made to improve existing electricity system infrastructure and expand grid access and capacity. In areas that are father from high populated zones, stand-alone systems are a more viable alternative. In the North-Central region, however, projects to develop isolated grids and stand-alone systems should be prioritized as the population is less dense and the terrain more difficult. Even though the Eastern region has a large potential for stand-alone systems, major urban demand centers such as Goma, Butembo and Beni could also benefit from improvements to and expansion of existing grids (Table 3).

TABLE 3 • Estimates on potential access to existing grid, isolated grids and stand-alone systems by region

Region	Total population estimate (2015)	Population living within the existing grid area *[which could theoretically reach Tier 5 access]*	Population living in towns with isolated grid potential[33] *[which could theoretically reach Tier 5 access]*	Population eligible for stand-alone systems *[which could theoretically reach Tier 2 access[34]]*
South-West	40,882,615	52%	6%	42%
East	17,081,462	32%	10%	58%
North-Center	23,760,160	0–1%	16%	83%

Source: Worldpop, World Bank estimates

4.1. THE SOUTH-WESTERN REGION: STRENGTHEN AND DENSIFY EXISTING INTERCONNECTED GRID BACKBONE AND FOSTER ISOLATED GRIDS AND STAND-ALONE SYSTEMS WHERE GRID IMPROVEMENTS ARE LESS VIABLE

The South-Western region is the most densely populated area of the country and around 20 million people lives within 50km of the existing grid, the highest number of any region[35]. Of the 41 million inhabitants, more than half live in urban areas[36], including four cities with more than one million inhabitants: Kinshasa, Lubumbashi, Mbuji-Mayi, and Kananga (*Figure 11*).

Given the high demand density and existing grid infrastructure, investments in the South-Western region electricity system should seek to:

i) strengthen and densify the existing interconnected grid backbone in order to improve reliability and quality of service and to keep up with fast growing demand;

ii) foster mini- grids and stand-alone systems where grid improvements and expansions are less financially viable.

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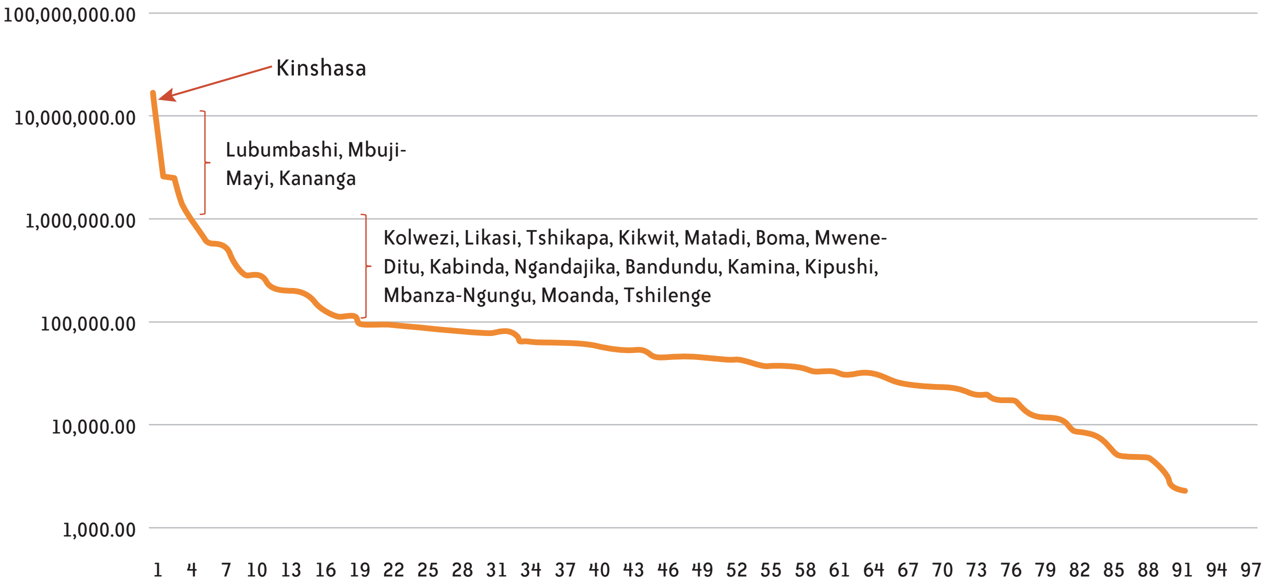
[33] An isolated grid (or mini grid) is a set of electricity generators and possibly energy storage systems interconnected to a distribution network that supplies electricity to a localized group of customers and operates independently from the national transmission grid.

[34] Households in Tier 2 can have electricity at least 4 hours per day and 2–3 hours per evening and can power television or fan (capacity <= 199W).

[35] Worldpop, SNEL.

[36] Worldpop 2015.

FIGURE 11 • Estimated distribution of cities in the South-Western region, by number of inhabitants (2017) (city population is on the vertical axis, horizontal axis denotes the number of cities)



Source: Authors, based on De Saint Moulin, 2010[37]

Strengthen and densify existing interconnected grid

The existing high-voltage (HV) transmission grid infrastructure is in good condition and recently underwent expansion. Between 2012 and 2017, SNEL's total HV grid length increased by 23 %, from 5,510 km to 6,771 km. The Kolwezi-Kasumbalesa axis was built and two additional lines between Inga and Kinshasa enable to secure the supply of Kinshasa in case of default on the existing lines. The Inga-Kolwezi HVDC line was also rehabilitated over the same period[38] and work is currently underway to increase the transit capacity from 560 MW to 1,000 MW (Map 11).

Despite expansions and improvements, demand is outpacing supply. Demand was estimated at 10,000 GWh in 2017 and is expected to grow to 28,000 GWh by 2030. The mining sector accounts for a large share of this demand, which is expected to reach 11,000 GWh by 2030.

Moreover, medium and low voltage infrastructure in many places is old and deteriorating. Cities such as Lubumbashi, Kolwezi and Likasi have aging distribution networks that are strained due to population and demand growth. Moreover, the Medium Voltage (MV) and Low Voltage (LV) networks in Kinshasa are currently operating below technical standards and require major modernization investments. For example, in April 2018, 20% of Kinshasa's MV equipment in service was overloaded (Table 4). This caused damages to equipment and required load shedding. The situation is aggravated by the old age of facilities which are becoming obsolete and the degradation of the LV grid, characterized by cables riddled with non-compliant junction boxes, deteriorating substations due to fraudulent connections and lack of maintenance.

In cities that already have grid access such as Kinshasa, Boma, Mbanza-Ngungu and Bandundu, electricity connections to new developments are needed to expand access to electricity (Table 5**).** The shaded areas in *Map 12* around Kinshasa in the West and Kolwezi in the South represent areas where grid densification could be the least-cost option.

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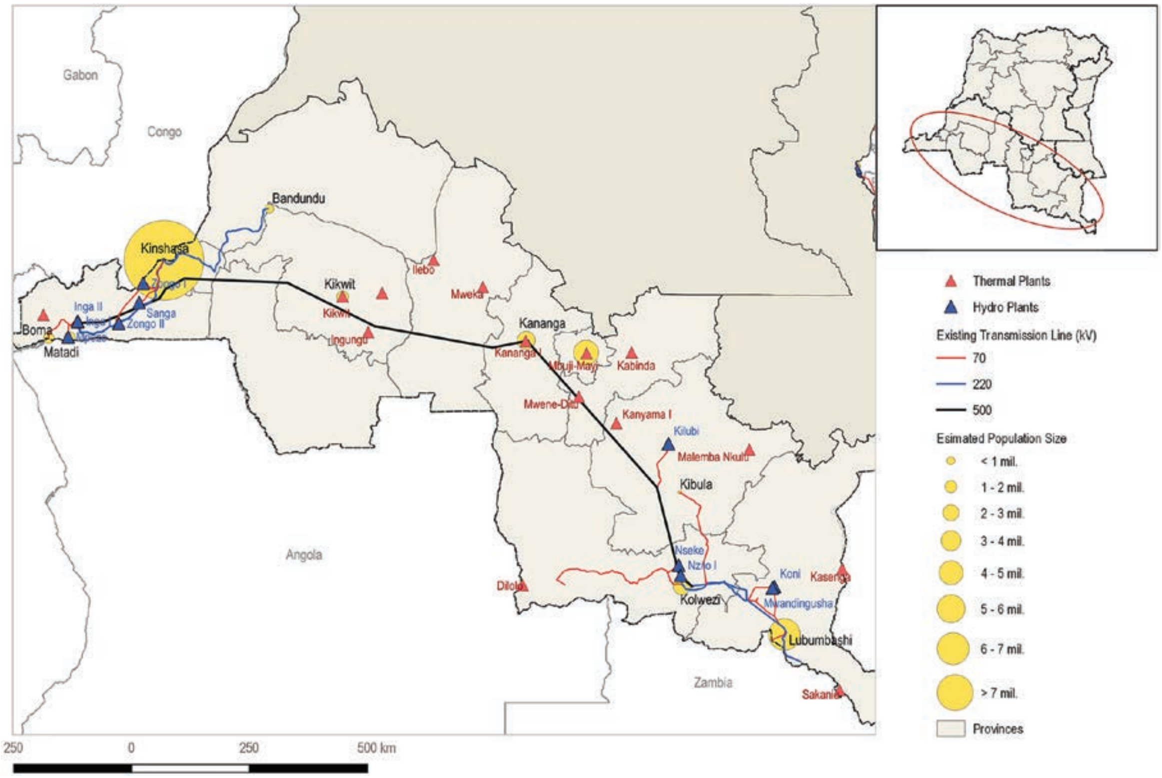
[37] De Saint Moulin, L. (2010). Villes et organisation de l'espace au Congo (RDC). Cahiers Africains. Afrika Studies. No. 77. Paris: L'Harmattan.

[38] Financed under the World Bank SAPMP project.

MAP 11 • Existing power system in the South-West region



Source: WorldPop, SNEL, Resource Matters, World Bank

TABLE 4 • State of distribution network in Kinshasa

Equipment	Total	In service	Out of order	Unknown	F<80%	80%<F<100%	F>100%
HV/MV Transformers	14	10	4	0	5	3	2
		71%	29%	0%	50%	30%	20%
MV/MV Transformers	44	40	4	1	19	12	8
		91%	9%	3%	48%	30%	20%
30 kV Lines	54	41	13	3	24	10	4
		76%	24%	7%	59%	24%	10%
20 kV Lines	69	65	4	4	49	9	3
		94%	6%	6%	75%	14%	5%
6,6 kV Lines	247	211	36	19	92	45	55
		85%	15%	9%	44%	21%	26%
Total	428	367	61	27	189	79	72
		86%	14%	7%	51%	**22%**	**20%**

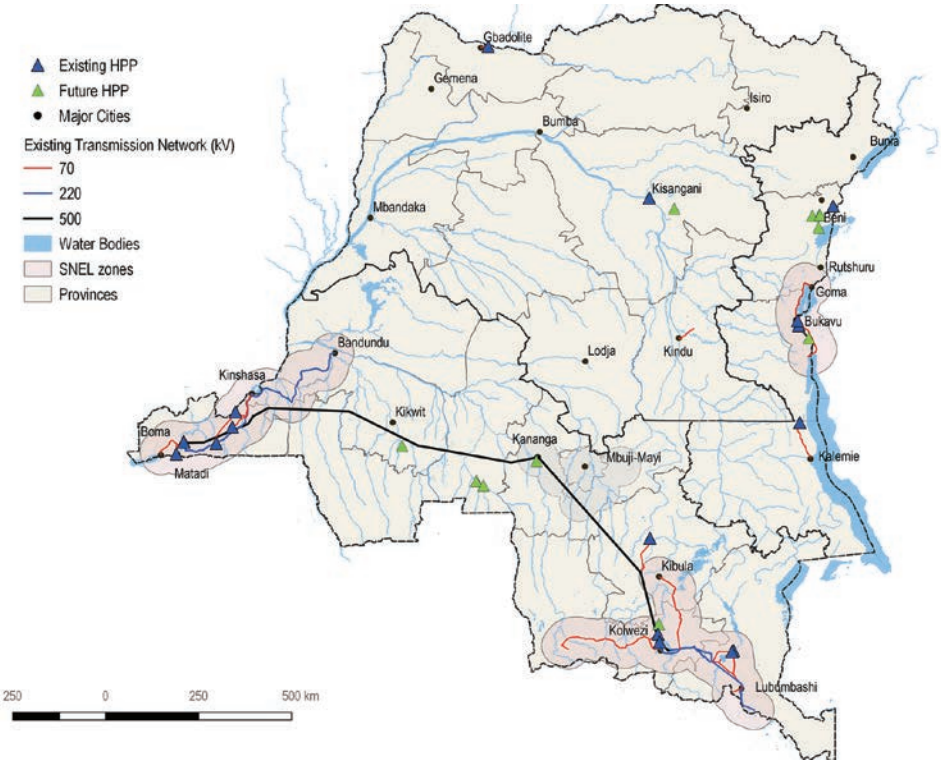
Source SNEL – Kinshasa Monthly Activity Report April 2018

TABLE 5 • Prioritized electricity improvement projects to be included in future least cost electricity sector development planning for key urban centers connected to the South-West backbone

Major Cities (CL: Chef Lieu)	Province	Connected to the South-West Grid (Yes/No)	Transmission Grid	Distribution Grid	Grid vs Isolated grids
Kinshasa	Kinshasa	Y	• Construction of 2 power stations 200 kV/400 kV in Inga and 400kV/200kV in Kinshasa to use the full dispatch capacities of the last 2 HV lines Inga-Kinshasa • Construction of the 220 kV lines between Zongo 2 and Kinshasa to dispatch the full capacity of Zongo 2 + Zongo 1 • Rehabilitation and maintenance of the existing grid (i.e. lines, HV/HV substations)	Rehabilitation, densification and extension of the distribution grid (i.e. MV and LV lines, substations, transformers)	
Matadi (CL)	Kongo Central	Y	Rehabilitation and maintenance of the existing grid	Rehabilitation, densification and extension of the distribution grids in the area	
Boma		Y			
Mbanza-Ngungu		Y			
Moanda	Kongo Central	N			A study will have to be carried out to determine the least cost option between the extension of the transmission grid or distribution grid from Boma or the development of a isolated grid
Bandundu	Kwilu	Y	Rehabilitation and maintenance of the existing grid	Rehabilitation, densification and extension of the distribution grids in the area	
Kolwezi (CL)	Lualaba	Y	Maintenance of the existing grid	Rehabilitation, densification and extension of the distribution grids (i.e. MV and LV lines, substations, transformers) in the Kolwezi-Kasumbalesa corridor	
Lubumbashi (CL)	Haut Katanga	Y			
Likasi	Haut Katanga	Y			
Kipushi	Haut Katanga	Y			
Kamina (CL)	Haut Lomami	N	Connection of Kamina to the South-West transmission grid through the construction of a 120 kV line between Kilubi and Kamina	Rehabilitation, densification and extension of the distribution grids in the area	

Source: Authors

MAP 12 • Targeted areas for grid expansion and densification



Source: SNEL, ESRI, Resource Matters, World Bank, authors

However, for grid densification to be the least cost solution and expanding access in the identified areas, rehabilitating existing capacity and additional production capacity will be required to supply new connections (Table 5**).** This capacity increase could be achieved through several means including through:

- rehabilitation and maintenance of existing facilities to recover the full installed capacity. As a priority, the rehabilitations of the last group of Inga 1 (G16) and the last 3 groups of Inga 2 (G24, G25 and G26) must be completed, and the rehabilitations of the Zongo 1 and Nzilo power plants must be initiated, ie 775 MW in total,
- development of the transmission grid to be able to dispatch the full capacity of Zongo 2,
- development of new projects from a least cost production plan, based on hydro or solar (particularly in the South) options anywhere along the backbone, and
- increase in imports in the short or medium term from neighboring countries to address especially unmet demand from the mining sector located in the South-East. Angola recently boosted its generation and plans to further develop solar and hydro in coming years, which should allow the country to export in the medium term. Zambia should also commission Kafue Lower hydropower project (750MW) within 2020–2021 which will provide opportunity for Zambia to export to DRC (especially to Katanga industries). Both governments have also decided to jointly expedite the development of hydropower on the common sites of the Luapula River (around 1000 MW of installed capacity) in order to supply mining and industrial activity. The interconnection between Kolwezi and Solwezi under development should also facilitate such export. In CAR, the opportunity of a new hydropower site on the Ubangui River (207MW) could enable to supply Gemena, Zongo and Libengue (DRC) in addition to Bangui (CAR).

Investigate isolated grids and stand-alone systems where grid improvements and expansions are less economically feasible

The economic desirability of mini-grids requires a case-by-case analysis that looks at remoteness, security, demand forecasts and SNEL's capacity to invest and expand the grid. With more than 2 million inhabitants, Kananga and Mbuji-Mayi are not connected to the transmission grid although very close to the Inga-Kolwezi 500 kV DC line. In these provinces of Kasai Central and Oriental, an alternative to mini-grids could be the construction of a third DC/AC conversion station near Kananga and a transmission line to connect Mbuji-Mayi. Further studies should investigate whether a mini-grid solution or the connection to the interconnected grid is the least-cost option (Table 6).

According to the mini-grid market opportunity assessment study (ADB and SE4All, 2017), isolated grids have been identified as an economically feasible solution in about forty small towns (Table 7), representing around 2.5 million people. Some of these towns have already existing or decommissioned generation and distribution infrastructure and could be candidates for rehabilitation or expansion (marked with an asterisk in Table 7). In addition, isolated grids could also suit a few additional mid-size towns such as Kikwit along the transmission grid that cannot be connected to the South-West backbone because of technical constraints and insufficient demand.

Some mini grids are already operating in the region. EDC has 400 customers in Tshikapa (Lungundi I)[39]. The main existing solar project in the DRC is a 1MW solar mini-grid with 3MWh of battery storage capacity built by Enerdeal and Congo Energy in the city of Manono, to supply the local population and SMEs. Enerkac has also developed a 1MW hybrid plant powering SNEL's Kananga mini-grid in Kasaï Central (non operational in 2019).

For the 17 million people who live in areas in the South-Western region that are neither eligible for grid nor mini grid connections, standalone systems could be the alternative. IRENA estimates that 1,2 million people already have access to solar lights in the country (2016)[40]. Even in areas reached by the grid, standalone systems are suitable as back-up supply solution where electricity service is unreliable. In the short term, standalone systems distributors focus on unserved urban areas which represent large demand centers relatively easily reachable. Decentralized generation offers more affordable service although providing a lower level of service. Without specific financing

TABLE 6 • Prioritized projects for major urban centers near the South-West backbone

Major Cities (CL: Chef Lieu)	Province	Connected to the South-West Grid (Yes/No)	Transmission Grid	Distribution Grid	Grid vs Mini-grids
Kananga (CL)	Kasai Central	N	Connection of Kasai Central and Kasai Oriental to the South-West transmission grid through the construction of a third DC/AC conversion station in Kananga and new 220 kV lines to cover at least Kananga and Mbuji-Mayi	Rehabilitation, densification and extension of the distribution grids in the area	**Option A:** A study will have to be carried out to determine the least cost option between the construction of a DC/AC conversion station + transmission lines or the development of micro-grids
Mbuji-Mayi (CL)	Kasai Oriental	N			
Mwene-Ditu	Kasai Oriental	N			**Option B:** Include these 4 cities in the study, ie the extension of the transmission grid from Mbuji-Mayi + construction of a distribution grid in each city
Ngandajika	Kasai Oriental	N			
Tshilenge	Kasai Oriental	N			
Kabinda (CL)	Lomami	N			

Source: Authors

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[39] ADB/SE4All (2017).

[40] http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jul/IRENA_Off-grid_RE_Solutions_2018.pdf.

TABLE 7 • Towns that could be candidates for isolated grids (new or rehabilitation/expansion) in the South-Western region

	Province	Town	Population (2015)	Distance to nearest hydro site (km)	Distance to nearest electricity transmission grid (km)
Hydro	Kasai	Tshikapa*	583,000	9	53
		Dekese	4,000	3	288
		Luiza	21,000	5	104
		Kazumba	6,000	5	42
	Kwango	Kahemba	25,000	8	192
		Popokabaka	17,000	16	119
		Feshi	10,000	11	129
	Kwilu	Mangai	59,000	6	144
	Mai-Ndombe	Inongo	63,000	16	193
		Nioki	57,000	0	75
		Kutu	51,000	6	110
		Kiri	19,000	7	280
Other renewables	Haut-Katanga	Pweto	35,000	307	124
		Sakania*	14,000	152	68
		Mitwaba*	6,000	255	133
	Haut-Lomami	Bukama*	97,000	172	61
		Mulongo	82,000	165	103
		Kipamba	43,000	166	145
		Malemba-Nkulu*	40,000	168	134
		Kabongo	20,000	51	106
		Kole	6,000	128	51
	Kasai	Mweka	75,000	29	129
		Luebo	42,000	45	97
	Kasai-Central	Demba	29,000	43	54
		Mankanza	25,000	39	98
		Dimbelenge	5,000	26	83
	Kasai-Oriental	Tshilenge	107,000	98	80
		Miabi	73,000	55	53
		Katanda	39,000	114	84
	Kongo-Central	Moanda*	118,000	468	81
		Luozi	18,000	285	53
	Kwango	Kasongo-Lunda	31,000	50	184
	Kwilu	Idiofa	81,000	73	58
		Dibaya-Lubue	51,000	34	153
	Lomami	Kabinda	201,000	142	154
		Lubao	35,000	102	241

(*continues on page 44*)

TABLE 7 • Towns that could be candidates for isolated grids (new or rehabilitation/expansion) in the South-Western region (*Continued*)

	Province	Town	Population (2015)	Distance to nearest hydro site (km)	Distance to nearest electricity transmission grid (km)
	Lualaba	Lubudi	30,000	130	53
		Dilolo	25,000	306	83
		Sandoa	14,000	263	110
		Kapanga	3,000	119	169
	Mai-Ndombe	Ilebo	108,000	42	128
		Mushie	56,000	79	61
		Bolobo	43,000	46	180
		Oshwe	30,000	28	203

Source: ADB&SE4All, 2017

Note: Towns marked with an asterisk have existing or decommissioned generation and distribution infrastructure which could be candidates for rehabilitation or expansion

mechanisms, the poor may not be able to afford the minimum demand that makes connection costs viable. This is particularly true in cities where poverty rate is low but the number of poor is high such as Kinshasa, Lubumbashi, and Kolwezi (World Bank, 2018). This question is addressed in Chapter 7.

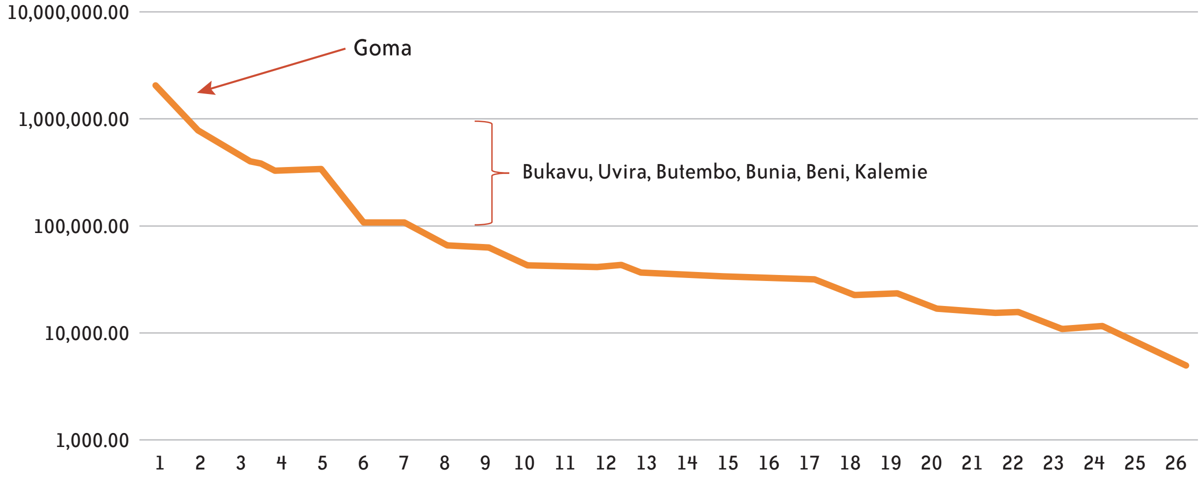
In conclusion, as most major cities of the South-Western region are already connected to the transmission grid, the level of demand (population density, economic activities), current supply and low risk environment economically justify distribution grid extensions and densification in these areas. The existing transmission network (HV lines and substations) requires rehabilitation work and needs to be maintained. All distribution grids require complete rehabilitation and modernization as a prerequisite for densification and extension, which will require construction of new substations HV/MV and MV/MV with transformers, MV and LV lines, cabins, smart meters, etc. The modernization of dispatching is also critical to efficiently supervise the power system. Mini-grids and stand-alone systems can also offer economic alternatives to grid expansion in areas far from the existing grid with low demand and challenging terrain.

4.2. THE EASTERN REGION: PROMOTING DECENTRALIZED LARGE-SCALE INFRASTRUCTURE TO PROVIDE SERVICE TO AREAS NOT COVERED BY SNEL’S EXISTING GRIDS

Beyond a certain distance and where accessibility is a challenge, the cost of connecting demand centers by extending the existing grid is prohibitive. In the Eastern region, further expansion is difficult because:

- the Mitumba mountain chain and a distance of 800km constrains extending the grid further East from Lubumbashi to Kalemie;
- sparse population and low demand make it hard to economically justify the extension of the grid beyond the South-Western zone where it currently runs (*Figure 12*). Out of 17 million people living in the Eastern region, only about one third live in highly diverse urban centers of more than 5,000 people – ranging from Goma with 1.9 million people to medium size cities such as Bukavu or Uvira and around 20 smaller towns between 100,000 and 5,000 inhabitants.

FIGURE 12 • Estimated distribution of cities in the Eastern region, by number of inhabitants (2017)[41]



Source: Authors, based on De Saint Moulin, 2010[42]

The Eastern region already has isolated grids powered by small or mid-sized HPPs, some of which are operated by SNEL[43] and others by the private sector. SNEL's plants and grids suffer from poor maintenance and are unreliable, including in Goma where private developers have installed their isolated grids. The developer Virunga SARL currently has 5,160 clients in Rutshuru/Kiwanja, 1,360 in Goma powered by the 13.1 MW plant in Matebe and 1,170 clients in Mutwanga supplied by deux plants for a total capacity of 1.7MW.Virunga SARL got a grant to connect 6,000 clients in Goma through a subsidy fund financed by a World Bank project. Its plant in Matebe supplies Goma through a partnership with the local industrial group SOCODEE[44] (Map 13). The developer Energie du Nord Kivu, a partnership between the electricity company STS and the province of North Kivu has 1 100 clients in Butembo, is constructing a line to supply Beni and plan to expand its installed capacity by up to 20 MW. The company Nuru (ex-Kivu Green Energy) serves 48 customers with a 55kW micro-grid in Beni, and recently built a 1.3MW solar power plant with lithium batteries in the Ndosho district to deliver electricity to 4,000 customers in Goma. Construction was completed in 6 months with the inauguration of the plant in early 2020.

Potential for isolated grids remains. There are 24 towns (approximately 1.7 million people) living beyond 50km from the existing grid that could be candidates for isolated grids (Table 8). The existence of numerous economic activities around these population centers could improve the financial viability of these grids. Moreover, spatial data indicates that mining activity is prevalent in the East of the country, although very limited information is available (Map 2).

For demand centers near potential hydro sites, new hydro powered isolated grids could be installed if the local security situation permits and if logistical constraints allow the construction and the maintenance of such facilities. Eight of the candidate towns (of around 400,000 people) for hydro-powered isolated grids are within 20km of a potential hydro site inventoried by the United Nations Development Program (UNDP) in the Renewable Energy Atlas.

For cities with security uncertainty, or ones that are far from hydro potential sites, solar PV plants equipped with batteries could power isolated grids where the solar resource is good. For example, in the Eastern region, about 1.3 million people are spread across 16 towns located beyond 50km from existing grid and could be electrified through isolated grids powered with

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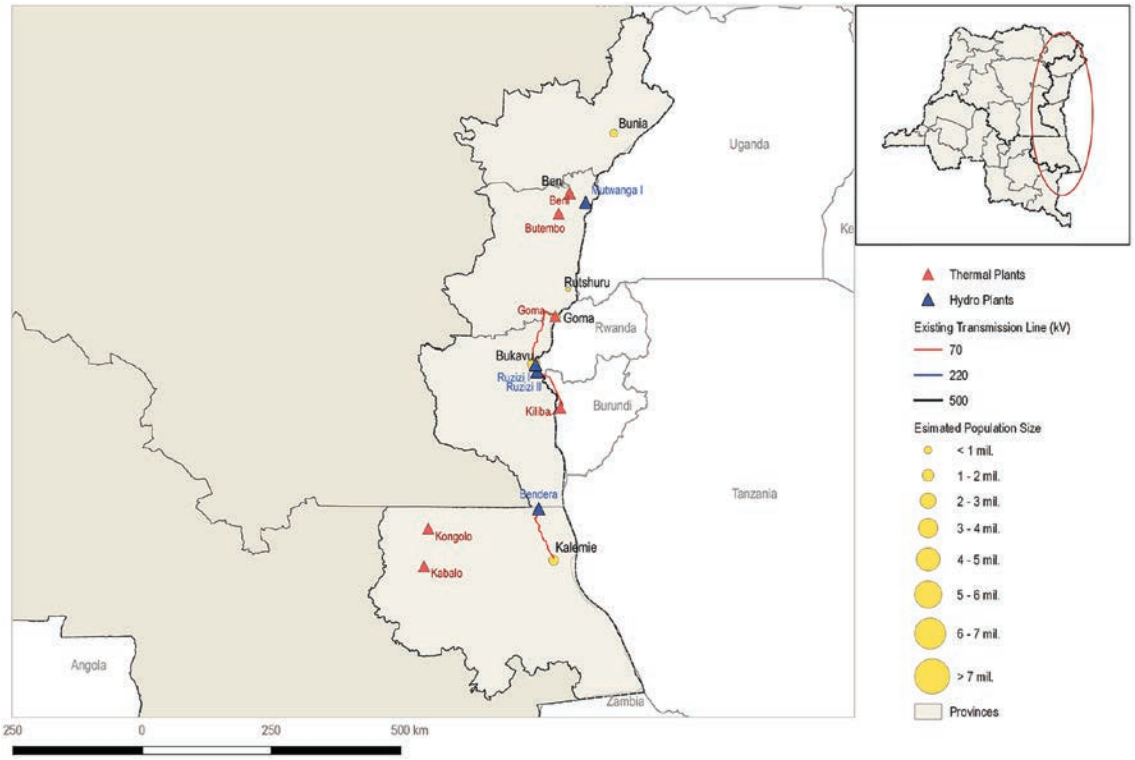
[41] Population estimates are approximate and may be subject to substantial fluctuations given lack of reliable data source and population movements observed in the region. For instance, Butembo's Mayor indicated that the city has about 1.2 million inhabitants in 2018 while estimates based on latest geospatial data available report 263,000 inhabitants.

[42] De Saint Moulin, L. (2010). Villes et organisation de l'espace au Congo (RDC). Cahiers Africains. Afrika Studies. No. 77. Paris: L'Harmattan.

[43] Including the Ruzizi 1 HPP[41] (29,8 MW of installed capacity but only 15,2 MW of average available capacity in 2017; around 37,000 clients) near Goma and the Bendera (17,2 MW of installed capacity but only 4,6 MW of average available capacity in 2017; around 8,000 clients) near Kalemie.

[44] The Goma-based SOCODEE group purchases 5 MW from Virunga SARL and has a concession to distribute this power in the city of Goma.

MAP 13 • Existing power system in the Eastern region



Source: WorldPop, Resource Matters, World Bank, authors

solar PV or hybrid solutions. Scaling up such initiatives and attracting new larger investments will however require addressing some key risk factors in the sector, namely a weak regulatory framework, difficulty to access credit, and low affordability.

Given the fragility and instability of the region, developing solar PV isolated grids could be easier and make more financial sense than attempting to rehabilitate existing infrastructure. For example, Bendera power station needs to be rehabilitated to recover 17.2 MW of capacity and rehabilitating the 132 kV Bendera-Kalemie transmission line is essential to supplying the city of Kalemie, with peak demand estimated by SNEL at 14 MW. Following investigations concerning the i) security to carry out the works of rehabilitation of the power station and line and ii) logistics to transport material, an alternative solution could be to construct a new photovoltaic (PV) plant in Kalemie with battery energy storage.

However, even if the vast majority of the Eastern region population could be connected to the grid or to isolated grids, more than half of people (about 9.8 million) would still rely on stand-alone systems for electricity. Stand-alone systems play a key role in alleviating poverty and in initiating economic diversification (through the emergence of new value chains) by providing a first level of access to electricity. They range from pico systems (solar lanterns), which provide partial tier 1 access (4-hour/day), to plug-and-play stand-alone solar systems and component-based systems (11+ Wp). Experiences from East Africa (e.g. Ethiopia, Kenya) have shown rapid increase in access to electricity through stand-alone solar systems by enforcing supporting regulatory framework and setting up financing mechanisms to support both developers and end-users.

TABLE 8 • Towns that could be candidates for isolated grids in the Eastern region

	Province	Town	Population (2015)	Distance to nearest hydro site (km)	Distance to nearest electricity transmission grid (km)
Hydro	Ituri	Aru	42,000	2	524
		Mahagi	26,000	4	476
	Nord-Kivu	Beni	129,000	9	224
		Katwa	82,000	13	190
	Sud-Kivu	Shabunda	28,000	8	169
		Kamituga	18,000	15	95
		Fizi	17,000	11	100
	Tanganyika	Kongolo	80,000	20	177
Other sources	Ituri	Bunia*	367,000	56	346
		Kituku	61,000	40	309
		Mongbwalu*	42,000	34	403
		Djugu*	38,000	27	406
		Irumu	15,000	26	321
	Nord-Kivu	Butembo*	263,000	32	176
		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
	Tanganyika	Kabalo	75,000	80	117
		Moba*	75,000	185	133
		Nyunzu	57,000	91	126
		Lukula	43,000	109	124

Source: ADB&SE4All, 2017

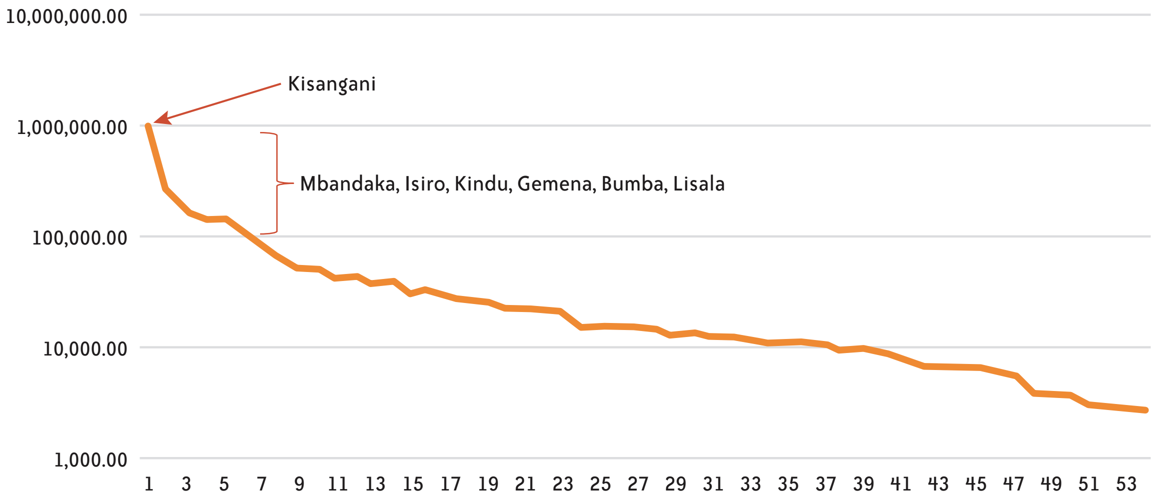
Note: Towns marked with an asterisk have existing or decommissioned generation and distribution infrastructure which could be candidates for rehabilitation or expansion

4.3. THE NORTH CENTRAL REGION: BUILD DECENTRALIZED RENEWABLES TO PROVIDE ELECTRICITY ACCESS TO THIS REMOTE AND SPARSELY POPULATED REGION

Given the remote and sparsely populated areas, decentralized renewables from isolated grids and stand-alone systems are the most attractive options for the North Central region. Of the three regions, the North Central region is the largest geographically with the lowest population density. Only Kisangani has more than 1 million inhabitants, six cities are between 1 million and 100,000 inhabitants, and six cities are between 50,000 and 100,000 inhabitants (*Figure 13*).

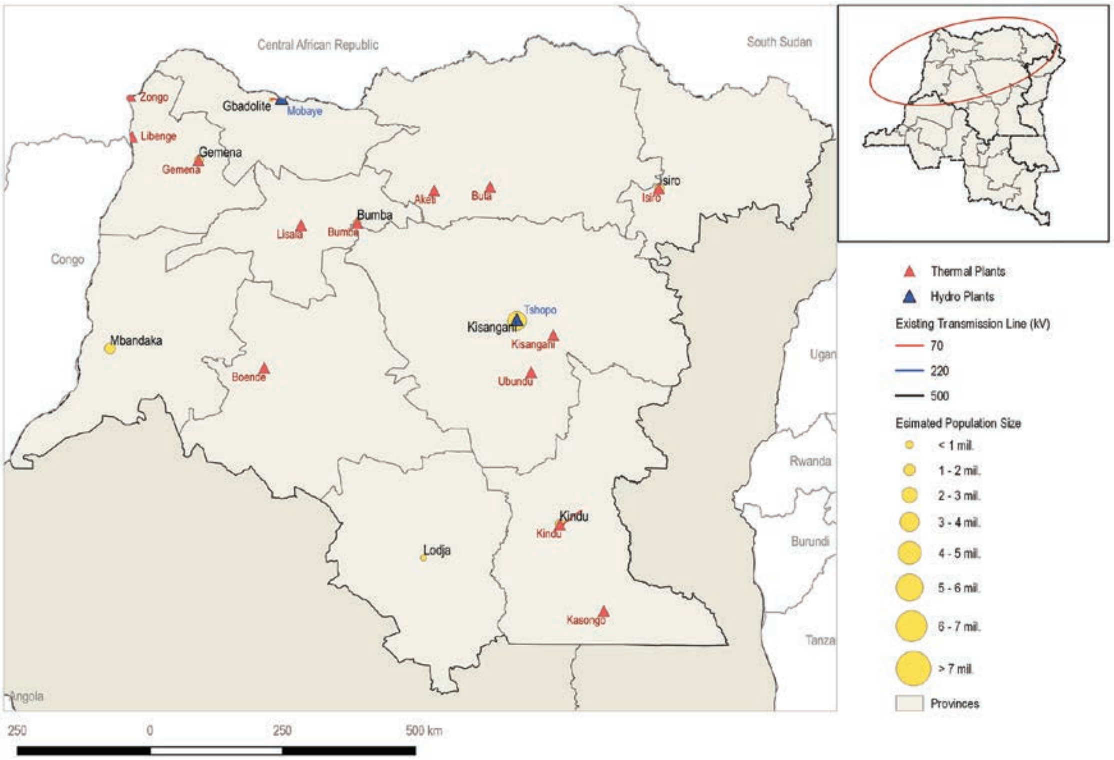
Urban centers in the North Central region do not have the critical mass of people and sufficient economic activity to justify the cost of building transmission lines from the South-Western backbone. For example, building a 400km line to connect Mbandaka to the closest grid-connected city of Bandundu would be more costly than other options. This

FIGURE 13 • Estimated distribution of cities in the North-Central region, by number of inhabitants (2017)



Source: Authors, based on De Saint Moulin, 2010[45]

MAP 14 • Existing power system in the North-Central region



Source: WorldPop, Resource Matters, authors

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[45] De Saint Moulin, L. (2010). Villes et organisation de l'espace au Congo (RDC). Cahiers Africains. Afrika Studies. No. 77. Paris: L'Harmattan.

partly explains why the region does not have any interconnected grid (Map 14) and why decentralized options are the most appropriate.

Under uncertainty and for communities far from the existing grid, isolated grids and stand-alone systems offer an attractive alternative. It is estimated that around 4 million people could be connected to isolated grids in the North-Central region. Isolated grids powered by small diesel generators operated by SNEL could offer opportunities for privatization and rehabilitation. They already exist in 32 different locations across the country (including a dozen in the North-Central region), but most are currently out of service for lack of fuel and maintenance. The total installed capacity is 28.8 MW, but the available capacity rate was around 7% in 2017. Half of the small generators are more than 46 years old. Hybridizing them with solar PV production may also be considered on a case by case basis where this reduces the cost of production. This will be particularly relevant where the diesel transport costs are high.

There are several ongoing efforts to improve electricity access through isolated grids in this region. For example, an expansion of the Mobayi Hydropower plant near Gbadolite is planned and would add 18.75 MW to the installed capacity of 11.25 MW. This would increase supply and access in border cities including Businga, Gemena, Mobaye, Ima-Langandji, Kongbo, Dimbi, Pavica, Alindao and Kembe. Another project in the region plans to connect Bangui, Zongo and Libenge and would strengthen power transfer and distribution in this area.

Twenty-five towns (around 1 million people) within 20km of a potential hydro site could be candidates for isolated grids powered by HPPs. A comprehensive economic and financial analysis would determine if additional costs related to the logistical complexity and remoteness of most urban centers make the project viable (Table 9).

The North-Central region has also a great potential for solar PV isolated grids which could connect about 3 million people to electricity (Table 9**).** Declining costs of solar equipment and the relative simplicity of construction and operations might encourage the development of solar technology in the region, which does not benefit from the same level of hydropower potential as the rest of the country. For example, the UK Department for International Development's (DFID) Essor program, which has for objective to support government reform to improve the business environment, has set up a dedicated project targeting the access to electricity across a few DRC cities, starting with a pilot phase targeting three cities in the Northern region. This initiative aims at supporting the Government of DRC in structuring and tendering the three new solar-based mini-grid concessions to private developer and operators in the cities of Gemena, Isiro and Bumba[46] by 2020. The purpose being to demonstrate a proof of concept and catalyze further mini-grid project investments across the country. Each mini-grid is expected to eventually provide electricity to between 100k and 300k people with an installed capacity of 3MW to 10MW.

Despite the isolated-grid solutions outlines above, around 80% of the North-Central population – 20 million people - will neither have access to viable grid or isolated-grid options. Stand-alone supply options are therefore the main and least-cost solution that can address both residential and SMEs power needs by providing a first level of access. Sales in the Eastern region, Kivu province have seen the largest commercial presence, largely due to products easily moving from neighboring Rwanda or Uganda. However, territory dispute and outright conflict in the region has also limited business and undermined the viability of establishing commercially viable markets.

Very few suppliers of quality verified products have made substantial efforts to penetrate the market due to the high immediate barriers to entry and in comparison, to relatively much easier markets nearby. A few private companies are currently selling stand-alone solar products in the DRC, including Altech (170,000 solar lanterns and 300 solar home systems), BBOX (10,000 households), Orange Energie (4,000 households)[47], d.light (50,000 households), Renewlt and Weast (3,000 SMEs and community facilities). But the lack of market assessment prevents from having a comprehensive picture of the market size as of today.

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[46] Although Bumba is among the hydro mini-grid candidates, its remoteness, the modest demand and the complex logistical implications of developing a hydropower plant in the region may lead developers to prioritize a solar solution.

[47] Sales data from suppliers.

TABLE 9 • Towns that could be candidates for isolated grids in the North-Central region

	Province	Town	Population (2015)	Distance to nearest hydro site (km)	Distance to nearest electricity transmission grid (km)
Hydro	Bas-Uele	Buta	74000	18	685
		Bondo	26000	18	853
		Bambesa	21000	20	660
		Ango	12000	18	706
	Equateur	Lukolela	21000	10	254
		Ingende	5000	14	369
	Haut-Uele	Watsa	43000	19	505
		Dungu	38000	1	584
		Wamba	25000	17	422
		Niangara	19000	13	602
	Maniema	Kindu*	215000	2	332
		Kasongo*	75000	11	259
		Punia	25000	4	285
		Kibombo	24000	10	363
		Kabambare	14000	3	150
		Lubutu	11000	15	278
	Mongala	Bumba	142000	7	828
		Lisala	108000	6	758
	Nord-Ubangi	Bosobolo	18000	8	870
		Yakoma	16000	2	972
	Sud-Ubangi	Zongo	45000	18	845
		Kungu	11000	7	699
	Tshopo	Opala	22000	19	519
		Ubundu	19000	18	411
	Tschuapa	Monkoto	12000	9	402
Other sources	Bas-Uele	Aketi	56,000	26	748
		Poko	15,000	127	568
	Equateur	Mbandaka*	418,000	79	377
		Basankusu*	38,000	51	555
		Isangi	16,000	94	295
		Bikoro	10,000	104	294
		Bomongo	7,000	21	551
		Bolomba	6,000	25	475
	Haut-Uele	Isiro	235,000	66	501
	Maniema	Kalima	66,000	21	246
	Mongala	Bonga	89,000	97	720
		Bongandanga	5,000	61	653

TABLE 9 • Towns that could be candidates for isolated grids in the North-Central region *(Continued)*

	Province	Town	Population (2015)	Distance to nearest hydro site (km)	Distance to nearest electricity transmission grid (km)
	Nord-Ubangi	Gbadolite	68,000	35	900
		Businga	44,000	22	836
		Mobayi-Mbongo	7,000	71	942
	Sankuru	Logja	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	252
	Sud-Ubangi	Gemena	181,000	46	765
		Libenge	34,000	88	773
		Budjala	29,000	27	694
		Bokungu	11,000	31	748
	Tshopo	Kisangani*	1,085,000	87	470
		Basoko	70,000	72	667
		Yangambi	57,000	24	576
		Bafwasende	20,000	88	358
		Yahuma	7,000	36	719
	Tshuapa	Boende*	47,000	45	506
		Ikela	21,000	107	547
		Befale	5,000	21	568

Source: ADB&SE4All, 2017

Note: Towns marked with an asterisk have existing or decommissioned generation and distribution infrastructure which could be candidates for rehabilitation or expansion

BOX 4 • BUMBA: A PROPOSED SOLAR HYBRID MINI-GRID COULD RETURN THE CITY TO A PATH OF ECONOMIC GROWTH AND SOCIAL DEVELOPMENT

With around 180,000 inhabitants, the city of Bumba is slowly recovering from armed conflicts. SNEL's diesel generator and distribution network have not worked for years, which hampers the development of income-generating activities such as local agribusiness (rice, cassava, maize, coffee, palm trees), and other industries that benefit from its strategic position along the Congo river. The town and the surrounding communities could benefit enormously from an electrification project.

The DFID-funded Essor Access to Electricity initiative has conducted technical pre-feasibility studies which suggest that the town has demand levels that would merit the construction of a solar hybrid mini-grid with an initial solar PV park of 10 MWp, 16 MWh of batteries and 4 diesel generators of 725 kW each. The initial investment in generation has been estimated to be $24 million and $12 million for distribution. It is expected that some 4,000 households and 420 non-residential consumers could be connected to the mini-grid network for a total consumption estimated at 7.1 GWh in the first year. On top of that, an additional $1.3m distribution costs is included in the initial estimated investment plan to finance additional connections during the first five years, reaching in year five 7,500 households and 720 non-residential customers for a total consumption of 15.5GWh. While households would only account for 34% of total consumption, they are forecasted as being important to the mini-grid's financial viability. The town benefits from two large potential customers, the Regideso and the SOCAM-NT group. As such, these could be the most important clients of the future solar mini-grid concession, but schools, a general hospital, health centers, hotels, boutiques and mills will also be important beneficiaries for which a social tariff may need to be envisaged in order to combine development objectives with a sustainably financed project.

MAP 15 • Map of the city of Bumba

Source: Essor

BOX 5 • BATTERY STORAGE: VIABLE OPTION TO SUPPORT ENERGY ACCESS IN THE FORM OF MINI-GRIDS AND GRID SERVICES

Battery storage has grown significantly over the past few years. Massive investments predominantly in lithium-ion batteries (current cell prices less than $250/kWh) are driving down costs while project developers are continuously getting better in designing and building customized storage systems. In the off-grid sector, lead acid has been the main battery application. However, several other technologies have emerged for the off-grid sector where Zinc Air batteries have become increasingly cost competitive with current cell prices of around $160–250/kWh with life cycles of more than 10,000 cycles. The main advantages of battery storage systems are the flexibility and the ease of implementation which makes it increasingly attractive to deploy as alternative means of electricity sources. This is mainly due to its modularity and ability to cope with drastic changes in the renewable energy generation.

Due to the current trends in cost decrease, clean energy mini-grids in the form of solar supported by battery storage has become not only a viable option but also a least cost option to supply electricity in the remote regions in Sub Saharan Africa. An adjusted cost estimate for autonomous mini-grids with the current cost decreases as of 2018 are expected to be around $ 3,000/kW including installation costs. With the support from battery storage, renewable energy mini grids, mainly solar, can be able to provide higher levels of services and are gaining momentum where grid extension or any other forms of energy supply is not a cost-effective and feasible alternative.

Battery storage can also provide a wide range of services to the grid such as frequency regulation, energy shifting, renewable energy capacity firming, transmission congestion management etc. depending on the needs of the system. In the case of systems with inadequate reserve capabilities, frequency regulation from batteries could provide the balancing of the generation and load that is required to be performed by the spinning reserves. In the case of fragile grids, battery storage can enable the integration of renewables into the systems. This is done by balancing the intermittent generation through the charging/discharging of the batteries providing a more stable output of these renewable sources.

There are challenges to growth; most companies have focused on relatively easier commercial options, spreading their business in denser areas and targeting customers with high spending power who are already connected to some level of electricity. Very high costs of doing business overall due to combination of various factors and challenging environment have prevented from developing stand-alone system business across DRC - including: high level of physical insecurity in many areas, lacking rule of law, high duties and taxes (totaling over 50% value of goods) combined with high level of corruption on import, foreign exchange risks and sanctions inhibiting money transfer from international banks.

Over the long run, standalone systems distributors should implement strategies to target both easy-to-reach markets but also more remote areas to maintain growth rates. The untapped last-mile areas, notably in the North-Central region represent significant growth drivers. But long distances, poor infrastructure and challenging geography/ terrain lead to “many DRC’s” which are separate, distinct, and yet relatively small markets. The ‘rural off-grid’ segment is very hard to reach, with limited mobile phone coverage and lack of functional mobile money infrastructure combined with very low purchasing power.

Reducing costs of doing business, building commercial demand and supporting affordable financing are three key areas of intervention that would foster quality-verified products market in the DRC. Grants and guaranteed removal of duties and taxes for quality verified solar lamps and SHS could reduce the costs of doing business for eligible companies and offset the massive overheads that are a necessity and allow profitability without pricing out customers at the lower end of the economic spectrum. Competitive tenders for public procurements - eligible only to quality verified products, and the availability of working capital and soft loans would enable suppliers to access more attractive financing mechanisms. Finally, consumer education programs differentiating “pricey” quality verified products from the poor quality, generic, smuggled/bribed lower cost competition, and government adoption and enforcement of standards could assist in creating markets for quality verified products and protect them from poor quality product dumping and corrupt importation.

5

EXPANDING THE ROLE OF THE PRIVATE SECTOR TO ACCELERATE ACCESS TO ELECTRICITY IN THE DRC

Photo : © Essor

5. EXPANDING THE ROLE OF THE PRIVATE SECTOR TO ACCELERATE ACCESS TO ELECTRICITY IN THE DRC

By 2030, 4,900 MW of available capacity is required just to maintain electricity access for 14 % of the population through the existing grid. This translates to USD 8 billion in CAPEX for generation alone. This does not include the USD 230 million needed for maintenance and repairs. At approximately 300 USD per connection, the cost of providing access through SHS to half the population in 2030 would be around USD 4 billion.

SNEL has not been able to expand its customer base in line with the rapid demographic growth, resulting in the large and growing access deficit, nor is it in a position to make the required investments to expand future access. SNEL estimates its total number of customers at around 860,000[48], 90% of which are thought to be residential. SNEL has added 23,000 new connections every year on average since 2010[49], far fewer than the 440,000 new households added each year in DRC since 2010[50]. Existing customers are mostly concentrated in Kinshasa, Bas Kongo and Katanga, with very few connections outside of the Southern provinces, leaving many highly populated areas without access.

Improving service for existing customers and offering electricity to the 86 percent of the population currently without access will therefore require strong participation from the private sector. This chapter looks at the role that private sector operators and financing have played in developing the power sector. It highlights the challenges they face to play a greater role and looks at some of the governance and legal barriers that will need to be overcome to scale up private sector participation significantly.

5.1. THE PRIVATE SECTOR HAS UNTIL RECENTLY PLAYED A LIMITED ROLE IN THE DEVELOPMENT OF THE DRC'S POWER SECTOR

After a 40-year monopoly, SNEL is no longer the only electricity operator, but it remains by far the largest. SNEL operates 95% of the DRC installed capacity and remains the only transport operator in the country. In 2014, the enactment of the Electricity Law changed SNEL's legal status to 'business corporation', the same status as any other company operating in the country. This effectively opened the way to the private sector owning and operating separate grids to SNEL's.

The private sector – mostly mining companies – has invested in expanding capacity on the grid, mostly through loans to SNEL, but has mostly shunned traditional models of investment such as Independent Power Producers (IPP) and Build-Operate-Transfer (BOT). Constrained in their production by a lack of electricity, mining companies have found various ways of investing in the power sector. They have mostly financed the rehabilitation or construction of production and transport assets through loans to SNEL. The largest of these projects financed the rehabilitation of Inga II turbines, construction of Nzilo II HPP, and improvements on the Inga-Kolwezi HV line through a USD 456 million credit from the Kamoto Copper Company (KCC) and Mutanda Mining (both Glencore subsidiaries)[51]. In total, mining companies have accumulated over USD 1 billion in lending to SNEL through such projects, almost entirely to improve supply of electricity to their mines. They have also formed PPPs with provincial governments, such as Enerkac in which the Kasai Central provincial government owns a 5% share. Mining firms have built their own power plants to supply their mines, such as SOKIMO, whose 11 MW Budana HPP supplies surplus electricity to the nearby cities of Buni and Mongbwalu.

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[48] SNEL data from 2016.

[49] COPIREP.

[50] Based on WDI population data and average household size of 5.3 (DHS).

[51] The FRIPT (*Fiabilisation, réhabilitation et renforcement des Infrastructures SNEL de Production et de Transport)* project also benefited from World Bank IDA loan.

Finally, three IPPs sell power to SNEL grids, operated by Hydroforce, Enerkac, and Congo Energy (see **5** below for a comprehensive list of private sector actors in the sector).

A significant scale up of private sector investments into the grid would require implementing SNEL's recovery plan so that it can become a credible off taker. The accumulation of credit from mines to finance grid supply expansion has reached its limits. Saddled with over 3 billion dollars of debt and very high losses, SNEL has a negative cash flow and is unable to make required investments. This situation has been prevalent since the 90s when the SNEL made its last significant investments in production. SNEL's poor performance is linked to an array of internal factors such as operational inefficiencies, inadequate human resources, and low performance culture, which are identified as priority areas of the recovery plan. This impedes private investments to expand production on the grid, as SNEL cannot credibly commit to a PPA. Chapter 6 focuses on SNEL's recovery.

Recent years have seen the emergence of private sector owned and operated isolated grids. These include isolated grids operated by Virunga SARL, which was founded by the Virunga National park's Virunga Foundation, and received donor funding to build and operate mini grids in Mutwanga powered by two HPPs of 0.38 and 1.35 MW respectively, and a 13.1 MW HPP at Matebe serving 5,520 customers. Another independent grid operator, Electricite Du Congo (EDC), rehabilitated the 1.6MW Lugundi hydro plant and supplies electricity to 400 clients in the city of Tshikapa. Meanwhile Energie du Nord Kivu (ENK), a PPP formed by the Belgium firm STS and the Nord Kivu provincial government, operate a grid in Butembo powered by a 1.8MW HPP and serving 1500 residential customers. Others, such as Proton, have secured concessions to operate grids, but are still seeking the funding.

The off grid solar sector has also seen the emergence of local and international companies that see great potential in this large market with little existing electrical infrastructure. Altech, a Congolese company distributing solar lanterns and small kits, has expanded its operations from Bukavu all the way across the South into all the main cities and to Kinshasa since it started out in 2013, selling over 170,000 solar kits. Since April 2019, Altech sells larger standalone systems (in partnership with Vodacom) in Kinshasa and Goma, with more than 300 systems sold as of end of 2019. BBOXX, a UK company with over 1 million customers globally, has equipped over 10,000 mostly residential customers in the North and South Kivus, mainly in the city of Goma where they started operations in 2017. In Kinshasa, it has partnered with Orange Energie and has over 4,000 residential customers. BBOXX has expanded its business in Bukavu in 2019 and has recently signed a memorandum of understanding with the Congolese government to electrify 10 million people in the DRC by 2025. Weast Energy, a Congolese company, have shifted from an EPC contract business to public customers to a SHS business to private customers, focused on larger consumers and productive users. Box 6 below presents the current panorama of private sector actors in the DRC power sector.

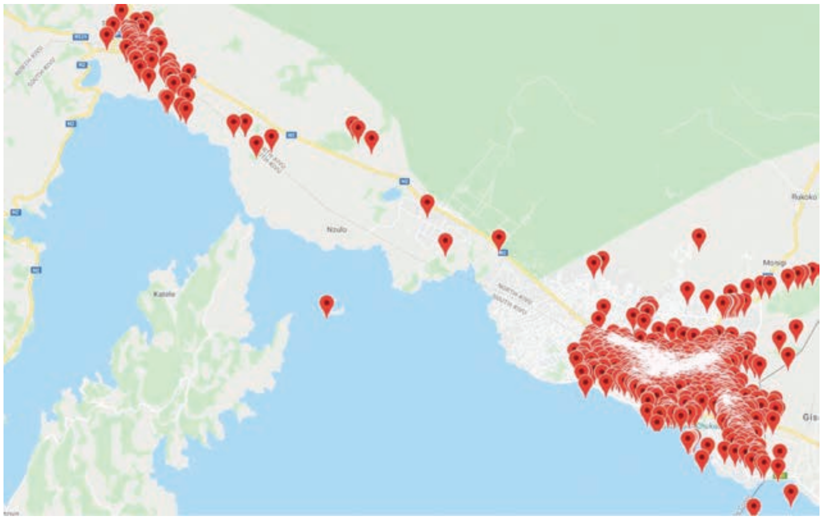
5.2. STRENGTHENING THE LEGAL AND REGULATORY FRAMEWORK TO FURTHER ATTRACT PRIVATE OPERATORS

Accelerating the development of concessions and attracting private investments and operators will require to enforce legal and regulatory reforms. It has been four years since the Electricity Law was enacted, yet many supporting decrees have yet to be implemented. Both the regulatory and rural electrification agencies - ARE and ANSER – have, in principle, crucial roles to play to implement and enforce rules, define tariffs, attribute concessions and support local governments with coordinating provincial electrification efforts. Yet these organizations are not yet operational. In the meantime, the Ministry of Energy is playing this role to some extent, but the regulatory uncertainty increases investment risk and affects the attractiveness of the sector to private investors.

Contradictions in the legal framework surrounding the ownership of existing and new assets by the State or the operators must be addressed before private-sector players take the risk of investing in large-scale projects. Some of the areas of law remain ambiguous, which dissuades investors. Current regulation and the absence of a regulatory agency generate uncertainty on aspects of tariff setting, preventing operators from designing viable projects. For example, concessions attribution and management remain unclear. The role of attributing concessions to grid operators shifts from

FIGURE 14 • Households electrified through solar home systems sold by BBOX in Goma

About 10,000 households electrified through BBOX kits in the Kivus



Source: BBOX

BOX 6 • MAIN PRIVATE SECTOR PLAYERS IN THE DRC POWER SECTOR

○ Prospect
● Present

Electricity operators	Typology of actors				Geographic presence				Clients		
	IPPs/ self producers	**Energy buyers**	**Isolated grid operators**	**Solar home Systems**	**West-Kinshasa**	**South-East**	**East**	**North-Center**	**Residentials**	**SMEs – admin**	**Mines**
Electricité Du Congo (EDC)			●			●			●	●	
Electricité du Nord Kivu (ENK)			●				●		●	●	
Virunga SARL			●				●		●	●	
SOCODEE			●				●		●	●	
Proton			●					○	●	●	
Altech				●	●	●	●	●	●		
BBOXX				●			●		●	●	
Orange Energie				●	●				●	●	
Weast Energy				●					●	●	
Cobra/Three Georges											
CONGO ENERGY	○				●	●			●	●	
ENERKAC	●				●						
Hydroforce	●										
KATANGA ENERGY		●									●
Ivanhoe	●					●					●
Kibali Gold	●							●			●
SICOHYDRO	○					○			○	○	○
Others: SUCRIÉRE KWILU, NGONGO, PERENCO, MIBA, CFU, PLC, ONG, SNCC, HEDC	●										

Source : Authors.
Note : list non exhaustive

the local to the national authorities if a grid extends past provincial border. With the current regulatory framework, it is uncertain whether the concession remains valid in such a case, introducing major risk for existing operators. Regulation does not yet define the terms for compensating operators when social tariffs are in force.

A series of legal texts on decentralization,[52] defining new roles and allocating responsibility between central administration and provincial authorities have added a layer of complexity. Decentralized decision-making is important to accelerate access to electricity in a country with such regional disparities and contrasted power needs. Nonetheless, the decentralization process has not been completed yet. The implementation of a partially decentralized institutional scheme for electricity causes conflicts and the risk of overlap in concession attribution. The allocation of financial resources between the different competent bodies has not been clarified and provincial authorities do not currently have enough institutional capacity to assume their new responsibilities including the analysis of concession proposals.

Existing investments and related agreements such as concession contracts and licenses need to be updated to comply with new regulations. Both SNEL and existing private operators must regularize their situation with central government as well as provincial authorities. The low legal capacity of SNEL and government counterparts make this process challenging. Updated agreements should envision future power systems and clarify what happens when grids become interconnected. They should define thresholds to limit the number of operators on the same territory. Taking these steps will reassure and encourage potential future investors.

5.3. THE EMERGENCE OF PRIVATE POWER GRIDS: THE CASE OF EASTERN CONGO

Eastern DRC is perhaps the best example of the development of the budding liberalized electricity sector. North Kivu, and the city of Goma in particular, is home to several models of private sector-led grid development. This region is home to the first privately operated mini-grid in the country and private distribution concessions compete with SNEL for customers. The region has the potential to develop interconnections with neighboring Rwanda and it has strong solar and hydro potential. The region's dense population and economic activity make it a possible candidate for an interconnected grid (*Map 16*). The speed of private sector electricity development will depend on how the provincial and central governments accompany the development of the sector, particularly through providing clear rules on concessions for protecting operators' investments and by easing access to credit.

The Eastern DRC is one of the most underserved regions in the country (see Map 6**).** The main SNEL network is in a dilapidated state and much of it was destroyed by a volcanic eruption. Service is unreliable; the available capacity of the grid is on average around 4 MW, for a demand that SNEL estimates at 60.2MW and the provincial government at 80 MW. The city of Goma, initially powered by a thermal power plant, is now connected to the Ruzizi I and II hydro sites through the Bukavu-Goma line. Several other localities are connected to this line, including Sake, Kiroche, Shasha, Minova, Bweremana, Bibatama. The SNEL grid does not extend north of Goma, and diesel thermal power stations in other cities in the northern part of the province such as the towns of Butembo, Beni, and Oicha, are no longer operating. SNEL also imports from the Ugandan network to serve certain cross-border localities including the locality of Kasindi (North Kivu).

The region has the potential to host many isolated grids that could progressively interconnect to link the strong concentration of economic activity and population with solar and hydro production, but provincial authorities will need to help accelerate this process through incentives and active regulation. Eastern DRC holds roughly 20% of total population. The population density around Bunia in Ituri, and around the cities of Goma and Bukavu in North and South Kivu, is among the highest in the country (Map 3). The area is also host to a buoyant mining activity (*Map 17*). The mining cadaster registers vast areas of formal mining around Bunia and North into the Haut Uele. It is unclear what source of electricity is currently powering these mines, but their size indicates an important electricity demand. In addition,

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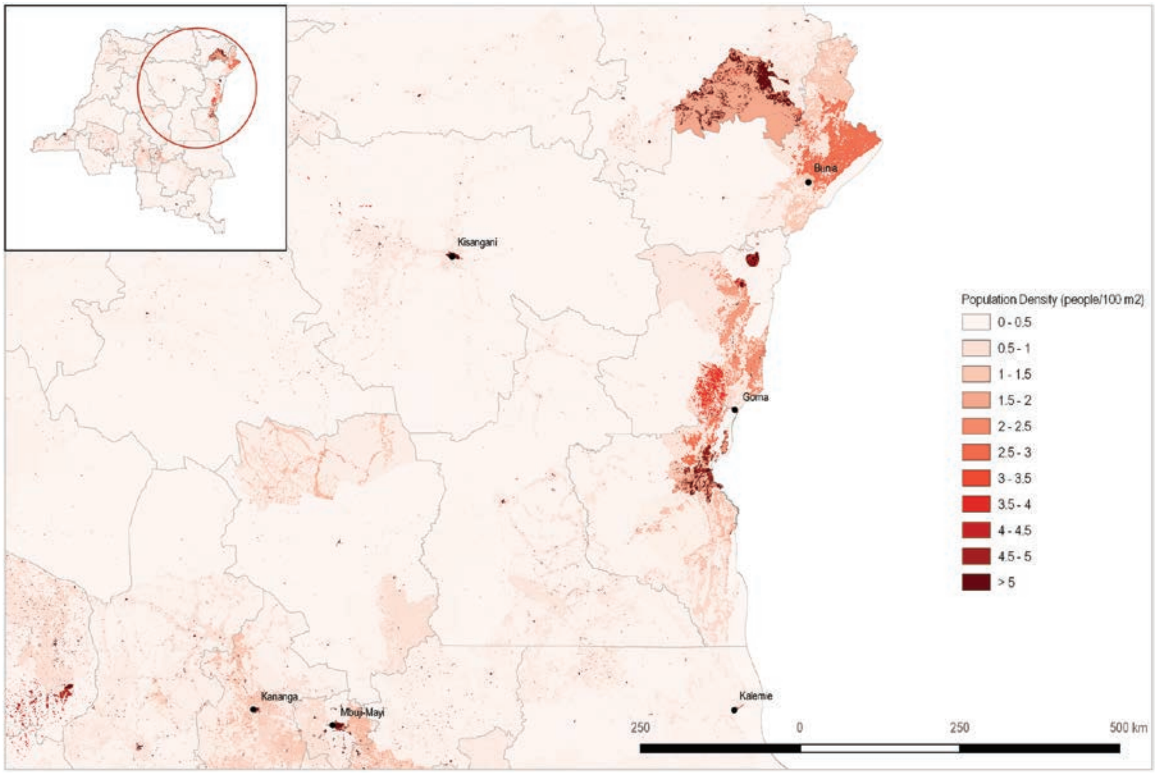
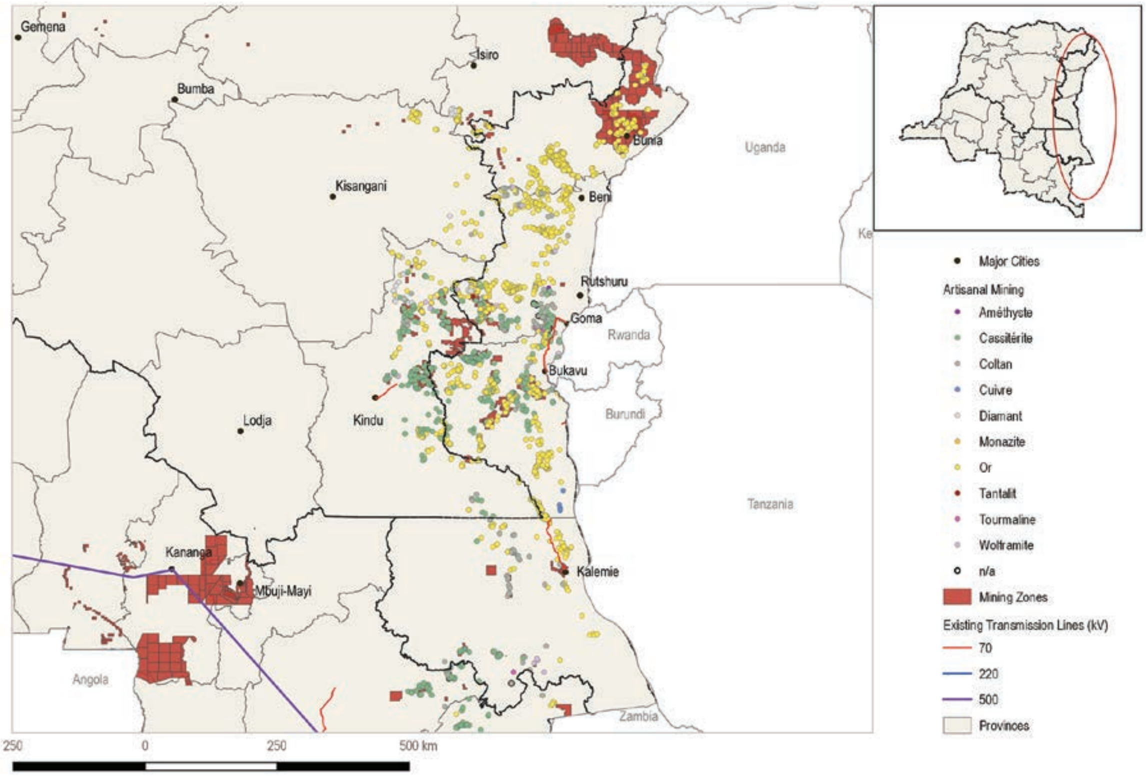
[52] Loi sur la libre administration des provinces du 31 juillet 2008 ; Loi organique N° 16/001 du 03 Mai 2016 fixant l'organisation et le fonctionnement des services publics du pouvoir central, des provinces et des entités territoriales décentralisées ; Loi organique n° 10/011 du 18 mai 2010 portant fixation des subdivisions territoriales à l'intérieur des provinces ; Loi organique n°08/016 de 2008 portant composition, organisation et fonctionnement des ETD et leurs rapports avec l'Etat et la province ; Loi sur la Conférence des Gouverneurs d'octobre 2008.

MAP 16 • Population density in Eastern DRC (people/100m²), 2015



Source: Worldpop

MAP 17 • Mining activities in the Eastern region



Source: CICOS, IPIS, World Bank, authors satellite imagery indicates the profusion of artisanal mining for gold, cassiterite, coltan and diamonds. While the scale of production may not require a large demand for electricity, income from this economic activity can fund isolated grids for household consumption.

Private operators are expanding by making use of industrial demand and interconnecting areas through bilateral power purchase and financial agreements. For example, the private company Virunga SARL has about 7,700 clients in Mutwanga, Goma and Rutshuru. Energie du Nord Kivu (ENK), a public private company of the Nord Kivu provincial government and a private company called STS owns and operates a 1.8 MW HPP in Butembo with a transmission line to supply the city of Beni. In Beni, the company Nuru (former Kivu Green Energy) supplies 48 clients connected to a 55kW micro grid. Industrial plants are used as anchor clients in an attempt to bring financial viability to isolated grids. For example, the mini-grid powered by the Mutangwa 0.4 MW HPP owned by Virunga SARL relies on the demand from the SICOVIR soap factory in Nzenga to take a significant amount of its supply. In Goma, the private operators Virunga SARL, SOCODEE and recently Nuru obtained licenses and have started to compete with SNEL for customers. SOCODEE financed a MV line to bring 5 MW from Virunga SARL's 13.1 MW Matebe hydro power plant to supply its network in the city of Goma. All of these operators are however confronting difficulties to commercializing their available power because the population cannot afford their high connection costs. Disputes between operators have also arisen, mainly due to the weak governance and regulation of the sector.

The coexistence of SNEL and private operators in the region points to the need for planning and coordination at central, provincial and local levels to ensure coherence in sector development. The concession for production on the Talya Nord site was contested between two operators because of competing concessions granted by the central ministry on one hand and the province on the other hand. For the city of Goma, the developers Virunga SARL and SOCODEE had disputes regarding the scope of their respective allocated concessions while SNEL has not regularized its concession yet and Nuru has recently obtained a license.

There is an important role for the regulator in tariff setting. Tariff structures approved by the Ministry of Energy for SOCODEE clients enable the operator to recover its costs. Nonetheless, the tariffs are much higher than tariffs paid by SNEL customers which are highly subsidized: $0.21/kWh for low-voltage clients ($0.16/kWh for medium-voltage) compared with the average tariff of $0.078/kWh for SNEL's clients. The coexistence of these different tariff levels could be problematic as operators compete for customers and SNEL cannot charge cost reflective tariffs. This is one important role the regulator needs to play once operational. A regulator will also ensure that tariffs charged by operators are reflective of reasonable costs. In the absence of regulator, neither the central nor provincial authorities have the capacity to fulfill these roles.

As more private operators enter the liberalized market, the role of SNEL will change. This role will depend on many factors including the intended commercial target and investment capacity. SNEL could remain a vertically integrated player operating from generation to transmission and distribution activities in certain area or it could focus its activities on generation and transmission. The recently renovated transmission network is a strategic SNEL-owned asset, from which the operator should minimize its return, for example by transporting electricity for private operators. SNEL could also restructure its activities in cost and profit centers. SNEL's restructuring must be driven by the new role SNEL will play in the future.

6

REFORMING THE NATIONAL OPERATOR, SNEL, IN SUPPORT OF A MORE SUSTAINABLE POWER SECTOR: A SHORT AND MEDIUM-TERM PLAN

Photo : © Pierre Lorillou

6. REFORMING THE NATIONAL OPERATOR, SNEL, IN SUPPORT OF A MORE SUSTAINABLE POWER SECTOR: A SHORT AND MEDIUM-TERM PLAN

This chapter examines the most critical short and medium-term measures that have been identified among the wider effort requested through SNEL's recovery plan and which are structural to improve the utility performance. SNEL is undergoing a recovery plan aiming at reforming in-depth the utility and preparing it to compete in a liberalized power sector. Change within SNEL was initiated in 2008 with the implementation of a prioritized rehabilitation program, followed by the signature in 2012 of a 5-year Performance Contract between SNEL and the DRC government, under the oversight of the Ministry of Portfolio and its technical unit, COPIREP. The performance contract established mutual commitments to improve utility performance and to increase government financial contribution to sector development. Unfortunately, it did not deliver on expected outcomes and expired in 2016. SNEL also sought technical assistance and signed a Service Contract with Manitoba Hydro International (MHI) in 2015. SNEL's Executive Board approved a 2018–2020 strategic guidance note in November 2017, which reasserts the company's ambition to recover. The recovery plan is focused on three key objectives: (i) maintaining, rehabilitating, and strengthening the utility power generation, transmission and distribution capacity, (ii) ensuring SNEL's financial recovery and restoring a break-even balance, and (iii) streamlining processes and strengthening management systems, which would lead to a more sustainable and competitive utility.

6.1. SNEL'S FINANCIAL DIFFICULTIES STEM, IN LARGE PART, FROM ITS COMMERCIAL WEAKNESS

Since only a few elements of the recovery plan have been yet implemented, SNEL is still unable to reconcile the electricity delivered to customers, the revenues from its sale, and the cash inflows from its collection. Obsolete distribution equipment and lack of wide-spread metering prevent SNEL from accurately tracking electricity beyond its high voltage network and billing electricity delivered to customers. Meanwhile fraud is rampant, taking the form of illegal connections, fake billing and leakages in collection. As a result, it is estimated that about 50% of SNEL's produced power is not monetarily valuated and does not translate into cashflows.

SNEL cannot quantify the amount of electricity delivered to about 99% of its customer base. Currently, 19% of LV clients and 90% of MV customers have meters. 86% of LV clients are billed monthly based on a flat rate, regardless of their actual level of electricity consumption[53]. However, lump sum billing is now prohibited by law, and SNEL must now install meters for all of its clients[54], which will greatly help billing practices. A campaign to install conventional and prepayment meters for 22,900 new connections was carried out in the Kimbanseke and Kisenso districts of Kinshasa.

Moreover, electricity connections are made by land plot containing several customers, but because of lack of metering, actual consumption is unknown. Fast growing settlements have overtaken urban planning and created informal housing areas that are not connected to basic services. This complicates SNEL's expansion of residential connections and has laid the foundation for illegal and shared connections. It is estimated that about 6 million low voltage people benefit from illegal connections. SNEL's inability to track household-level consumption results in fixed-price invoicing and the emergence in some areas of "sub-utilities" selling power from a single connection to several end-users.

Billing is patchy, and bills recovery is very low. On average, SNEL does not bill 1 in four customers and recovers only 60 cents on every dollar it bills. Bill collection rates range from 89% for high-voltage customers to 70% for medium-voltage and 51% for low-voltage clients. The segment of low-voltage clients represents 48% of default payments, followed by 24% for

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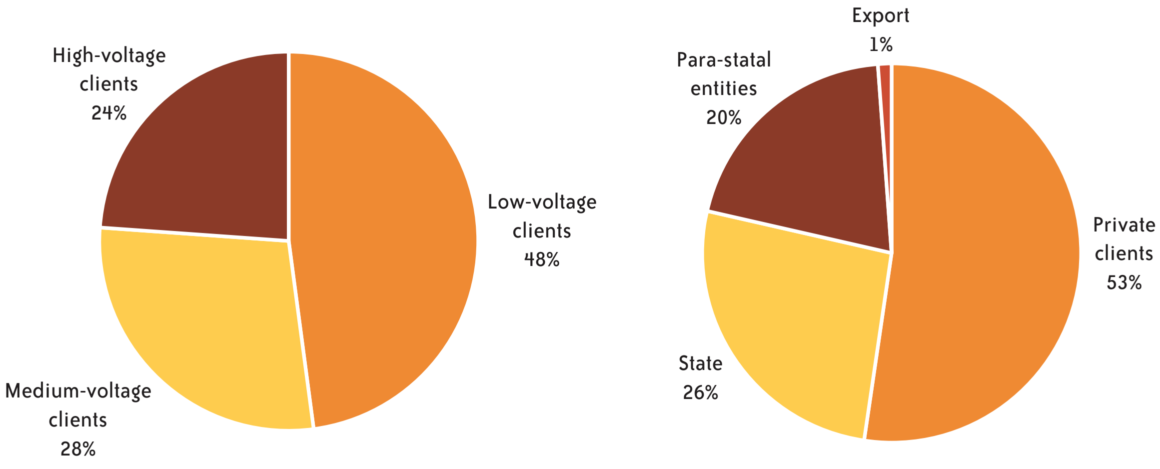
[53] SNEL.

[54] SNEL Management, 2020.

FIGURE 15 • Breakdown of default payments by client' segment, 2018



Source: SNEL

high-voltage customers and 28% for medium-voltage customers. If private customers represent 53% of arrears, the State and parastatal agencies/institutions represent 46% of defaults in 2018. (*Figure 14*). Lack of metering at the end-users' level prevents SNEL from shutting off power in case of default payment. The advisability of initiating a pilot to outsource billing and collection services activities to a private operator, starting for example with Kinshasa area could be analyzed by SNEL and could assess impact on revenues and commercial losses.

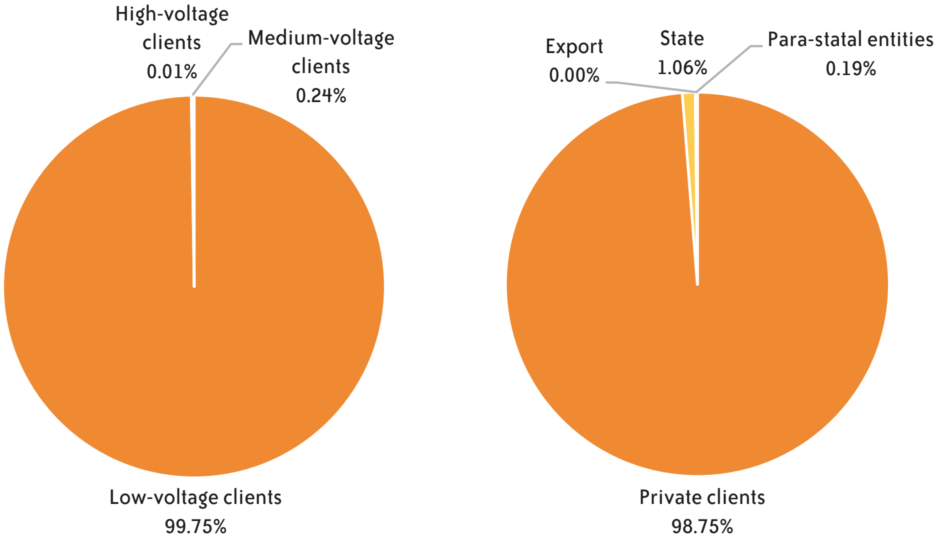
Given the interference of the State in the company management, some customers ("ayant-droits") – which are billed by SNEL – do not pay and continue to be supplied with electricity. State-owned companies and the government are among SNEL's poorest payers. The government and 27 State-owned companies have accumulated almost $1 billion in unpaid bills owed to SNEL as of the end of 2011. Since then, they accumulated additional USD 191 million, equally shared between the State and State-own companies. Regideso, Gecamines and SNCC are responsible for 72% of the debt as of 2017. They, however, benefit from reliable service through priority dispatching – de facto impose on SNEL-at the expense of other customers.

The Performance Contract between the GoDRC and SNEL failed in reducing sustainably arrears. According to Deloitte's audit conclusions and as requested in the decree no. 12/031 of October 2nd, 2012 on SNEL's liabilities, receivables held by SNEL on other State-owned companies should be converted into equity participation in these companies. To date, the process has been stopped and no action has been taken by the Government. Even though the consumption of public institutions and beneficiaries is submitted monthly to the Ministry of Budget for approval, these receivables remain mostly unpaid.

In the meantime, beyond its high voltage network, the absence of metering and monitoring equipment along the distribution systems prevents SNEL from optimizing its power flows and identifying in real time bottlenecks and inefficiencies. Dispatching activities rely on bottom-up information, coming from operations and maintenance teams working on the ground. These teams are largely composed by non-specialized daily workers who have no incentive to well-perform and follow operation and maintenance (O&M) best practices. Overall, the number of daily workers has been constantly increasing to reach more than 2,300 staff in 2017.

Poor service quality has eroded SNEL's relationship with customers and increased instances of non-payment and fraud. As service quality deteriorates, SNEL customers are less and less willing to pay. This creates a vicious circle, exacerbating SNEL's inability to invest in rehabilitation and modernization of productive assets, further worsening service reliability. SNEL's customer relationship with HV and MV customers is a major consideration for its financial viability. Both client segments represent together only 0.25% of SNEL's clients but 76.4% of its revenues (*Figure 16*; *Figure 17*). Ensuring their satisfaction could secure cashflows in the short run. Nonetheless, LV customers account for 99% of SNEL's clients. Less volatile, they should represent SNEL's core customer basis over the long term. Minimizing non-payment and fraud are priorities for this segment of clients.

FIGURE 16 • Typology of SNEL's clients, 2018



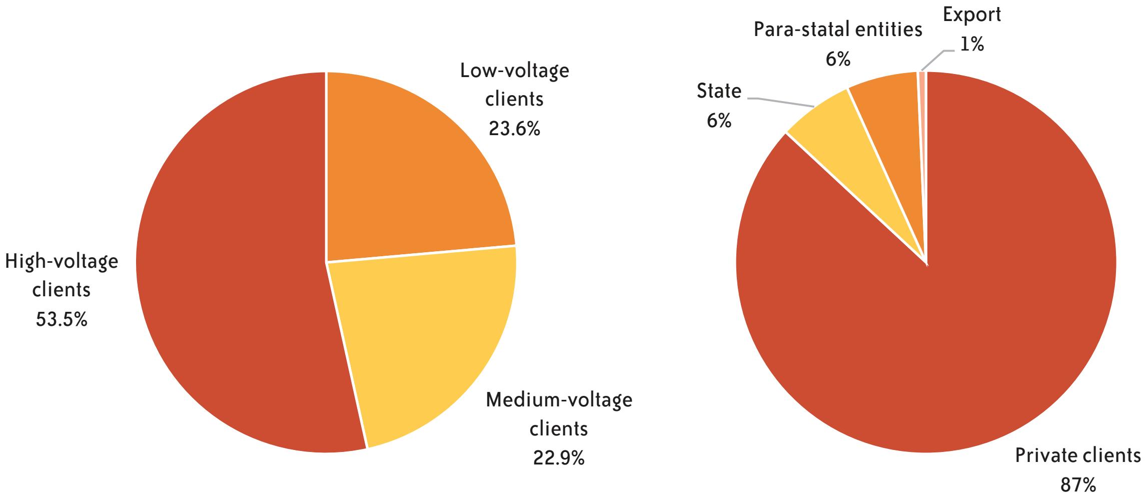
Source : SNEL

6.2. RESTORING FINANCIAL HEALTH OF SNEL'S DISTRIBUTION SEGMENT TO SECURE REVENUES

In a context of limited cash flow and constrained investment capacity, SNEL must screen each investment in terms of profitability for the company. SNEL has identified a $1.3 billion envelope of non-prioritized investments whose impact on its viability has not been assessed. However, its current indebtedness does not allow such amount of investment. The recovery plan listed priority investments to improve SNEL's operational efficiency and commercial performance for a total of $329 million (*Table 10*). These investments focus on increasing SNEL's ability to recover revenues, rather than on expanding its customer base.

On the investment side, SNEL's recovery plan centers around the rehabilitation of Kinshasa's distribution grid and the modernization of commercial systems. Kinshasa is SNEL's core customer base with 1,300 medium-

FIGURE 17 • Sales in value (USD) by typology of clients, 2018



Source : SNEL

TABLE 10 • Priority investments to expand electricity access and restore power reliability in Kinshasa

Investment	$US million
Electrification of 75 cities in Kinshasa peripheral areas to connect 250,000 new clients	127
Installation of pre-paid meters	118.7
Rehabilitation of substations	29.5
Purchase of spare parts for strategic equipment	18
Construction of new substations	16.5
Rehabilitation of LV network in 6 "CVS"[55]	6
Modernization of distribution dispatching center	4
Recruitment of maintenance teams with appropriate tools and equipment	3.9
Removal of separate substations	3.65
Purchase of tools	2
TOTAL	**329.250**

Source: MHI, SNEL

voltage and 512,000 low-voltage official connections. The system has been tested as infrastructure ages and as growing population adds demands to the system. Rehabilitating existing distribution networks in and around Kinshasa is an urgent priority to avoid system collapse. Some works on rehabilitation of Kinshasa low-voltage cabins and lines, and the replacement of circuit breakers have recently started in Kinshasa but are largely insufficient. Investments to make the network more reliable and stable are another prerequisite to improve the quality of service in Kinshasa area. The addition of substations, the modernization of distribution dispatch, the installation of metering equipment, the procurement of spare parts on strategic equipment, and the removal of antenna cabins would support a better optimization of power flows and increase the system safety. The mass deployment of prepaid meters for low-voltage customers would limit fraud and cash transfers with the ultimate objective of increasing SNEL's revenues. It however implies a robust IT support system which implementation has been significantly delayed. These investments would enable SNEL to expand its customer base in the Kinshasa periphery and connect about 225,000 new customers. Certain investments in improving the reliability and strengthening of network equipment have been made through the PMEDE project, including in particular the installation of unloading cabins, the remediation of pipes, the reinforcement of installed capacities of 8 substations.These investments must result in an improved quality of service, particularly for those customers from whom an increase in revenue recovery is expected.

In addition to investment in distribution, improving the operation and maintenance of infrastructure and equipment would result in a better service reliability. Securing O&M financial resources through sufficient budget allocation, and efficient spending processes (including local delegation of O&M budget management) is crucial to ensuring investments live their full life. A maintenance contract for HV transmission lines is in the process of being signed. Funds from EIB in addition to monthly payments from SNEL are held in an escrow account in Luxembourg. For 5 years, the maintenance operator will be responsible for setting up an annual maintenance program and training SNEL's staff.

Physical investments must go hand in hand with the recruitment and training of sufficient staff in areas of expertise where there is a significant shortage of skilled personnel, including network management, operations and maintenance, I&T as well as automation and protection. SNEL's human capital reached 6,616 staff and 2,500 daily workers in 2017. The number of invoiced customers per agent remains below the threshold of 120 to 150 fixed in the performance contract and was of 67 (including daily workers) in 2017. Comparatively, the Ivorian

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[55] CVS stands for "Centres de Vente et de Service " (Points of sales and services).

Electricity Company (CIE) was at a threshold of 342 customers per agent at the end of 2016. The modernization of Sanga training center, and the incentivizing of core business postings to attract new talents would improve productivity and operational performance.

Furthermore, collecting on unpaid bills by government and government-owned companies is essential to restoring SNEL's health. Setting up a budgetary or tariff structure which provides subsidies to these institutions could be explored given that some provide strategic and essential services and simply cannot pay. Scaling up energy efficiency in key government companies should be a priority as it would reduce energy consumption and make bills more affordable.

6.3. CHANGING ATTITUDES AND BEHAVIORS

The success of the recovery plan requires a change in customer attitudes and employee behaviors. In a more competitive environment, SNEL has to transition from being an integrated power supplier to a sales company and a power manager. This shift in role implies major transformation in culture and governance to become more client-centered and results-oriented. Strong leadership and continuous commitment from SNEL's top management would drive this transformation. Nonetheless, changing employee behaviors must go together with shift in customer habits. Metered consumption and secured payments will have significant impact on demand patterns and will change unsustainable widespread practices such as electric cooking.

While prepayment using modernized payment platforms (by mobile application, etc.) can cut out the middle man, customers must feel an improvement in the quality of service or their attitudes towards payment will not change. The revenue collection process through the "CVS" has favored direct monetary transactions which prevent SNEL from any reliable sales monitoring and accurate account reconciliation statements. This process has been managed by either daily and rotating workers or SNEL's non-specialized staff, who in both cases have never benefited from commercial and business training. Securing bill collection through electronic transactions based on actual electricity consumption will improve client experience and decrease the feeling of resentment from customers paying a fixed price for very poor service.

A communications campaign can help explain SNEL's efforts and restore a healthy customer relationship. The campaign should describe the efforts being made to improve service and reliability and it should focus on a few key messages tested by focus groups. The campaign could seek to speak to different audiences, including the public, residential and industry sectors, and could offer energy savings tips to empower customers to be part of the solution.

There will be staunch resistance to the changes required inside SNEL. Change management has not been part of the recovery plan implementation so far. An internal change management campaign explaining reforms and how these will benefit the employees is essential to getting buy in. Moreover, the deep renewal of human capital through a transparent and competitive process can also support the change in working habits and management practices.

A big push on Human Resources policies is needed to promote worker satisfaction through renewed training programs, and job rotations. Human resources management has been neglected for years driven by vested interests and poor governance. Staff training does not match operational needs. SNEL's staff is 52 years old on average and the hiring freeze over the last years hindered the reversal of the pyramid. There is no clear career path along which staff could build up skills and specialization. Operational postings which imply in most cases rough working conditions with no financial incentive are not attractive. New recruitment should seek in priority technical, commercial and specific administrative (financial, IT) skills to fill out the current skills gap that hamper the effective implementation of the recovery plan. Core business priorities should drive the redesign of training curriculum and the adjustment of salary schemes to keep staff motivated and committed. Promoting interactions and synergies across teams to avoid working in silos would facilitate staff mobility and significantly improve the utility performance.

BOX 7 • MAIN CONCLUSIONS FROM TECHNICAL AND FINANCIAL AUDIT OF THE PERFORMANCE CONTRACT AND THE SERVICE CONTRACT TO SNEL

The first phase of SNEL's recovery strategy was structured around 3 contracts: Performance Contract between SNEL and the GoDRC, Services Contract between SNEL and MHI and Technical and Financial Audit Contract run by Deloitte. The audit concluded that the overall level of execution of the recovery plan remains insufficient in relation to the recovery schedule and the expectations of the various stakeholders. The main activities considered as a key success factor for SNEL's recovery have not been completed (appropriation of the recovery plan by general management and staff, setting up the steering committee, implementation of results-based management, change management, ICT master plan). MHI experts remained immersed in daily jobs to the detriment of the company's transformation and recovery activities. Shortcomings were particularly noted on procurement, IT and HR activities. On the performance contract, no significative achievement was made on the GoDRC commitments while about 70% of SNEL's commitments were respected. The main unachieved commitments are the launch of the clearing process of debts and cross debts, the reform of the consumption payment control system for public sector clients, balance sheet restructuring and debt settlement, and collaboration to control electricity consumption between SNEL and public-sector clients.

7

TO PROVIDE RELIABLE ELECTRICITY SERVICE AND TO EXPAND ELECTRICITY ACCESS IN THE DRC, OPERATORS NEED AFFORDABLE CAPITAL AND TARIFFS THAT COVER COSTS

Photo : © Frederic Verdol

7. TO PROVIDE RELIABLE ELECTRICITY SERVICE AND TO EXPAND ELECTRICITY ACCESS IN THE DRC, OPERATORS NEED AFFORDABLE CAPITAL AND TARIFFS THAT COVER COSTS

This chapter examines how expanding credit and low-interest capital for private operators is the key to offering affordable electricity to customers. The government and IFIs have an important role to play to work with local commercial banks to offer attractive financing.

The chapter also explores the role of renegotiating regulated tariffs in restoring SNEL's financial health and to allowing it to make investments for the future, and the reexamination of its debts to reduce the debt burden that constrain its cash flows.

7.1. EXPANDING CREDIT AND LOW-INTEREST CAPITAL FOR PRIVATE OPERATORS IS KEY TO OFFERING AFFORDABLE ELECTRICITY TO CUSTOMERS

Private operators set their own tariffs, which are not currently regulated in an ad hoc way. Each operator agrees on a tariff with the Ministry of Energy or provincial authority. For example, in the Goma area in North Kivu Virunga SARL charges USD 21c/kWh (before taxes) as does SOCODEE for LV customers, and USD 16c/kWh for MV. Meanwhile, BBOXX's offers range from USD 17 to USD 100 per month for residential power service.

Affordability is a big concern for private operators of isolated grids seeking to connect new customers. Connection costs are often too high for many households, SMEs, and public service institutions such as hospitals, and schools. To overcome this barrier, private operators have started to provide short-term loans to end-users to facilitate payment of connection fees. Meanwhile, off grid solutions are highly adaptable in such low affordability environment to adapt the level of service to customers' needs and means. Distributors must provide flexible payment PAYGO solutions to allow customers to spread out payment for the equipment, generally over up to 2 years.

In order to scale up lending services, or simply to finance capital expenditures, private operators of isolated grids need access to capital; which is currently limited in DRC. Private operators face very high costs and short repayment periods for loans from the commercial banking sector. Most loans are not over 1 year in maturity, and interest rates reach the double digits. These high financial costs are passed to consumers, slowing the growth of access. Local banks (which already work with Virunga and EDC/STS respectively) are liquidity-constrained and may not be in a position to provide affordable long-term debt. Meanwhile, off grid distributors are reliant on access to capital to be able to offer PAYGO solutions to customers. This business model is highly capital intensive as it requires upfront payment of equipment, for which customer payment is spread out over months or years.

The government and IFIs can help catalyze access to local, small-scale financing for market actors, engage financial institutions in market programs, and provide targeted incentives and financial mechanisms that support the market without distorting it. The government could provide grants to isolated grid operators and off grid companies to expand their distribution network to residential customers in priority areas. This can be done through establishing an electrification fund that provides subsidies to operators on a results basis for each household they connect, helping to bridge the affordability gap. CAPEX financing through long-term concessionary loans could also complement developers' equity for electricity generation, transmission and distribution projects. Lines of credit through commercial banks and microfinance institutions can also help introduce liquidity for the provision of loans to help finance capital expenditures. As some developers face issues raising early-stage capital, support could be provided for preparation work such as pre-feasibility and feasibilities studies, and resources assessment. In addition, technical assistance to banks to better understand the sector can help raise their appetite for lending. Finally, concessions for electrification can be drawn up and auctioned off to the bidder needing the lowest amount of grant money to subsidize initial capital investment.

7.2. RENEGOTIATING REGULATED TARIFFS AND REDUCING SNEL'S DEBT BURDEN ARE ESSENTIAL TO RESTORING SNEL'S FINANCIAL HEALTH AND TO ALLOWING IT TO MAKE INVESTMENTS FOR THE FUTURE

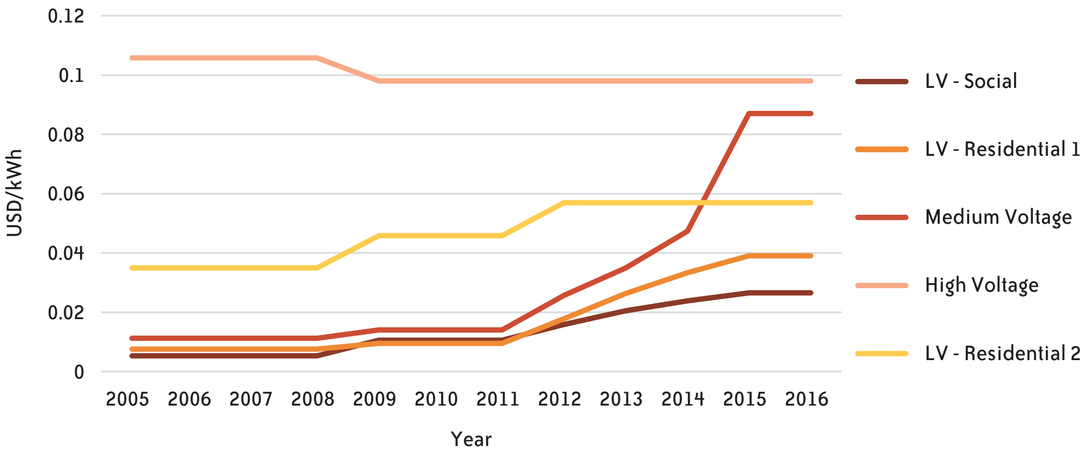
Unlike private operators that set their own tariffs, SNEL tariffs have been set by the government. In theory, with the goal of cost recovery. In practice, however, the tariff cost base has not been revised since 2009. Tariffs are set according to Ministerial Decree n°005/CAB/MIN-ECONAT&COM/2009 from March 2009, based on standardized costs, and updated only to reflect inflation, but not readjusted to reflect any changes in costs (*Figure 17*). The average effective tariff is around USD 7.7 c/kWh.

Under the current tariff regime, SNEL claims tariffs have not been able to cover costs, operations and maintenance, sector development and working capital. Currently SNEL loses 50 cents on every kWh produced because of non-payment of bills (*Figure 18*). If these commercial losses were reduced by moving towards metered, quantity-based billing rather than lump-sum billing, the tariff should be able to at least cover costs. A tariff proposal taking into account "actual costs, the truth of the prices, the non-transferability of charges and the equal treatment of all customers" was sent by the SNEL General Management to the competent authority in May 2019 with no follow-up received as of today.

Mining tariffs, in particular, could be set higher, if SNEL were allowed to negotiate directly with each company. HV clients currently pay a tariff of 5.69 cents/kWh for power purchased from SNEL (*Figure 18*) and many of them are already paying over 10 cents/kWh to import power, and over twice that much for power from diesel generators. The principle of free tariff negotiations for large customers and eligible accounts needs to be enshrined in the law to allow SNEL to negotiate its tariffs directly with mining clients.

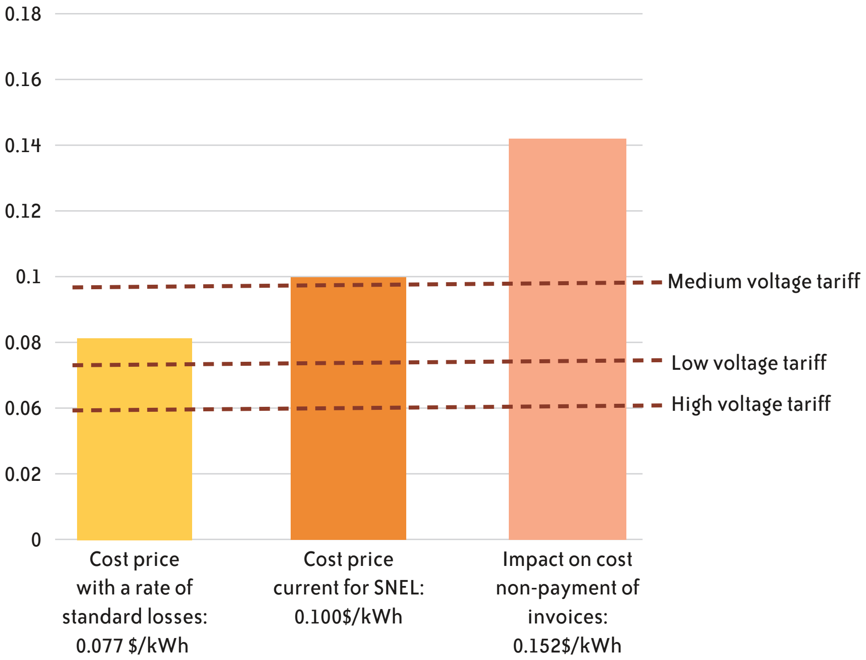
Once the regulatory authority is up and running, it will play a key role in the tariff setting process. The regulatory agency should propose, for adoption by inter-ministerial decree of the Ministers of Economy and Electricity, "the rules and

FIGURE 18 • Evolution of SNEL tariffs, 2005–2016



Source: SNEL, presentation DEC, Assises de l'Electricite.

FIGURE 19 • Comparison of SNEL's cost/kWh v. tariffs per client typology



Source: SNEL

procedures for setting electricity tariffs for the final consumer, access tariffs for transmission and distribution networks, and producer tariffs "(Article 24). The regulator should also verify the proposed tariffs and the costs recorded by the operators (Articles 23 & 25) and propose to the Ministers of Economy and Electricity "the producer tariff, the tariff for the use of the transmission and distribution networks on the basis of the cost elements provided by the operators" (Article 94).

SNEL's debts total over USD 3 billion, or 6 times annual revenues. These debts include USD 885 million in loans from MDBs, and USD 904 million in loans from private (mining) companies known as "PPP debts". Debts have more than doubled since 2013, and unpaid debts accumulate additional interests each year. Due to the difficulty faced in repaying these loans, the total amount of capital and interest due is higher than the amount borrowed for all (2.68 borrowed against 3.07 owed today) but the IDA debts. This is particularly true for the PPP debts that accrue penalties.

SNEL has a negative cash balance, yet the servicing of long-term debt will require USD 370 million in cash in 2018. SNEL's cash position was USD -13 million in December 2016 and improved to USD 16 million in December 2017. Given its negative cash balance, SNEL must make debt payments by taking out short-term loans. SNEL uses short-term debt to cover incompressible expenses, such as salaries, but cannot afford maintenance of its installations. This is the main factor leading to accelerated degradation.

Financial audits are currently being conducted for SNEL for the past six years. These audits can be used to develop a financial model for the utility to structure debt and prioritize investments. For example, improvements in the terms of SNEL debt towards mining clients would provide some breathing space and allow the company to clean out its supplier accounts. The burden of HV client debt on SNEL's financials locks out future cash inflows preventing sound operational management of the network.

8

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