Conceptual Plan for Enhancing Transmission Infrastructure to Expand Electricity Access in the Democratic Republic of Congo (DRC)

A project of USAID's Energy Efficiency for Clean Development Program (EECDP)

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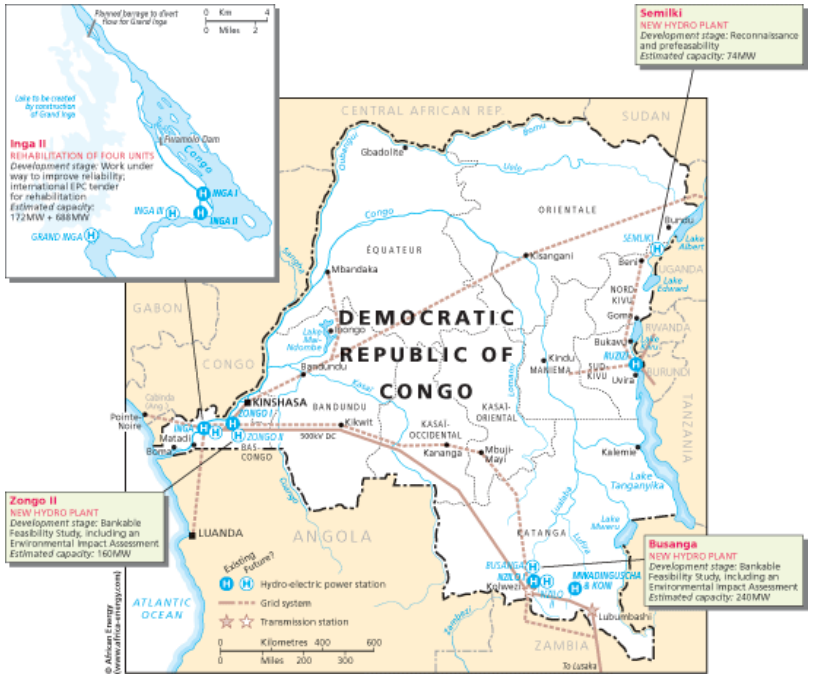
USAID's Energy Efficiency for Clean Development Program (EECDP)

- EECDP is a 6-year cooperative agreement between USAID and ICF, a global energy and environmental consultancy
- EECDP develops projects to explore and demonstrate successful strategies for advancing energy efficiency and related power sector improvements in support of clean energy
- Projects have been implemented in partnership with USAID missions to address key questions and critical barriers around energy efficiency. Some of the highlighted projects include:
  - Identifying best energy efficiency investments in six emerging markets, including **Mozambique** and **South Africa**
  - Direct technical assistance and training to utilities in **Tanzania** and **Ghana**
  - Opportunities assessment for industrial energy efficiency in **Bangladesh**
  - **Ghana** Integrated Resource and Resiliency Planning (IRRP) Program
  - **Tanzania** Integrated Resource and Resiliency Planning (IRRP) Program
  - **Southeast Asia** regional energy performance benchmarking for the building sector

Agenda

- **Project Background**
- **Overview of electric power sector in the DRC**
  - Regulatory Structure
  - Generation Resources
  - Demand Trends
  - Transmission Infrastructure
- **Demand projections for the focus cities/population centers**
- **Identification of supply-side resources for the focus cities/population centers**
- **Assessment of supply and demand projections for the focus cities/population centers**
- **Identified Transmission Projects for the DRC**
- **Challenges and Discussion**



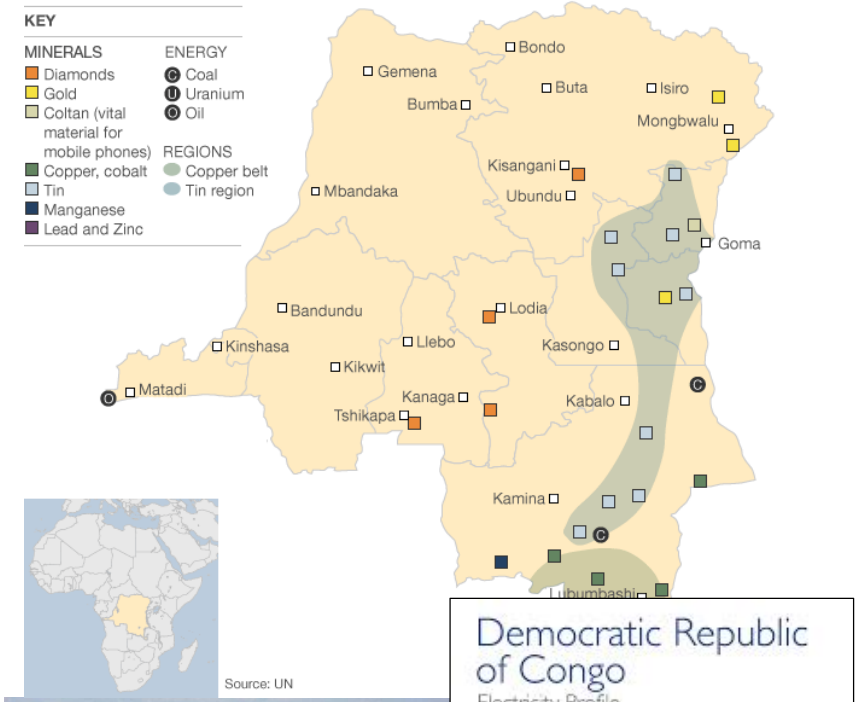
Source: www.geni.org

Project Background

Project Background

- ICF was engaged by USAID to identify and develop conceptual plans for expanding, enhancing and augmenting transmission infrastructure in the DRC.
- **Methodology**
  - ICF reviewed publically available reports, press articles and maps to identify resources and solutions that can improve energy access.
  - Selected four cities/population centers for detailed analysis
  - Projected the expected demand for the cities taking into account expected per capita electricity demand, projected population, load factor and reserves requirement
  - Assessed the existing and potential hydropower sites for the four cities from publically available reports and press articles
  - Projected the supply and demand curves for the four cities using the appropriate scenario assumptions
  - Identified potential projects to improve energy access in the four cities

Democratic Republic of Congo (DRC)



- The Democratic Republic of Congo (DRC) is the second largest country in Africa with a total land area of approximately 2.3 million sq.km., slightly less than one-fourth the size of the U.S.
- The country's population is estimated to be approximately 81.3 million as of 2016.
- The county's economic output (GDP) for 2015 stood at $35.24 billion and the annual economic growth for 2010-15 period averaged 7.7%.
- Despite the fact that DRC is endowed with rich hydropower potential and other renewable resources, there is a substantial unmet electricity demand.
- The DRC has one of the lowest electrification rates in the world, with approximately only 9% of its total population of 80 million having access to electricity.
- The electrification rate for urban areas is approximately 19%, while the rate in rural areas is 2% (as of 2013).

Source: CIA Fact Book –See link ; World Bank – See link

Source: ICF

Overview of the electric power sector in the DRC

Regulatory Structure

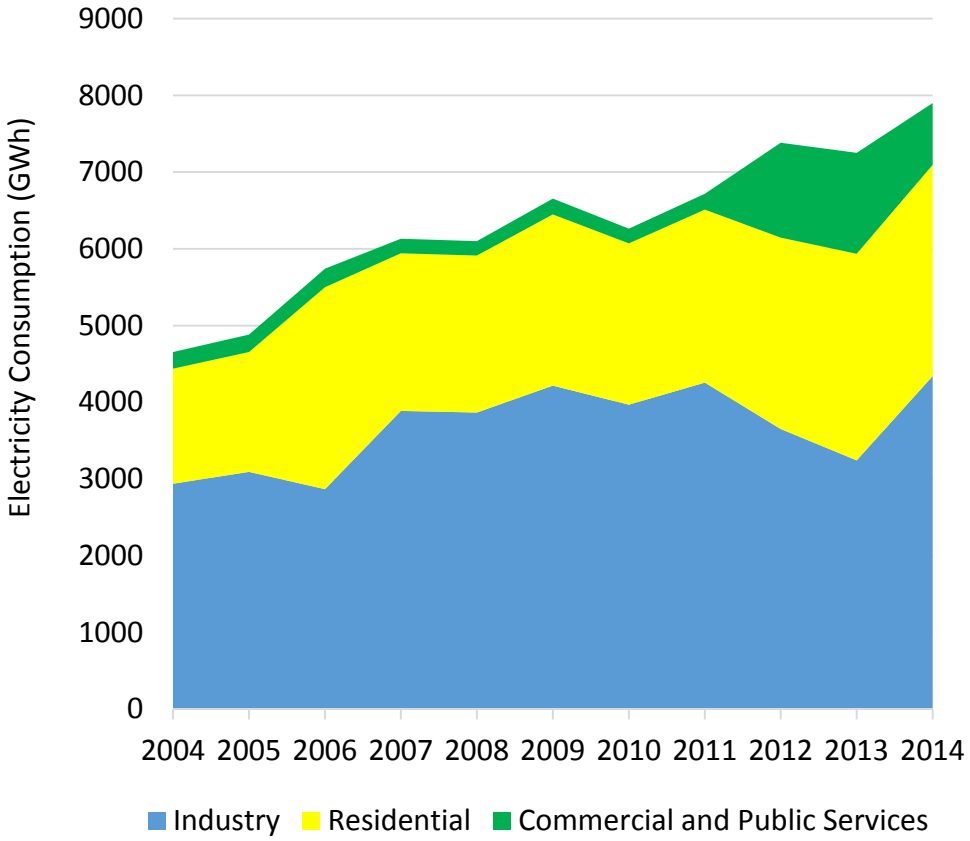
- Société Nationale D'électricité (SNEL) is the state owned enterprise in the DRC with mandate for electricity generation, transmission, distribution and trading of power.
- Electricity Law n°14/011 promulgated on June 17th, 2014
  - Liberalization of the electric power sector for private initiatives
  - Tariff rules for transparency and cost recovery
  - Creation of dedicated institutions
  - Diversification of energy mix
  - Focus on energy conservation and efficiency measure
  - Increasing electrification rates
- Decree n°16/013 promulgated on April 21st, 2016
  - Creation, organization and functioning of Electricity Regulatory Authority (ARE)
- Decree n°16/014 promulgated on April 21st, 2016
  - Creation, organization and functioning of National Rural Electrification Agency (ANSER)

Source: SNEL –See http://www.snel.cd/
DRC Essor Preliminary Information Memorandum (Nov 2016)

Historic electricity demand trends

In 2014, the DRC consumed **7,899 million kWh** of electricity, out of which 55% was supplied to industrial customers, 38% to residential customers and 7% to commercial/public services.

For the years 2004-2014, the **industrial and residential sector demand** have increased by an annual average rate of **5.2%** and **8.2%** respectively.



Source: IEA – DRC Statistics

Installed, Potential and Unmet Demand

Regions and Provinces	Population (2015)		Potential MW	Number of Potential Sites	Installed Capacity (MW)	Available Capacity (MW)	Unmet demand (MW)
	Total	Households					
Bandundu (Kwango, Kwilu, Mai-Ndombe)	9,334,354	1,395,614	172	114	3.57	1	343
Bas-Congo	3,900,605	761	64000	24	1867	891	108
Equateur (Equateur, Mongala, Sud-Ubangi, Nord Ubangi, Tshuapa)	9,361,891	1,362,989	122	58	19.3	1.9	345
Kasai Occidental (Sankuru, Kabinda, Tshilenge)	6,451,265	913,358	433	64	9.1	4	229
Kasai Oriental (Kasai, Lulua, Mbuji-Mayi)	6,397,800	1,230,665	252	65	16.5	11	303
Katanga (Lualaba, Haut-Lomami, Haut-Tanganykia, Haut-Katanga)	11,134,237	1,912,324	2231	70	583.6	350.16	339
Kinshasa	9,380,802	1,707,582		8			442
Maniema	1,993,619	408,321	458	140	18.45	1	103
Nord-Kivu	7,792,284	600,554	332	130	8.84	8.84	139
Province Oriental (Base-Uele, Ituri, Tshopo)	10,309,347	1,645,276	2684	52	71.37	23	398
Sud-Kivu	5,274,847	739,778	1197	41	79.54	8.5	180
Total	**81,331,050**	**11,917,222**	**71,881**	**766**	**2,677**	**1,300**	**2,929**

Source: UNDP – DRC Atlas (2014) (p.30)

Note: [1] The population numbers are extrapolated for 2015.

[2] The potential MW refers to the untapped hydropower potential that has been identified by the UNDP DRC Atlas (2014). Also, the number of potential sites refers to the potential hydropower sites identified by the report till date.

[3] Installed Capacity refers to the current rated capacity of all power plants (incl. non-hydro resources).

[4] Available capacity is the MW capacity that is available for dispatch currently (out of the installed capacity).

[5] Unmet demand refers to the current MW required to extend a threshold level of electricity consumption to the remainder of the population without access to electricity.

Existing hydropower units

Unit Name	Rated Capacity
Western Grid Network	
Inga 1	351 MW
Inga 2	1424 MW
Zongo 1	75 MW
Southern Grid Network	
Nseke	260 MW
Nzilo	108 MW
Mwadingusha	68 MW
Koni	42 MW

Unit Name	Rated Capacity
Isolated Hydro-electric Networks	
Ruzizi 1 & 2	44 MW
Sanga	11 MW
Tshopo	18 MW
Kyimbi	18 MW
Mutwanga	10 MW
Other IPPs	135 MW

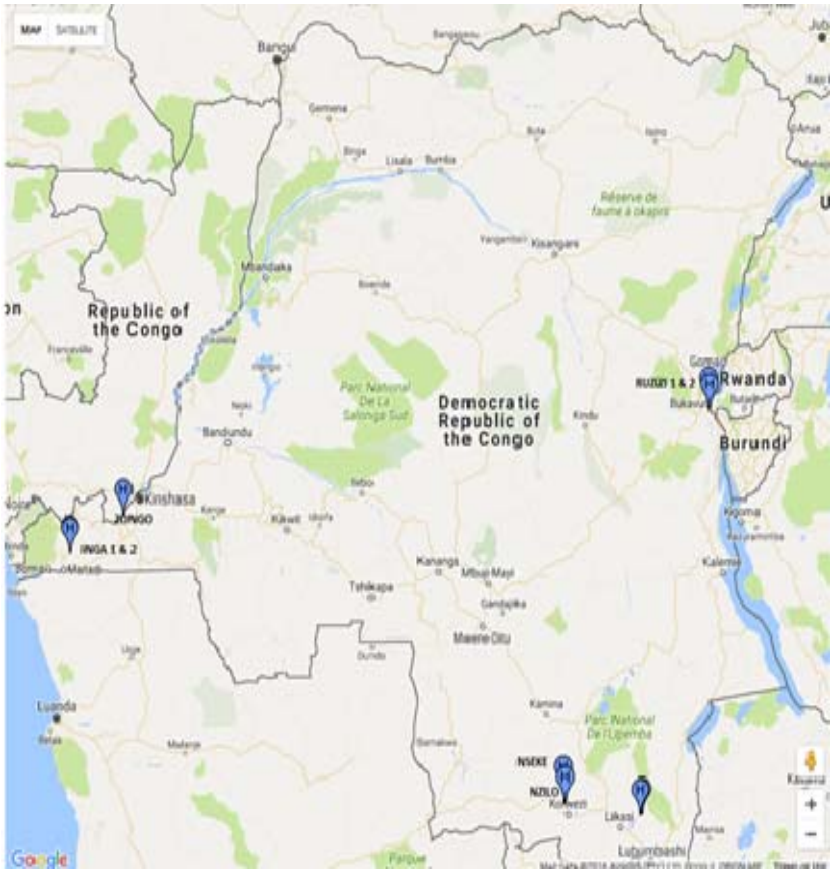
Source: SNEL (2013), Kadiayi (2013)

Total existing installed capacity of central power plants in the country is **2,590 MW** (Hydropower accounts for 2,472 MW and the rest are combustible fuels)

Only **half of the installed capacity is available for dispatch** at any given time due breakdown and lack of proper maintenance issues

Source: UNDP –DRC Atlas (2014)

Map of hydropower units in the DRC



Source: Global Energy Observatory (2016) for mapping feature

Proposed hydropower units

Project Name	Location & Rated Capacity	Current Status
Inga III Project (part of Grand Inga Project)	Inga Site (Bas Congo Province) Phase I: 4800 MW	Phase I of the project is expected to commence in late 2016 or 2017. Power purchase agreements signed with South Africa and other countries. Construction contract yet to be awarded.
Zongo 2	Zongo Site (Bas Congo Province) 150 MW	Bank of China/Sino-Hydro signed the agreement in 2011. Construction commenced in 2012. First unit is projected to come on line in July 2017.
Busanga	Busanga, Katanga Province 240 MW	Agreement signed with Sinohydro Corp. and China Railway Group in 2016. 170MW is expected to be supplied to Sicomine Copper mines, while the rest is supplied to the province.
Katende	Katende, Eastern Kasai 64 MW	Project funded by EXIM Bank of India. Plant construction is estimated to be 60% complete. Transmission lines yet to be constructed and to be connected to Kananga and Mbuji-Mayi.
Kakobola	Kakobola, Western Kasai 10.5 MW	Project funded by EXIM Bank of India. Plant construction is 95% complete. Transmission lines to be connected to Kikwit, Idiofa, and Gungu. Tender process underway.

5264.5 MW of potential hydropower capacity are under in construction or in active development.

Source: Press articles, stakeholder inputs. Also see ICF report for detailed references and descriptions.

Renewable Energy Potential

Solar

- High solar energy potential for the country (3.5 – 5.5 kWh/m^2/day)
- No grid-scale solar plants in the country today

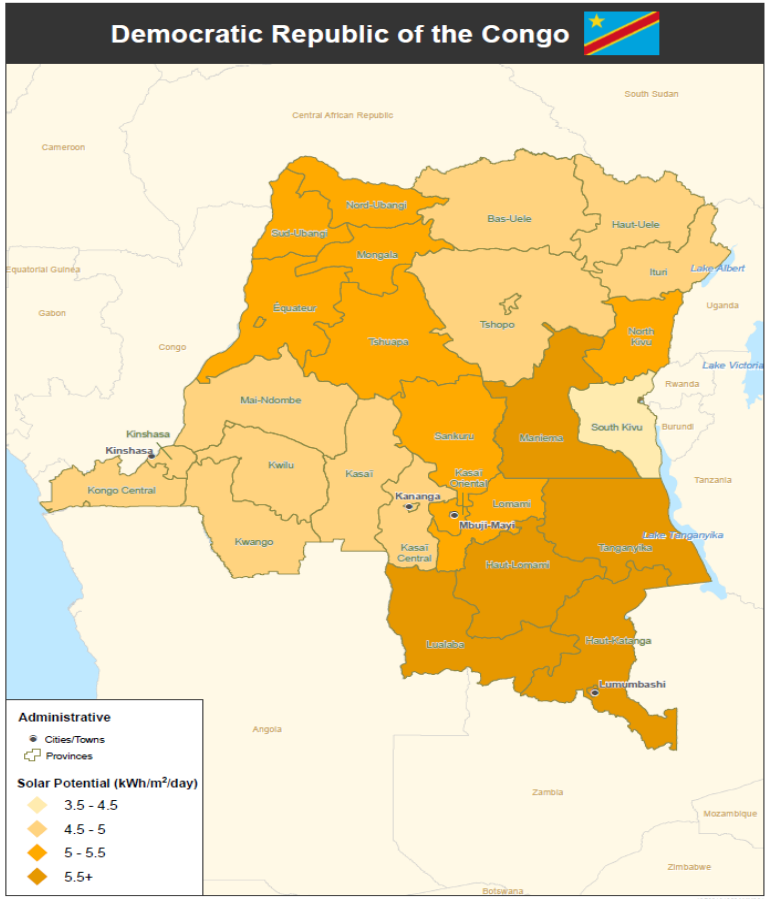
Biomass

- Biomass is an important source of primary energy in the country
- No **central** biomass-based power plants in the country

Wind

- DRC is endowed with adequate wind resource sites to develop micro-grid or distributed-grid networks with wind units
- On average, the wind speed for the country ranges between 2 - 4 m/s
- No central wind-based power plants in the country

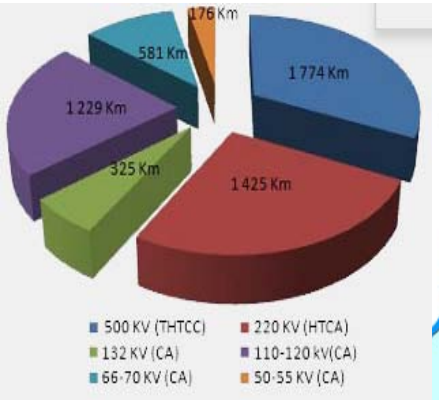
Source: UNDP Atlas - 2014



Source: UNDP DRC Atlas (2014)

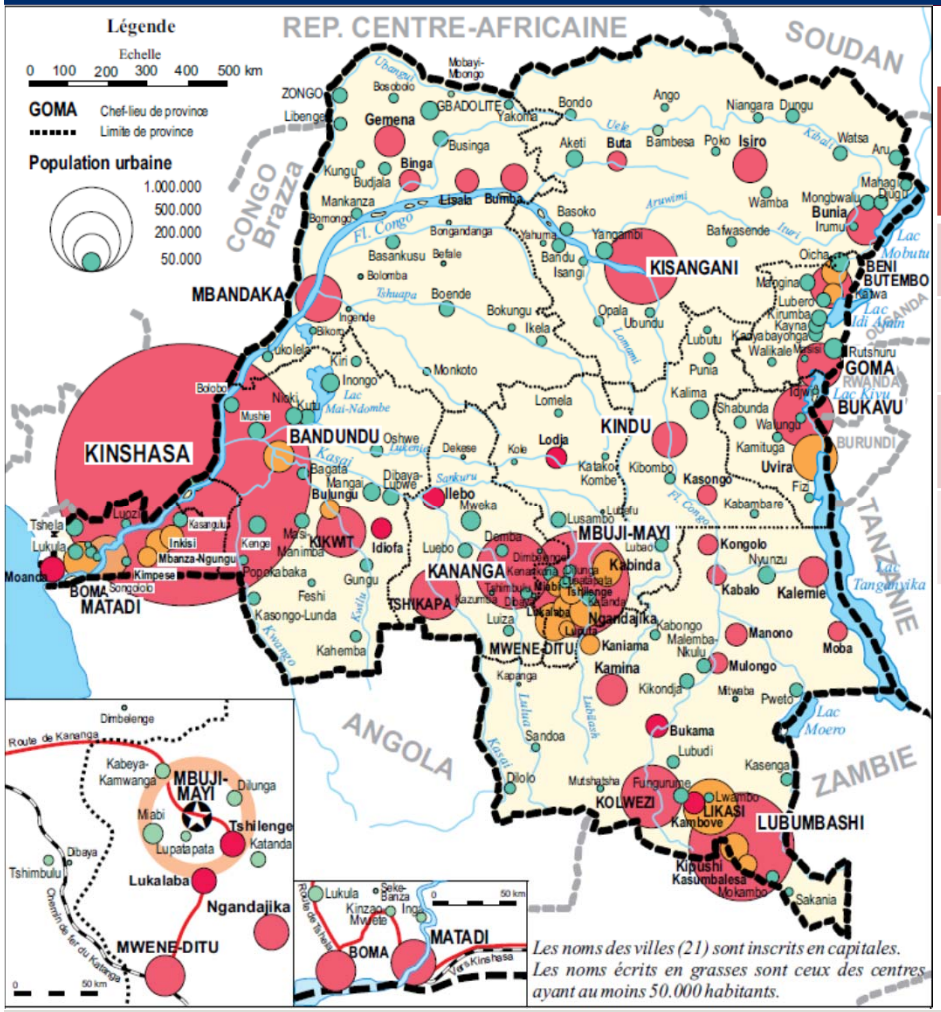
Existing transmission network in the DRC

Major Transmission Lines	Voltage Level
Inga – Matadi - Boma Monanda	132 kV
Inga – Kinshasa	132 kV
Kinshasa – Bandundu	220 kV
Inga – Kananga – Kolwezi	500 kV (HVDC)
Kilubi – Kamina	70 kV
Kolwezi – Kisanga	132 kV
Kolwezi – Lubumbashi	132 KV
Mwadingusha – Likasi	132 kV
Lubumbashi – Kitwe	132 kV



Source: SNEL (2015) for the pie-chart, World Bank for the map and ARC GIS for list of major transmission lines SNEL (2016) - http://www.snel.cd/stats/chiffres.php

Selected Focus Cities



Selected Focus Cities

City	Province	Pop.	Unmet Demand (MW)	Provincial Electrification Rate (%)
Kikwit	Kwilu	1,326,068	343	0.6%
Kananga	Kasai-Occidental	1,271,704	229	0.5%
Tshikapa	Kasai-Occidental	3,450,615	229	0.5%
Mbuji Mayi	Kasai-Oriental	3,367,582	303	1%

Source: CAID(2017) for population and UNDP DRC Atlas (2014) for unmet demand estimates

Selection Rationale

- Major population centers
- Rising energy demand
- Potential development corridor
- Situated along the Inga-Kolwezi power route
- Investment-scale projects

Source: UNDP Atlas (2014)

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Demand projections for the focus cities

Demand Projections - Assumptions

ICF used the electricity demand gap metric (or unmet demand) from UNDP Renewable Energy Atlas (2014) to compute the actual per capita electricity demand

$$Current\ Unmet\ Demand(2014) = \frac{(2014\ Population * \%Without\ elec.access) * 250\ kWh}{(24\ hrs.* 365\ days) * 1000 * Load\ Factor} * 1.2\ (Reserves)$$

$$Future\ Demand\ (2035) = Unmet\ Demand\ (2014) + \frac{(2035\ Pop. - 2014\ Pop.) * 425\ kWh}{(24\ hrs * 365\ days) * 1000 * Load\ Factor} * 1.2\ (Reserves)$$

Different Tiers of Energy Access (as defined by the World Bank)

USE OF ELECTRICITY SERVICES

TIER 0	TIER 1	TIER 2	TIER 3	TIER 4	TIER 5
None	Task lighting **AND** phone charging (or radio)	General lighting **AND** television **AND** fan (if needed)	Tier 2 **AND** any low-power appliances	Tier 3 **AND** any medium-power appliances	Tier 4 **AND** any high-power appliances

For the demand projection, we assume an estimated per capita consumption of 350 kWh/capita/year (corresponds to Tier 3 consumption) for all cities in 2016. The per capita consumption is estimated to increase to 525 kWh/capita/year by 2035 (corresponds to Tier 5 consumption).

Note: ICF used the electricity demand gap metric (or unmet demand) from UNDP Renewable Energy Atlas (2014) to compute the actual per capita electricity demand . In 2014, the unmet demand for the country was estimated to be 2,926 MW, while the available capacity was 1,222 MW. Since the population of the country in 2014 was estimate to be 76 million, the threshold per capita electricity demand in the country is estimated to be approximately 244 kWh/person/year. A World Bank report estimates the per capita demand to be at least 425 kWh/person for a Tier 5 consumption pattern. Hence we assume this target as the basis to compute the overall demand for cities by 2035.

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Projected Demand - Kikwit

Kikwit is a city of about 1.3 million in the province of Kwilu (formerly with Bandundu).

The economy of the city is driven by agricultural production and trading of palm oil, cassava, rubber, peanuts and maize. Kikwit also has food processing industries and an airport.

The projected peak demand for Kikwit increases from 116 MW in 2016 to 293 MW in 2035.

Kikwit	Projected Population	Unit per capita electricity demand (kWh/year)	Projected Electricity Demand (MWh/year)	Projected Peak Demand (MW)
2016	1,326,068	350	464,124	116
2020	1,480,943	387	572,891	143
2025	1,700,215	433	736,014	183
2030	1,951,953	479	934,883	233
2035	2,240,964	525	1,176,506	293

Source: ICF projections and CAID(2017) for 2016 population.
Note: The starting population for 2016 is sourced from CAID (2017). The population growth rate is assumed to be 2.8% annually based on World Bank projections for the country. The per capita is extrapolated linearly from 350 kWh/year in 2014 to 525 kWh/year in 2035. The projected peak demand is estimated using the formula outlined earlier.

Projected Demand - Kananga

Kananga is a city in the Kasai-Occidental province. As of 2016, its population is estimated to be approximately 1.27 million with an urban area density of 866 inhabitants/km^2 in 2016.

The city is an important commercial and administrative center. The city is also part of railway network in the country.

The projected peak demand for Kananga increases from 111 MW in 2016 to 281 MW in 2035.

Kananga	Projected Population	Unit per capita electricity demand (kWh/year)	Projected Electricity Demand (MWh/year)	Projected Peak Demand (MW)
2016	1,271,704	350	445,096	111
2020	1,420,229	387	549,405	137
2025	1,630,512	433	705,840	176
2030	1,871,930	479	896,556	223
2035	2,149,093	525	1,128,274	281

Source: ICF projections and CAID(2017) for 2016 population.

Note: The starting population for 2016 is sourced from CAID (2017). The population growth rate is assumed to be 2.8% annually based on World Bank projections for the country. The per capita is extrapolated linearly from 350 kWh/year in 2014 to 525 kWh/year in 2035. The projected peak demand is estimated using the formula outlined earlier.

Projected Demand - Tshikapa

Tshikapa is a city in Kasai-Occidental province. As of 2016, its population is estimated to be 3.45 million.

The economy of the city is driven by mining industries.

The projected peak demand for Tshikapa is expected to grow from 301 MW in 2016 to 762 MW in 2035.

Tshikapa	Projected Population	Unit per capita electricity demand (kWh/year)	Projected Electricity Demand (MWh)	Projected Peak Demand (MW)
2016	3,450,615	350	1,207,715	301
2020	3,853,621	387	1,490,743	371
2025	4,424,198	433	1,915,212	477
2030	5,079,256	479	2,432,696	606
2035	5,831,304	525	3,061,435	762

Source: ICF projections and CAID(2017) for 2016 population.
Note: The starting population for 2016 is sourced from CAID (2017). The population growth rate is assumed to be 2.8% annually based on World Bank projections for the country. The per capita is extrapolated linearly from 350 kWh/year in 2014 to 525 kWh/year in 2035. The projected peak demand is estimated using the formula outlined earlier.

Projected Demand – Mbuji Mayi

Mbuji-Mayi is a major urban center in Kasai-Oriental province with a population of approximately 3.36 million in 2016.

The economy of the city is driven by industrial diamond mining, breweries and hotel industry.

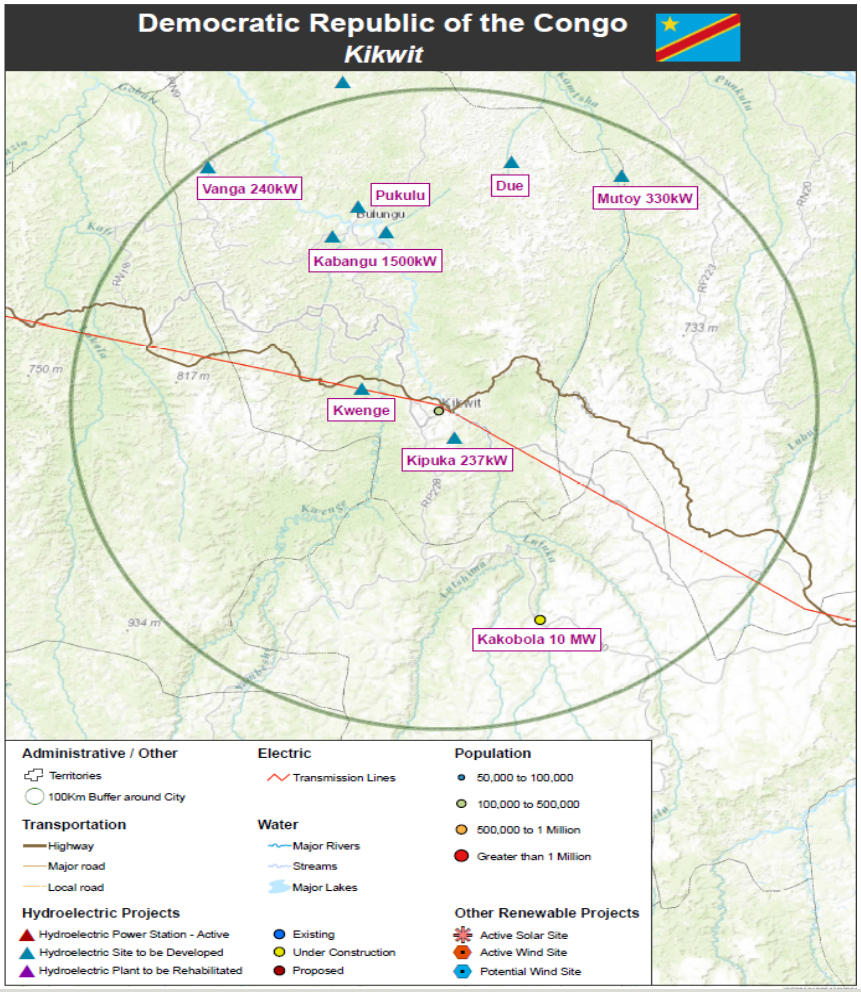
The projected peak demand for Mbuji Mayi is expected to grow from 294 MW in 2016 to 744 MW in 2035.

Mbuji Mayi	Projected Population	Unit per capita electricity demand (kWh)	Projected Electricity Demand (MWh/year)	Projected Peak Demand (MW)
2016	3,367,582	350	1,178,654	294
2020	3,760,890	387	1,454,871	362
2025	4,317,737	433	1,869,126	466
2030	4,957,033	479	2,374,158	591
2035	5,690,984	525	2,987,767	744

Source: ICF projections and CAID(2017) for 2016 population.
Note: The starting population for 2016 is sourced from CAID (2017). The population growth rate is assumed to be 2.8% annually based on World Bank projections for the country. The per capita is extrapolated linearly from 350 kWh/year in 2014 to 525 kWh/year in 2035. The projected peak demand is estimated using the formula outlined earlier.

Supply-side resources for the focus cities

Kikwit – Available supply resources



Under-construction

A 10.5 MW plant at Kakobola is 95% complete. Transmission lines have been financed but are yet to be constructed.

Projected Peak Demand	
2016	124.6
2020	142.7
2025	183.3
2030	232.8
2035	293.0

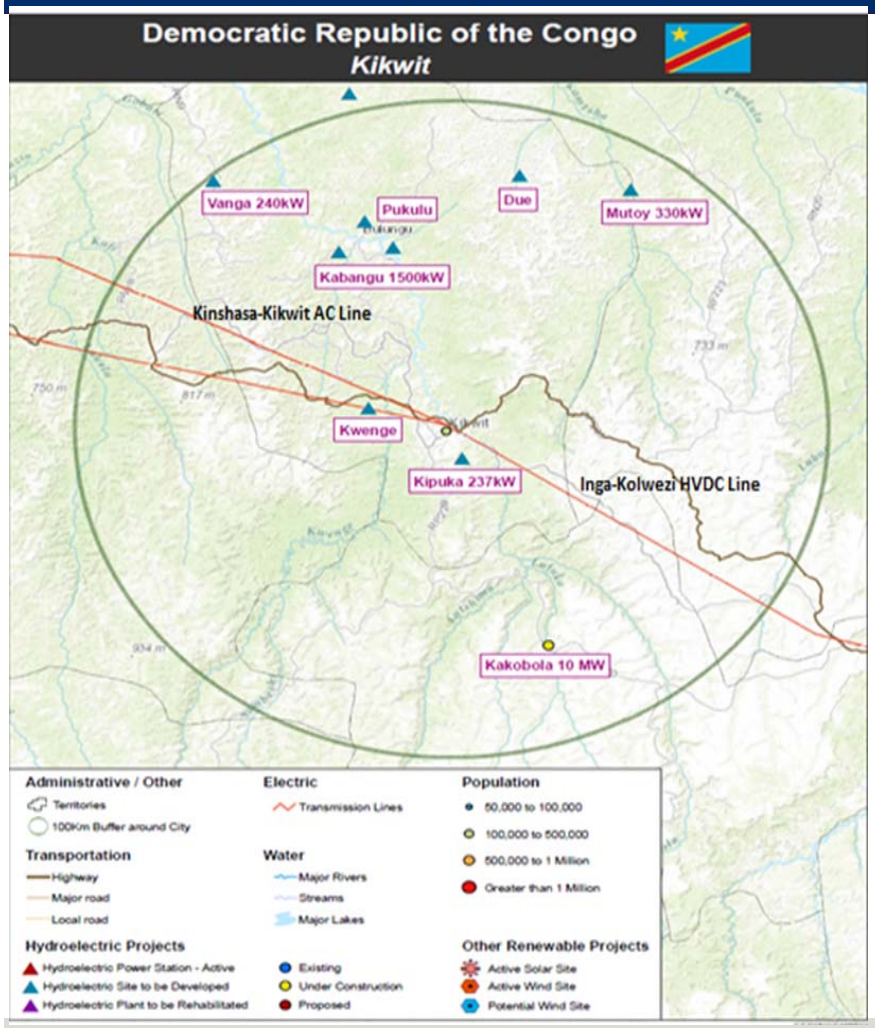
Potential Sites

- Kabangu (1.5 MW)
- Vanga (0.2 MW)
- Kipuka (0.2 MW)
- Mutoy (0.3 MW)
- Libidi, Kwenge, Due, and Pukulu.

The total rated capacity of potential hydropower units is approximately 2.2 MW.

Source: ICF

Kananga – Available supply resources



Under-construction

Katende (64 MW) is currently under-construction (45% complete). 20MW would be supplied to Kananga. Transmission lines to Kananga and Mbuji-Mayi have been financed but are yet to be constructed.

Potential Sites

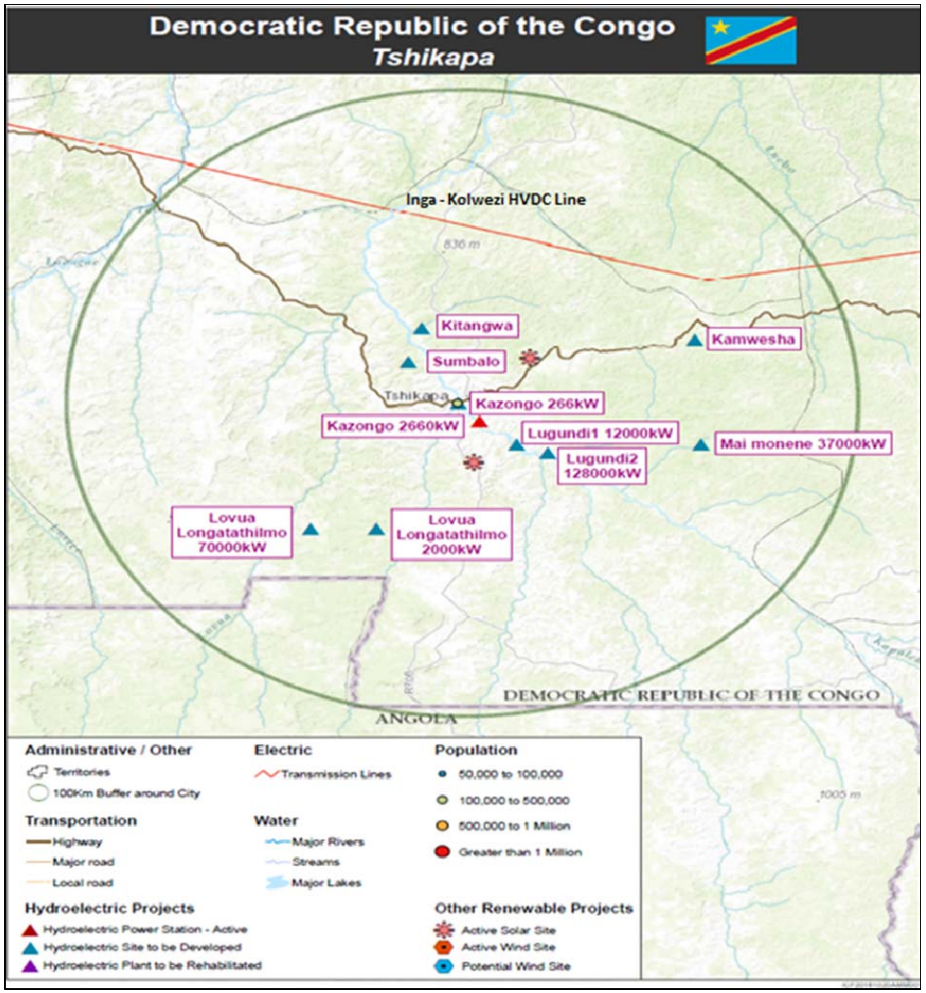
- Gorge de Lubundaje (24 MW)
- Masambo (9.4 MW)
- Kawula (0.8 MW)
- Dibaya (0.4 MW)
- Kajangaji (0.3 MW)
- Dibataye (0.2 MW)
- Tshibao (0.2 MW)
- Bukonder (0. 2MW), and
- Tshidimba (0.25 MW)

The total rated capacity of potential hydropower units is approximately 36 MW

Projected Peak Demand	
2016	119.5
2020	136.8
2025	175.8
2030	223.3
2035	281.0

Source: ICF

Tshikapa – Available supply resources



Operating Units

- Kazongo plant (2.6 MW)
- Lungudi plant (1.5 MW)

Potential Units

Potential local hydropower sites:

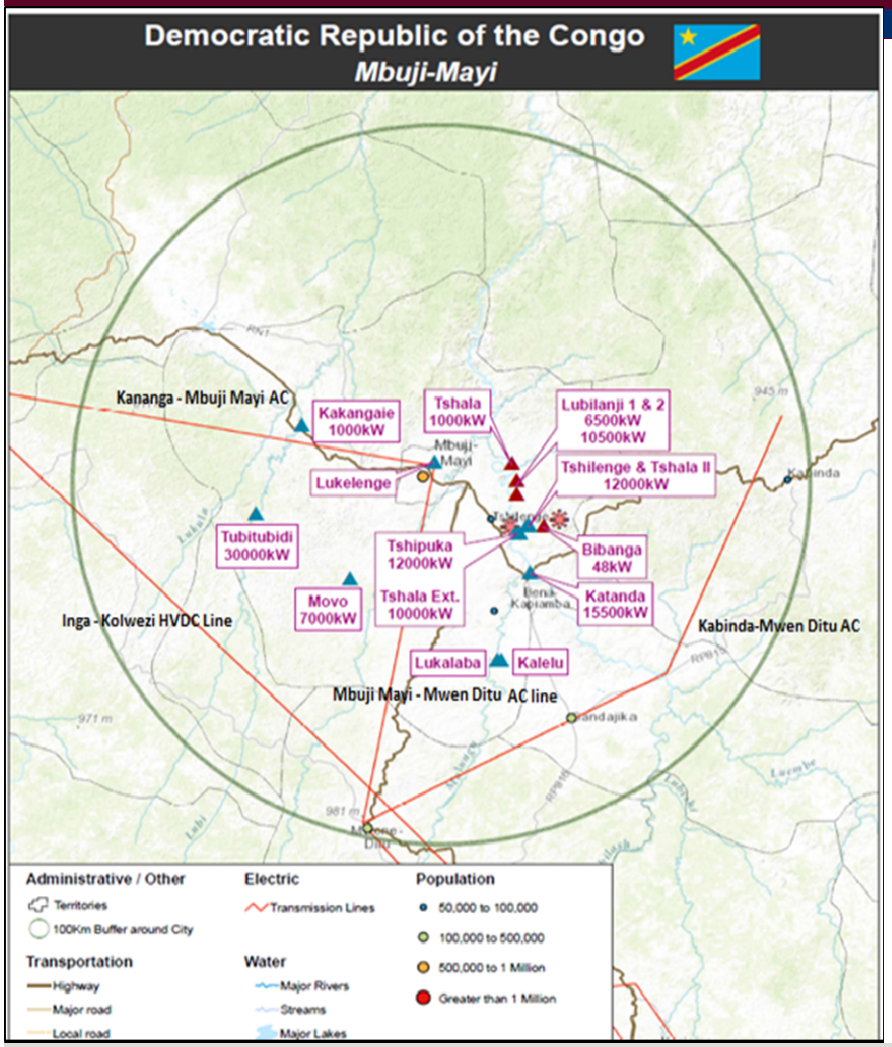
- Lungudi 1 (expansion) (12 MW)
- Mai Monene (100 MW)
- Lovua Longatathilmo (70 MW)
- Lovua Longatathilmo 2 (2 MW)
- Sumabalo; Kitangwa and Kamwesha.

Projected Peak Demand	
2016	324.3
2020	371.3
2025	477.0
2030	605.9
2035	762.5

The total rated capacity of potential hydropower sources is approximately 184 MW.

Source: ICF

Mbuji Mayi – Available supply resources



Operating Units:

- Lubilanji 1 (6.5 MW),
- Lubilanji 2 (10.5 MW),
- Tshala (1 MW), and
- Bibanga (0.05 MW).

Under Construction:

- 30 MW From Katende

Projected Peak Demand	
2016	316.5
2020	362.4
2025	465.5
2030	591.3
2035	744.2

Potential Sources:

- Tshipuka (12 MW) and Tshipuka Extension (10 MW)
- Tubitubidi (30 MW),
- Katanda (15.5 MW),
- Movo (7 MW), and
- Kakangaie (1 MW).

The total rated capacity of all these potential sites is approximately 106 MW.

Source: ICF

Supply-demand projections for the focus cities

Supply-demand projections - Scenarios

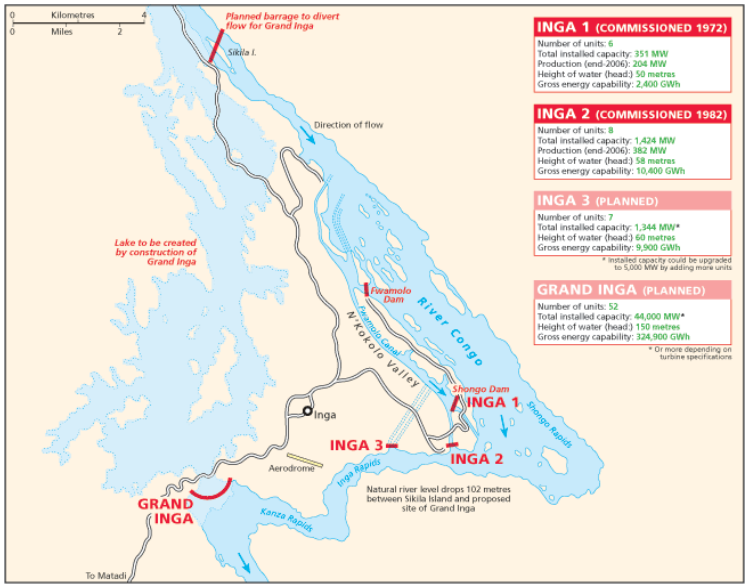
ICF developed two scenarios to meet the projected energy demand for each of the four selected cities.

Scenario 1 - Local Resources Development:

- Assumes that local supply resources would be developed by 2020.
- Local supply includes potential energy sites (mostly hydroelectric) within a 100 km radius of the individual cities.
- The remainder of the power requirement would be supplied by existing AC transmission lines.

Scenario 2 – Inga III Development:

- Assumes that the 4800 MW Inga III hydropower project would be completed by 2025.
- Power from Inga III would supply to hinterland cities through augmented AC and HVDC transmission lines.

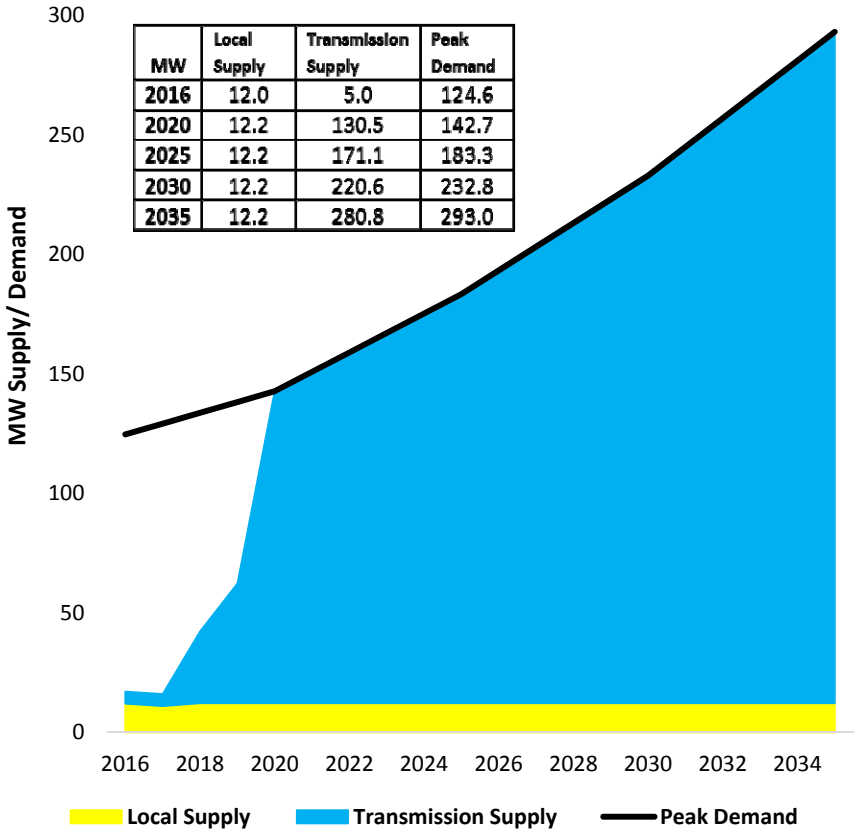


Source: www.geni.org

Supply-demand projections - Kikwit

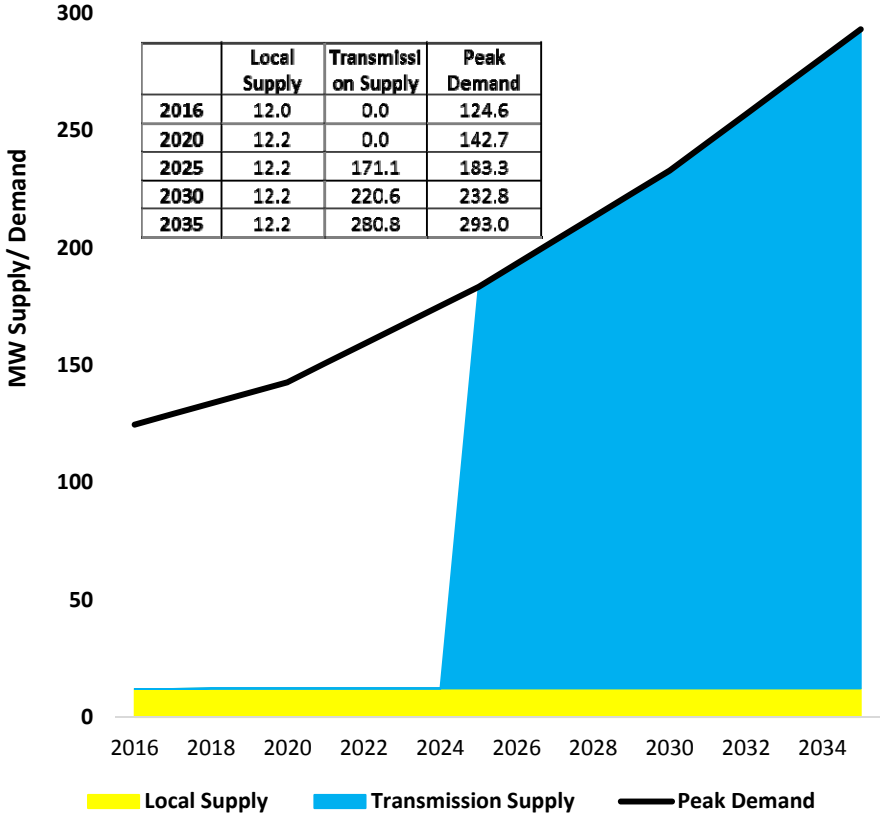
Scenario 1 - Local Resources Development

MW	Local Supply	Transmission Supply	Peak Demand
2016	12.0	5.0	124.6
2020	12.2	130.5	142.7
2025	12.2	171.1	183.3
2030	12.2	220.6	232.8
2035	12.2	280.8	293.0



Scenario 2 – Inga III Development

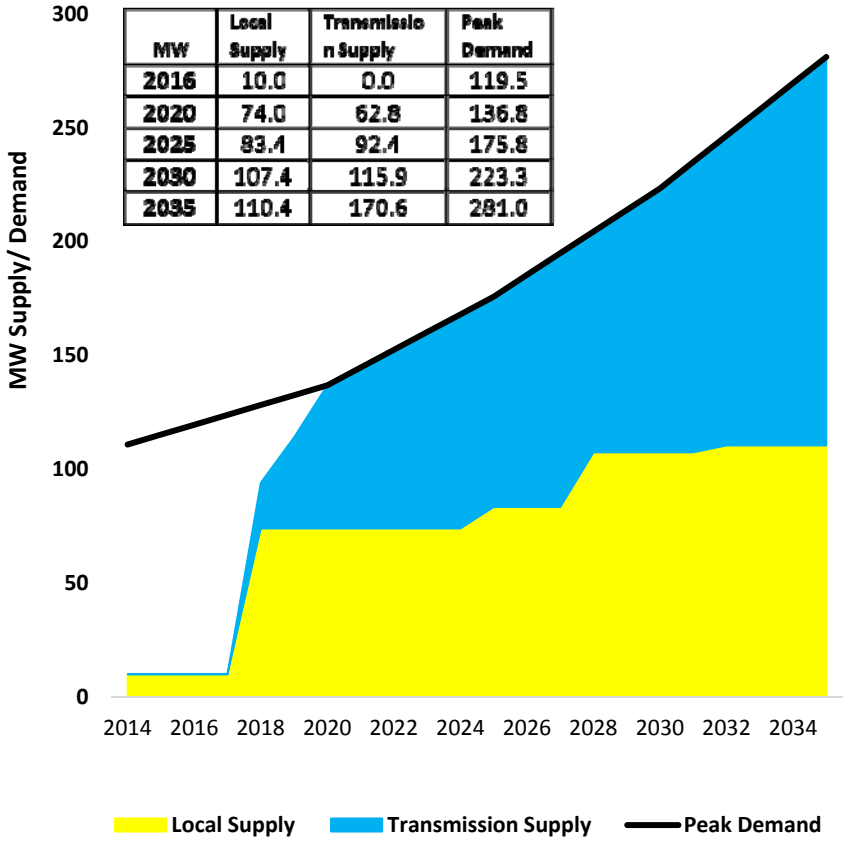
	Local Supply	Transmission Supply	Peak Demand
2016	12.0	0.0	124.6
2020	12.2	0.0	142.7
2025	12.2	171.1	183.3
2030	12.2	220.6	232.8
2035	12.2	280.8	293.0



Supply-demand projections - Kananga

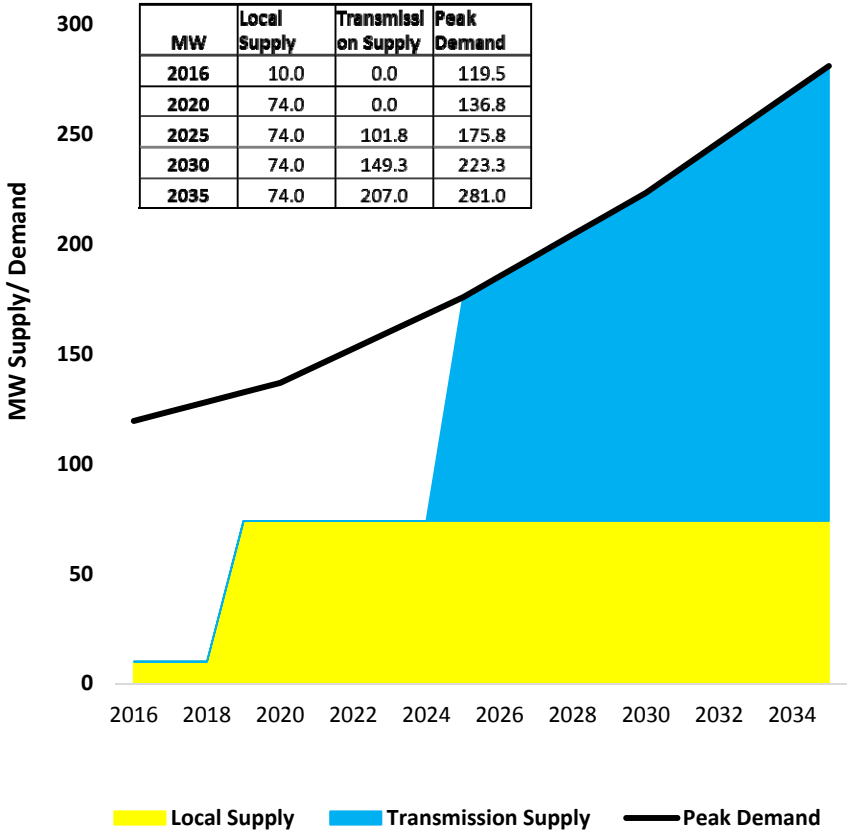
Scenario 1 - Local Resources Development

MW	Local Supply	Transmission Supply	Peak Demand
2016	10.0	0.0	119.5
2020	74.0	62.8	136.8
2025	83.4	92.4	175.8
2030	107.4	115.9	223.3
2035	110.4	170.6	281.0



Scenario 2 – Inga III Development

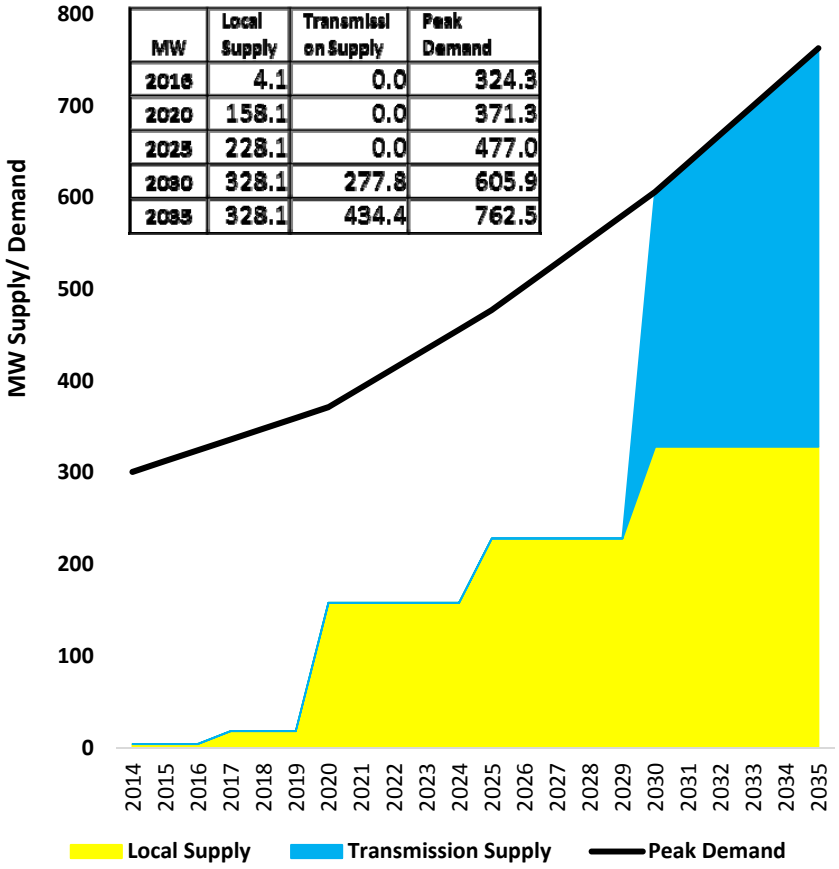
MW	Local Supply	Transmission Supply	Peak Demand
2016	10.0	0.0	119.5
2020	74.0	0.0	136.8
2025	74.0	101.8	175.8
2030	74.0	149.3	223.3
2035	74.0	207.0	281.0



Supply-demand projections - Tshikapa

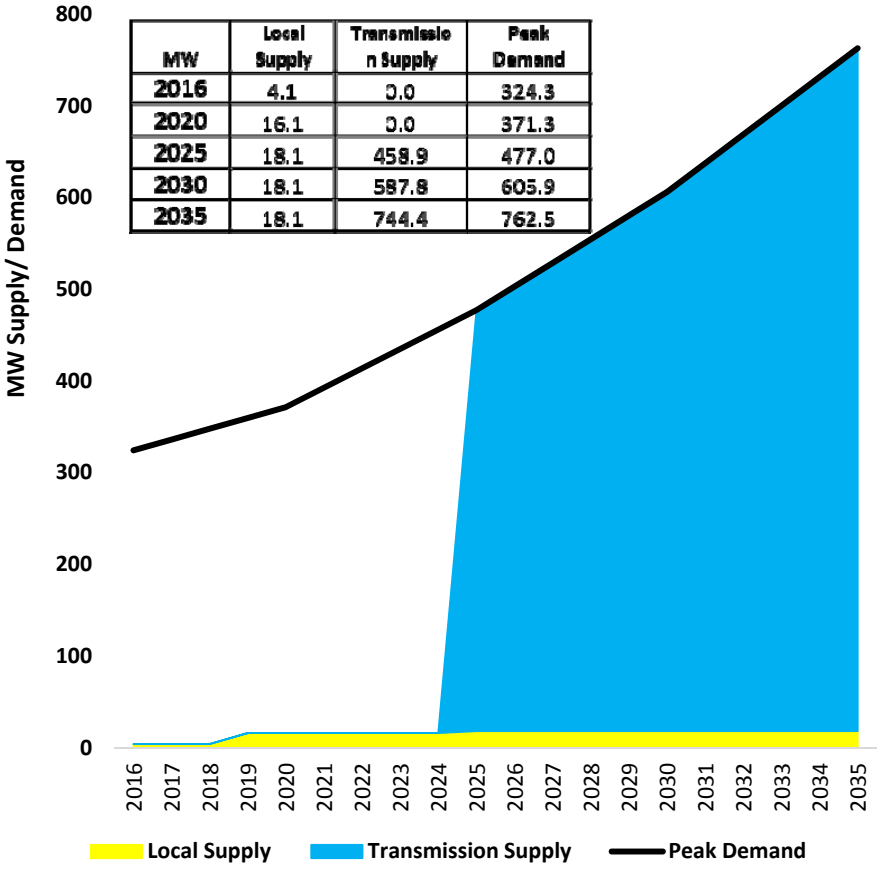
Scenario 1 - Local Resources Development

MW	Local Supply	Transmission Supply	Peak Demand
2016	4.1	0.0	324.3
2020	158.1	0.0	371.3
2025	228.1	0.0	477.0
2030	328.1	277.8	605.9
2035	328.1	434.4	762.5



Scenario 2 – Inga III Development

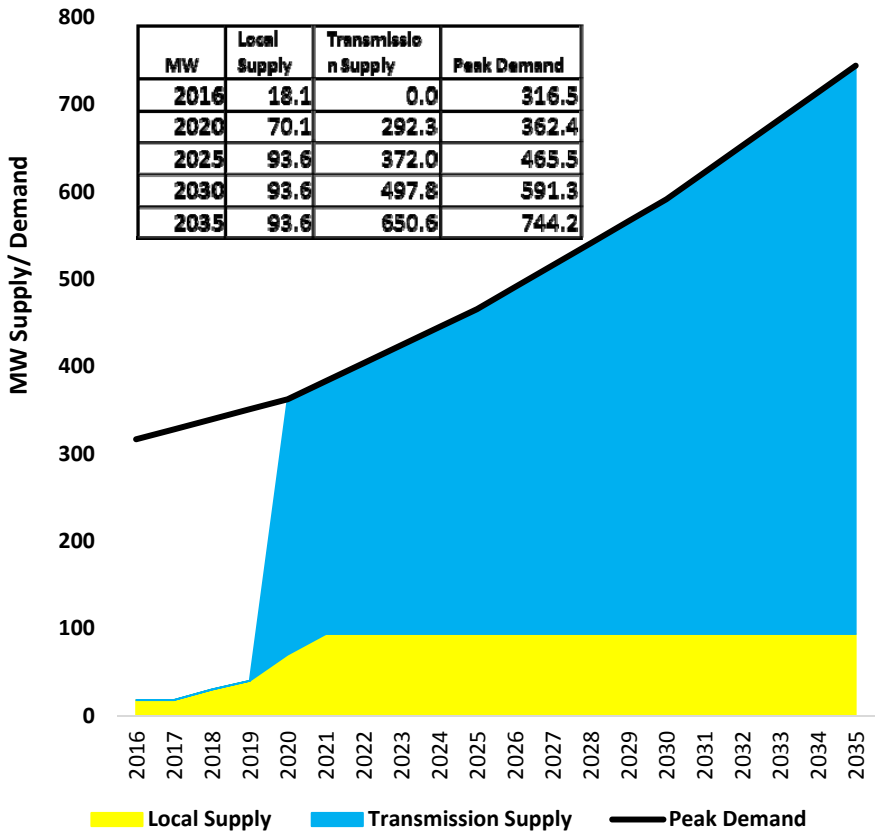
MW	Local Supply	Transmission Supply	Peak Demand
2016	4.1	0.0	324.3
2020	16.1	0.0	371.3
2025	18.1	458.9	477.0
2030	18.1	587.8	605.9
2035	18.1	744.4	762.5



Supply-demand projections – Mbuji Mayi

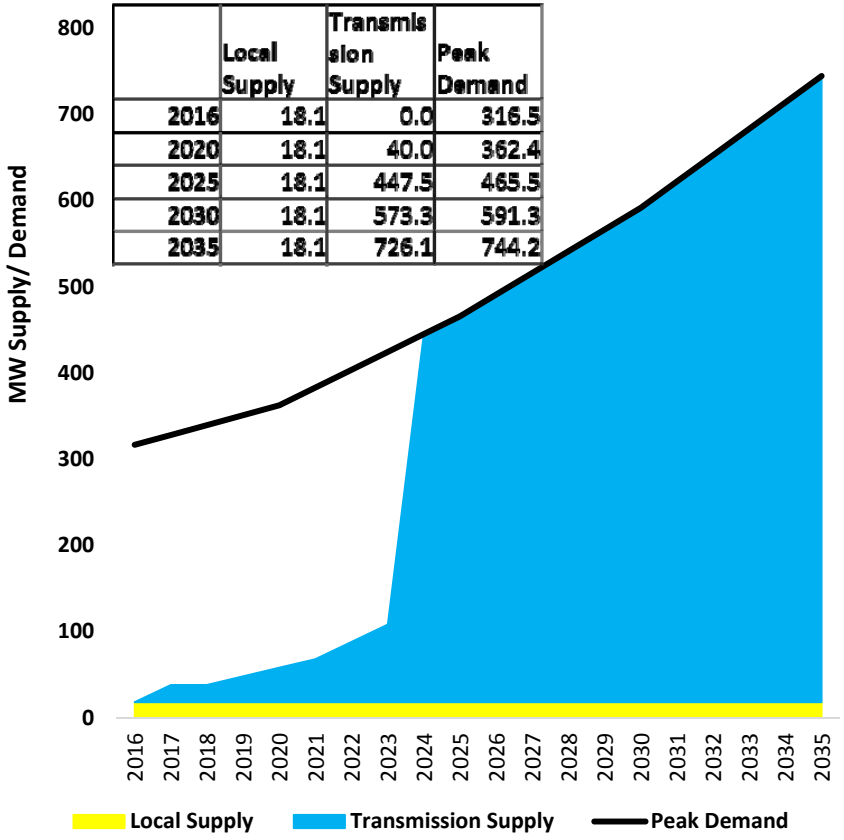
Scenario 1 - Local Resources Development

MW	Local Supply	Transmission Supply	Peak Demand
2016	18.1	0.0	316.5
2020	70.1	292.3	362.4
2025	93.6	372.0	465.5
2030	93.6	497.8	591.3
2035	93.6	650.6	744.2



Scenario 2 – Inga III Development

	Local Supply	Transmission Supply	Peak Demand
2016	18.1	0.0	316.5
2020	18.1	40.0	362.4
2025	18.1	447.5	465.5
2030	18.1	573.3	591.3
2035	18.1	726.1	744.2



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Project Fact Sheets

Unit Infrastructure Cost Assumptions

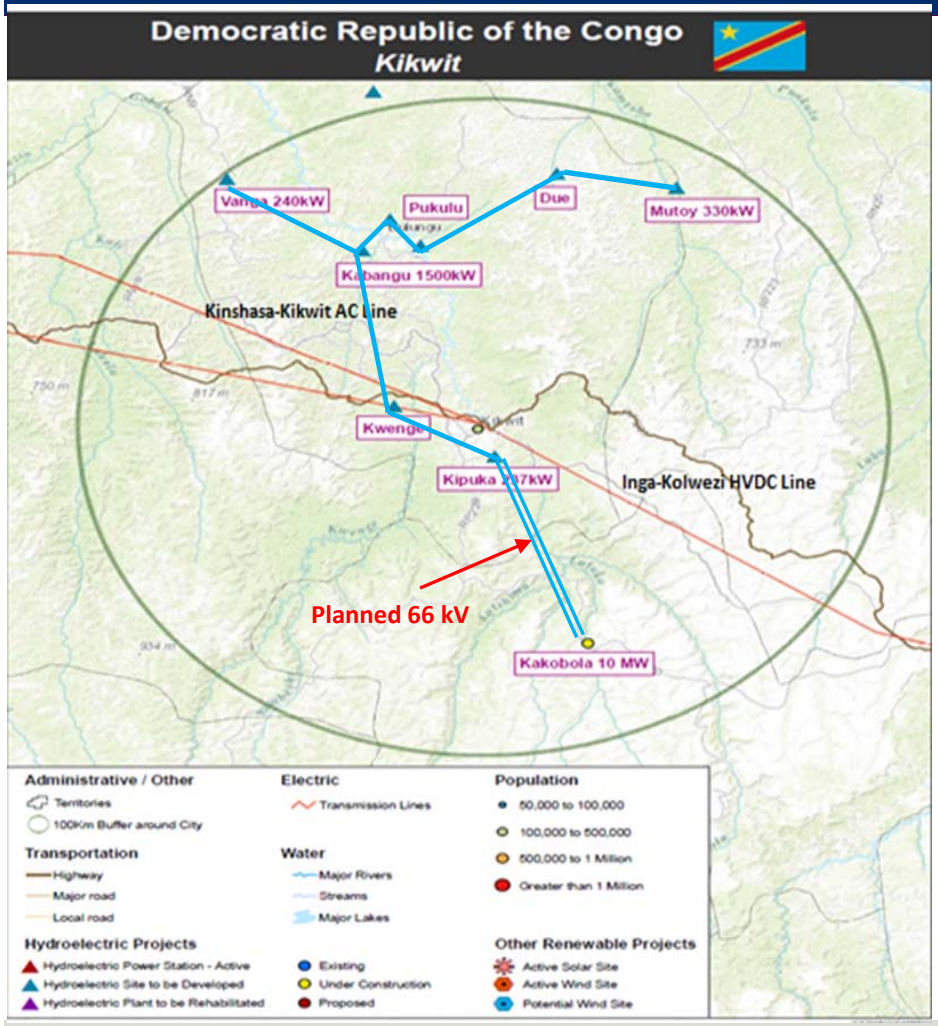
The cost estimates of the conceptual projects are generated using median estimates from the following table.

Unit infrastructure costs for power infrastructure projects in Sub-Saharan African Countries

Type	Unit	Lower Quartile	Median	Upper Quartile
Distribution (less than 66 kV)	US $/line km	8,253	13,986	16,233
Transmission (greater than 66 kV)	US $/ line km	34,558	46,684	54,013
Substations (less than 50 MVA)	US $/ MVA	300,634	347,495	396,627
Substations (greater than 50 MVA)	US $/MVA	81,896	116,346	186,123
Service Connection	US $/connection	1,232	1,362	2,450
Service Connection with street lighting	US $/connection	833	1,029	1,112
Street lighting	US $/connection	2,130	2,985	4,102

Source: Africon (2006). The cost estimates are inflated to 2015 US $ using an average annual inflation factor of 6%.

Project 1: Local Collector Transmission Network for Each Individual City



Description

The project consists of constructing a collector-type 220kV transmission network for individual cities to supply the power output from local hydropower projects to the city centers.

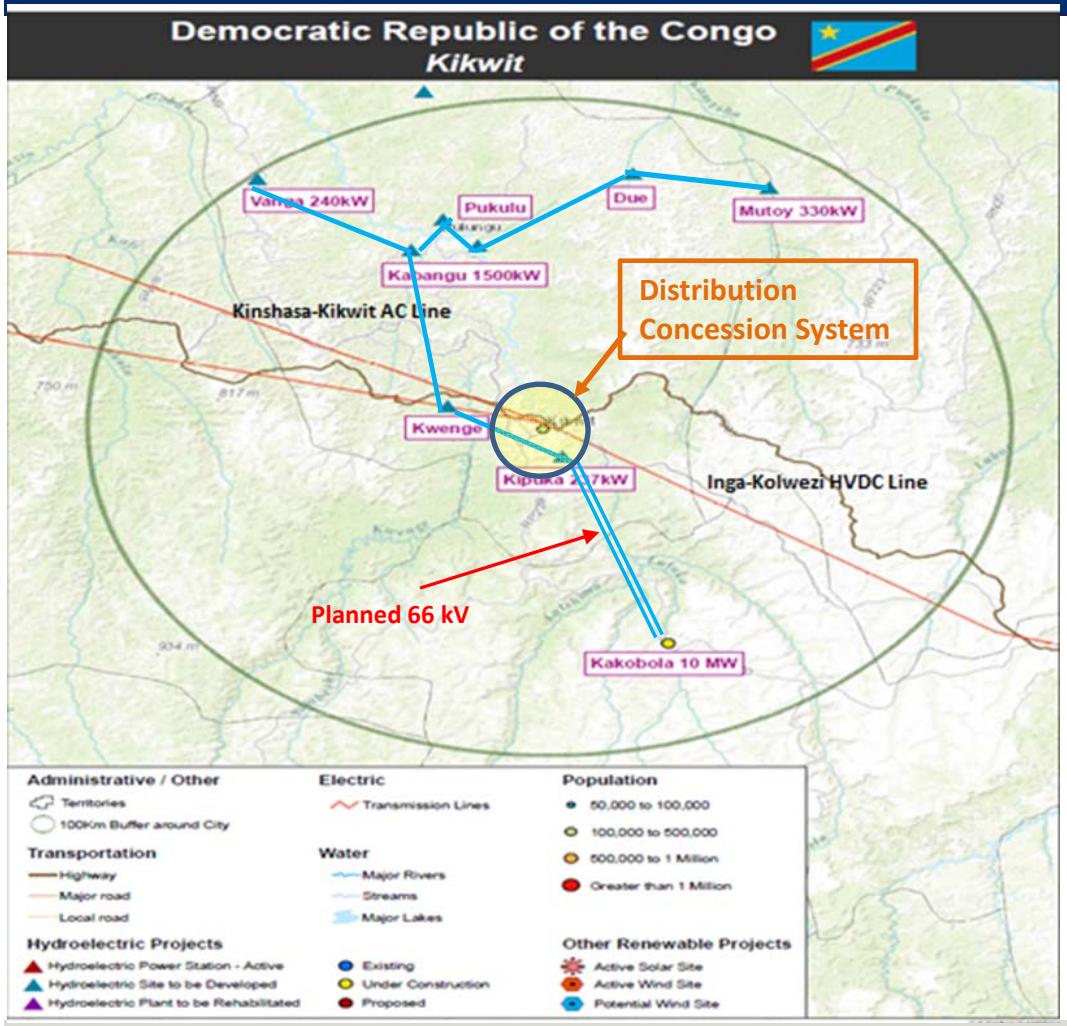
Cost Estimates

In general, a 50 mile (~80 km) collector system with two major substations (at 100 MVA each) and four minor substations (at 25 MVA each) is expected to cost around $190 million (2015 $).

Benefits

The collector systems will improve electricity access to the four cities and also improve overall grid reliability.

Project 2: Distribution Concession System for Kikwit



Description

This project would construct a distribution system (11-33kV) emerging from the city's local collector system (Project 1). As a pilot, the network would have 20x 400 Volt lines with 500 connections per line = 10,000 connections. The concession system would be developed by a competitively-selected private party.

Cost Estimates

ICF estimates the cost of low voltage distribution networks at $50,000 /km. Also, the cost of end-user interconnection is estimated to be around $500 per connection.

Benefits

- Greatly enhanced access to power at household level

Project 3: Central AC Backbone

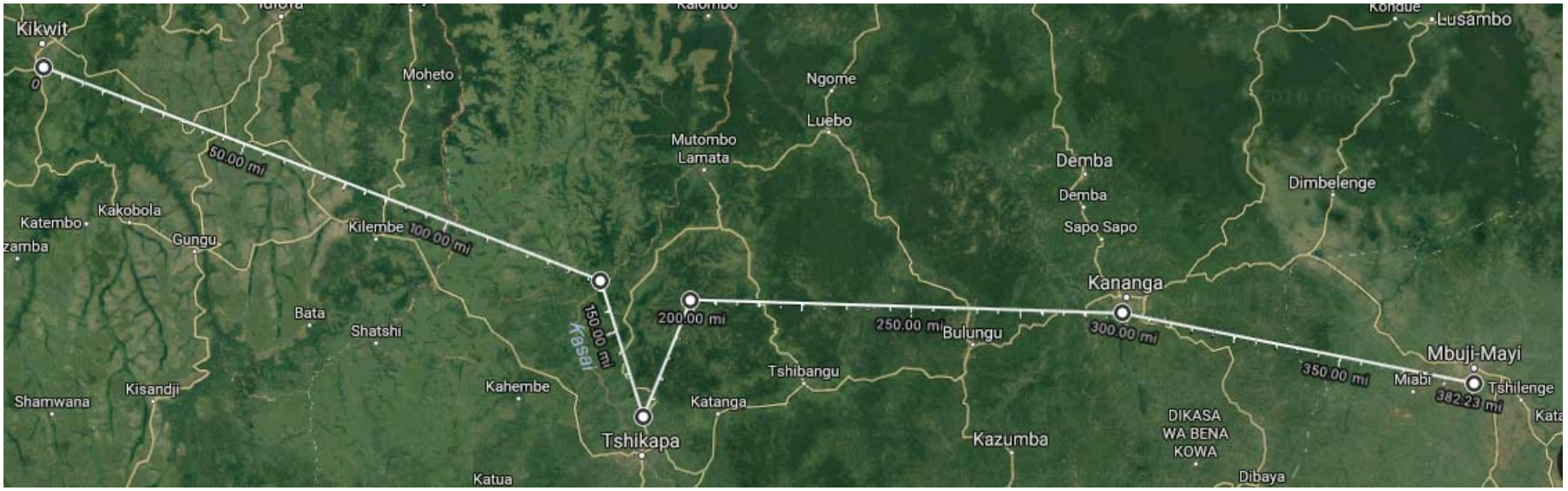
Kikwit – Tshikapa – Kananga - Mbuji Mayi

Description

The project consists of building a 500 kV AC line connecting the cities of Kikwit – Kananga – Tshikapa – Mbuji Mayi. The line would be part of the proposed AC backbone for the country.

Cost Estimates

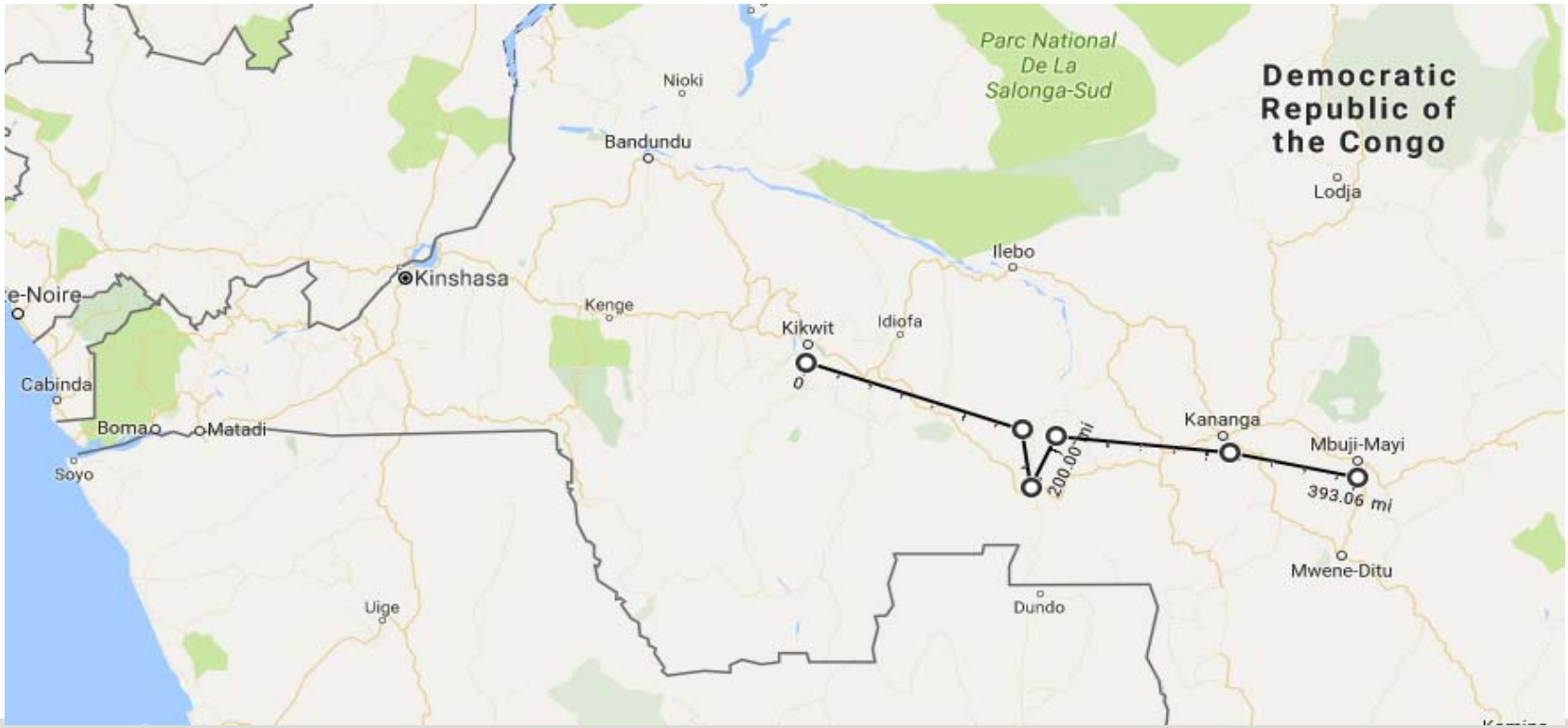
The line is expected to be 400 miles (~650km). The total project cost is expected to be approximately $415 million (2015 $).



Project 3: Kikwit – Tshikapa – Kananga - Mbuji Mayi AC Transmission "Backbone"

Benefits

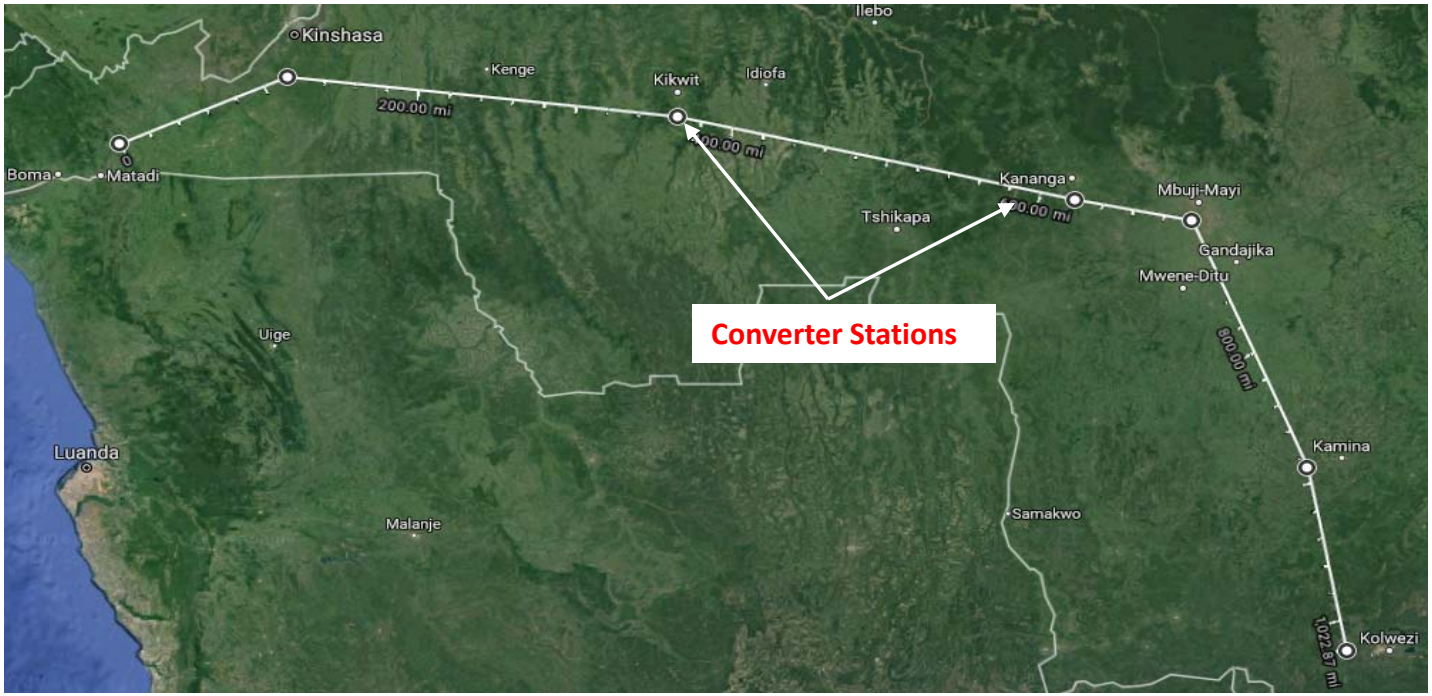
The AC transmission line is expected to improve electricity access and reliability for the entire country. It also serves as a regional grid network to distribute power generated in Central provinces.



Project 4: Augmentation of Inga- Kolwezi HVDC line

Description:

The project would construct a second HVDC line (1000kV) parallel to the existing Inga – Kolwezi line in the DRC. At least two converter stations, at Kikwit and at Kananga, would be constructed to provide the option of connecting those population areas at a later date.It is expected that this line will double the transfer capacity from Inga site to cities in Central and Southern provinces of DRC.



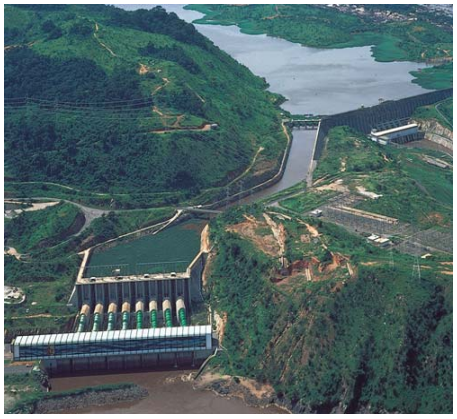
Project 4: Augmentation of Inga-Kolwezi HVDC Line

Cost Estimates

Since the length of the line is expected to be 1,060 miles (or 1,700 km), the project cost with transmission line alone is expected to be $794 million (2015 $). The cost of an HVDC inverter station is expected to be around $100 million each (2015 $). The project cost associated with inverter stations alone is expected to be $400 million. With allowances for other incidental costs and overruns, the overall project cost is expected to be around $1254million (2015 $).

Potential Benefits

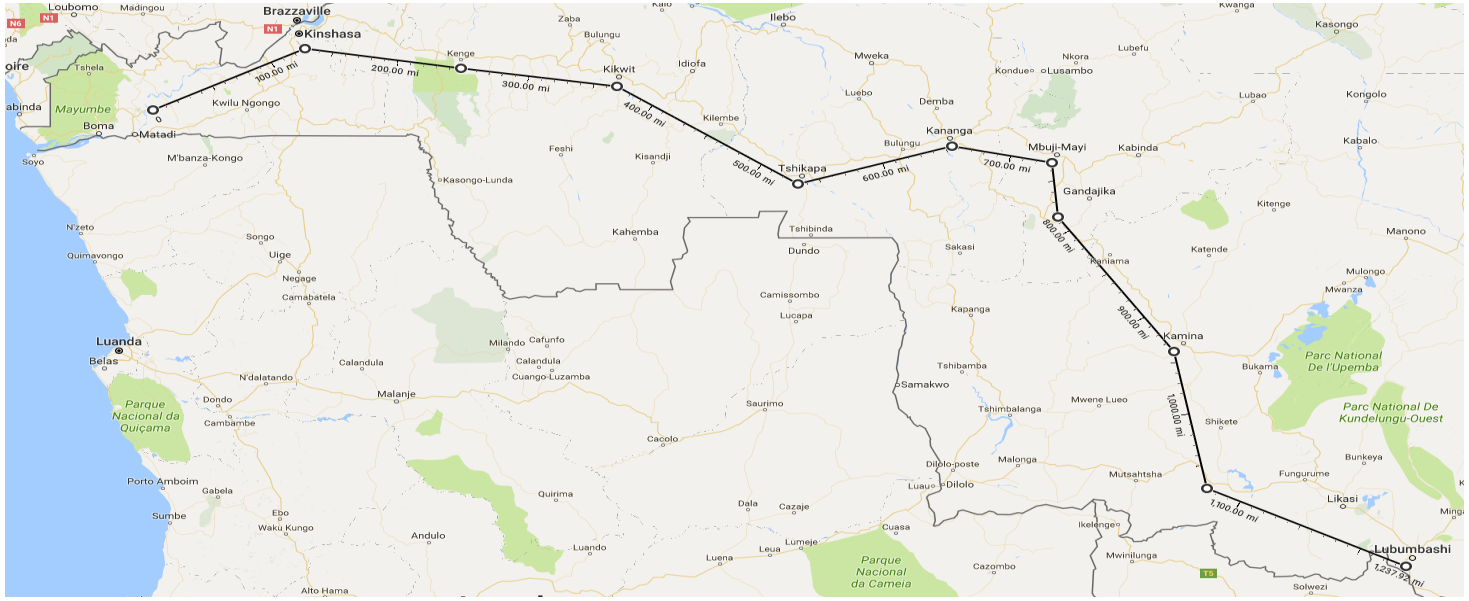
The project would enable power evacuation from Inga 3 via high-capacity lines and provide the option of connecting cities in the hinterland. The project can also facilitate the export of power to other countries.



Project 5: AC “backbone” Project for the DRC (Grand Inga – Kinshasa - Mbuji Mayi – Lubumbashi)

Project Description

The project involves extending the 500KV line in Project 3 in either direction to complete a an AC “backbone” line from Grand Inga site across the country to its southeastern regions. The project could be implemented in two phases. In the first phase, the Kikwit-Mbuji Mayi AC line could be extended westward to the Grand Inga site. In the second phase, the AC line could be extended from Mbuji Mayi to Lubumbashi.



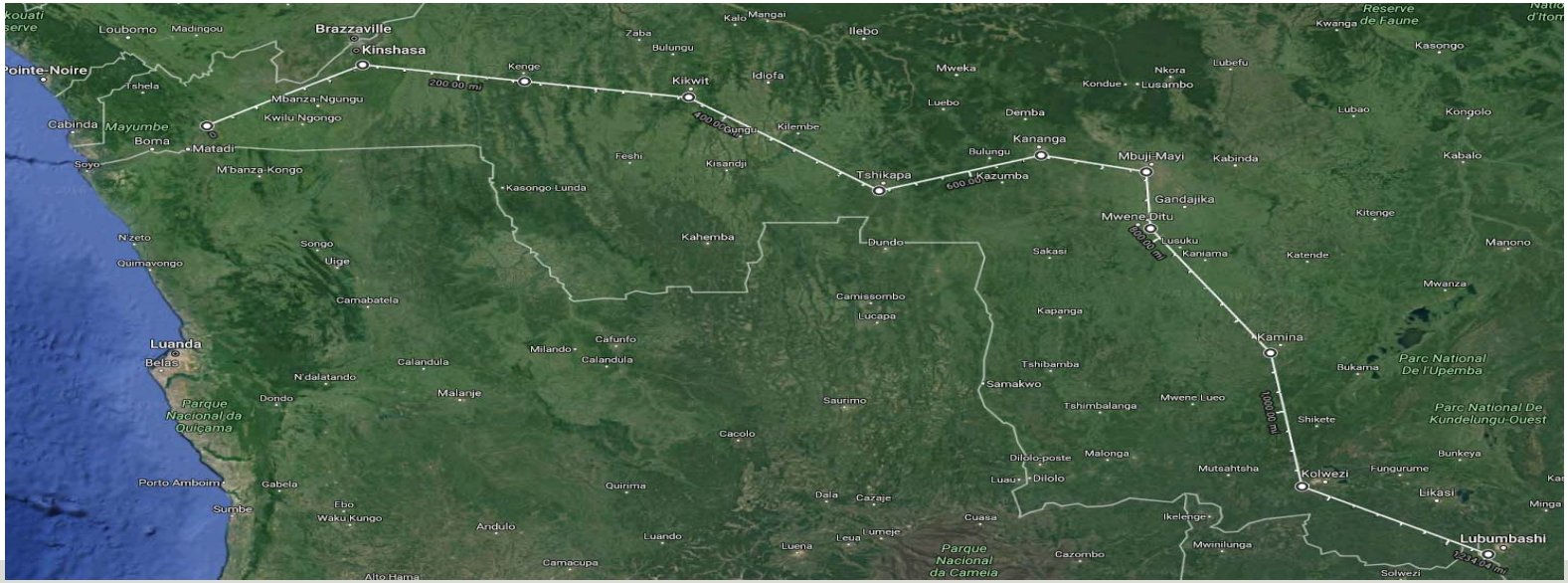
Project 5: AC “backbone” Project for the DRC (Grand Inga – Kinshasa - Mbuji Mayi – Lubumbashi)

Cost Estimates

The total cost of Phase I transmission line is expected to be $575 million. The total cost of Phase II transmission line is expected to be $368 million. The total construction cost of substations alone is expected to be $600 million. The overall project cost (for both Phases) is expected to reach approximately $1623 million (all in 2015 U.S $).

Project Benefits

The project offers improved reliability and electricity access to hinterland cities. Also, being an AC line, it is easier to tap into the line to supply to major load and population centers in the hinterland.



Summary of Proposed Projects

Project Name	Estimated Cost (in 2015 USD)
1-Local collector transmission network for individual cities	$190 m*
2-Distribution concession system for Kikwit	N.A
3-Central AC “Backbone” Kikwit-Tshikapa-Kananga-Mbuji Mayi	$415 m
4-Augmentation of Inga-Kolwezi HVDC line	$1254 m
5-DRC AC “Backbone” (extension of central backbone to Inga 3 and to Lubumbashi)	$1623 m

* Cost estimates are furnished for a typical collector system of certain configuration.

Challenges and Discussion

1. Most households live life on a day-to-day basis and cannot afford to pay for internal house wiring or small appliances
   - Need innovative solutions:
     - Provide small appliances to customers and incorporate costs in the tariff
     - Install pre-paid meters, so that customers only use what they can afford to pay for
2. Equipment across provinces varies, resulting in wide cost variations
   - Manitoba Hydro is performing a study on standardizing equipment and installation practices
3. Planning is made difficult by lack of information. Many demand studies have been done and projections vary widely.
   - Need an authoritative, credible study
4. DRC taxes are too high
   - Need tax incentives to attract private development capital for the identified projects

Thank You !