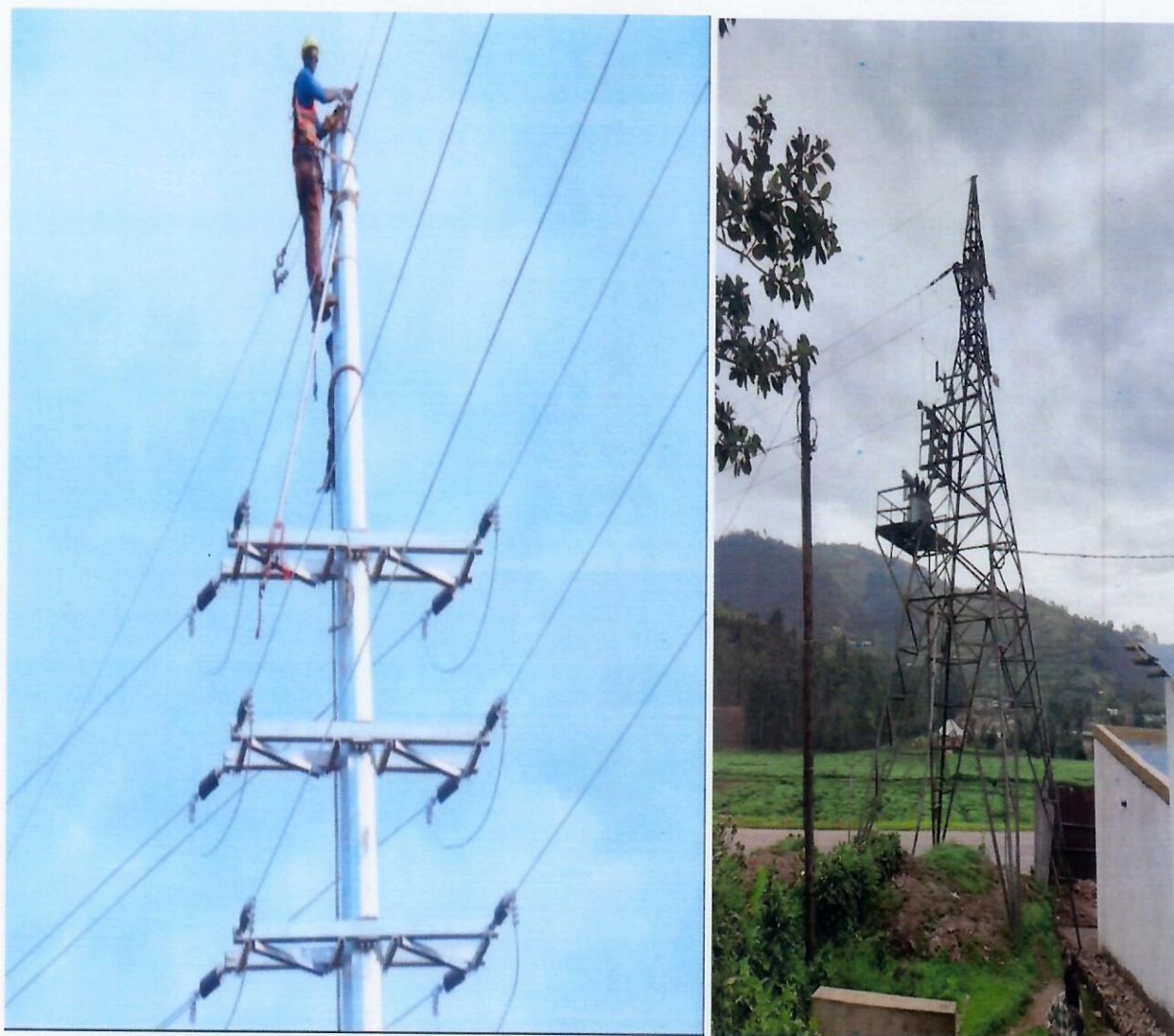




Rwanda Electricity Distribution Master Plan



June- 2023 Revision

APPROVALS








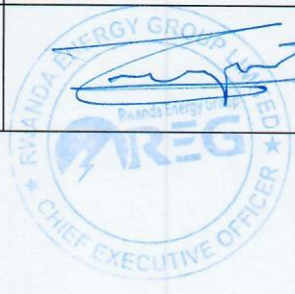
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I. INTRODUCTION

I.1. Introduction

Rwanda Energy Group (REG) through its subsidiary companies i.e. Energy Development Corporation Limited and Energy Utility Corporation Limited is mandated to provide affordable, adequate, reliable, and quality electricity services to the customers through transmission and distribution networks established across the country.

Towards realizing the mission, vision, and destination statement of REG as outlined in the Energy Sector Strategic Plan (2017-2024), there is a need to expand and reinforce the distribution system to address the system deficiencies.

The existing distribution networks are modeled and accordingly, the technical evaluation is carried out adopting the generally accepted load forecasting framework i.e. Trend analysis, the power requirement for the next ten (10) years are forecasted. Subsequently, the network capability and the system gaps are identified with proposed distribution system planning.

The plan proposes the required system reinforcement, upgrades and network expansion Programme that ensures that the network is robust and reliable to transmit and carry the load demands as and when it grows and more so with the injection of power from the generation projects in pipeline.

The single to three-phase distribution network conversion across the country is reproduced in this development plan based on field data.

Finally, necessary contingency plans, up-gradation, and reinforcement plans are proposed as annual investment plans based on the outcome of the simulation results using Power Factory Software.

I.2. Objective

- To carry out the system study of the existing distribution network, forecast and come out with the comprehensive strategic distribution plan.
- To provide affordable and adequate electricity, reduce losses, improve power quality, reliability, optimize the resources and gear towards excellent customer services; and
- To come out with annual investment plans.

I.3. Major Updates made in the Distribution Plan

Key updates made during the revision of are listed below:

1. Updates on Anticipated Major load demand on Distribution network from 2023-2028
 - Data were collected from different Institutions such as MINICOM, MINAGRI, WASAC, DISTRICTS , CITY OF KIGALI and stakeholders.
 - Network strengthening initiatives so as the feeders affected will cope with the anticipated load demand

2. Assessment of all Distribution Transformers Loading profile countrywide to identify the status of each transformer whether are critically overloaded or under-loaded for a better planning
3. Update of the list of Distribution Network Strengthening projects in pipeline i.e. funded and un-funded projects:
4. Illustrate the required Investment for distribution network strengthening projects

I.4. Expected Key Outputs of the development Plan

The expected key outputs of the development plan shall include but not limited to the following:

- (i) A detailed long-term demand forecast for Rwanda
- (ii) An estimate of distribution investment costs to meet demand growth.
- (iii) A program of distribution loss reduction initiatives.

I.5. Current Distribution Network Configuration

The Rwandan Distribution network is composed of 33 sub-stations (high to medium voltage) that include: GIKONDO, JABANA, Mt KIGALI, BIREMBO, GASOGI, KIGOMA, KARONGI, RULINDO, MUSHA, MURURU 1, KILINDA, KABARONDO, RWINKWAVU, NTARUKA, MUKUNGWA, CAMP BELGE, KIBOGORA, MASHYUZA, BUGARAMA, GATUNA, NTENDEZI, RUKARARA, GIFURWE, GABIRO, NDERA, NYABARONGO I, GAHANGA, NZOVE, BUGESERA, SHANGO, RUBAVU, RWABUSORO, NYABIHU.

The distribution voltage is 30 kV country wide except Kigali and Rwamagana operating at 15 kV but this level of voltage is no longer developed or extended as REG intends to phase it out and move to a single 30 kV distribution level.

By end June 2022, the distribution network is composed of 10,520km of medium voltage lines (30kV and 15kV), 18,465.7km of low voltage lines (0.4kV), a total of 6610 distribution transformers and a total of 1,376,998 customers connected to the grid.

I.6. Challenges in the Distribution Network

The distribution network suffers from poor reliability and quality of supply, which requires a huge budget to improve the issues. Some of the key issues identified during the development of this master plan are briefly described below:

- Overstretched LV network causing voltage drops in different parts of the country

- Weak sections of MV feeders unable to facilitate load transfers.
- Power cuts and delayed fault identification due to old Underground network in Kigali and Secondary cities
- Single phase network unable to facilitate some economic activities in fast growing areas
- Un-mapped Distribution network limiting proper planning for network expansion & reinforcement
- Insufficient intelligent switching devices (automatic load breaker switches, auto reclosers
- Old MV cabins and LV distribution boards/panel
- Long distance from HV substation to the load centers
- Network topology, radial in nature mostly up countries

II. PLANNING AND DEVELOPMENT APPROACH OF DISTRIBUTION MASTER PLAN

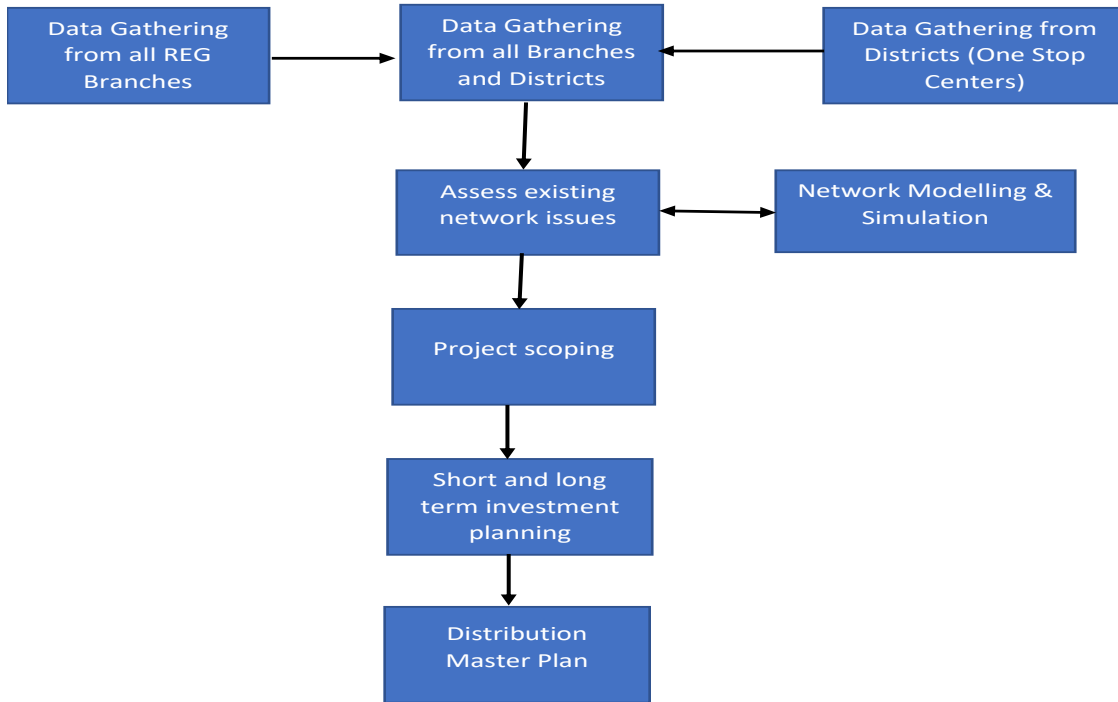
II.1. Overview

Distribution master plan highlights solutions to the existing challenges identified in the distribution network through different actions/projects:

- Substation upgrade (Gikondo, Gahanga, Nzove, Gasogi, Birembo, Mukungwa, Nyabarongo and Bugarama)
- Introduction of distribution management system (DMS) and improved methodology for infrastructure and customer mapping
- Upgrade and extension of MV lines to solve voltage drop issues
- Upgrade of existing LV lines to solve voltage drop issues
- Rehabilitation of Low voltage U.G Network in Kigali and secondary cities
- Construction of switching MV/LV Cabins: country wide
- Renovation of existing Electro-Mechanical MV/LV Cabins
- Reconductoring and Construction of MV links to facilitate configuration (Load transfer between feeders)
- Upgrade of single-phase network
- Reducing feeder length
- Monitoring Distribution transformer loading status through installation of smart meters

II.2. Development Methodology

The process by which the Distribution Master Plan was developed is shown in Figure:



Apart from the network data and models, key inputs to the planning studies were the demand forecast and the standard guidelines.

Long term planning was based on the development of ‘generic networks’ to represent the different typical network Topologies and off-grid configurations as per NEP. These were used along with the county level demand forecast to determine the long-term investment requirements.

II.3. Data Gathering

Data was gathered from different REG Hubs & branches, districts, and other stakeholders.

The data obtained in the hubs were used to update field data that was previously used, this was with the purpose of minimizing the number of assumptions that needed to be made with respect to the network models.

Alternatively, data about the ongoing revisions of urban development master plans, irrigation and mineral processing areas were also collected from relevant institutions such as CoK, MINICOM, RDB, MINAGRI, Rwanda Mines Petroleum and Gas Board, Rwanda Housing Authority, and Local administration entities. During this update a projected electricity demand for the productive use areas, were estimated in this document upon acquisition of relevant data from projects owners.

II.4. Validation and Simulation of distribution network model

The distribution network was modelled using DigSilent Power Factory simulation software and is updated regularly as the network evolves. This involves modelling of a wide range of cable sizes and types, substation's locations, and transformer types and sizes, settlement of LV consumers and optimum feeder routing from LV consumers connected to distribution transformers.

Using the simulation model, different analysis is carried out on the loading of the MV feeders, MV line losses, network peak points identified. Below is a table showing the simulation results reflecting the status of the MV lines with the loading and power losses on each feeder.

S/N	Feeder Name	Peak average Scenario			Off-Peak average Scenario		
		Peak Load [MW]	Peak Losses [MW]	% Of losses against Load	Off-peak Load [MW]	Offpeak_Losses [MW]	% Of losses against Load
1	Birembo SS_Gikomero	1.036	0.007	0.68%	0.688	0.003	0.44%
2	Birembo SS_Kibg/Nyar	1.382	0.02	1.45%	0.936	0.008	0.85%
3	Birembo SS_Kibg/Reme	0.966	0.007	0.72%	0.643	0.003	0.47%
4	Birembo SS_Kinyinya	2.258	0.062	2.75%	1.576	0.027	1.71%
5	Bugarama _CIMERWA	8.024	0	0.00%	5.373	0	0.00%
6	Camp Belge SS_Kinigi	1.806	0.014	0.78%	1.188	0.005	0.42%
7	Camp Belge_gisenyi	2.819	0.09	3.19%	2.006	0.11	5.48%
8	Camp Belge_prime cem	1.349	0.005	0.37%	0.98	0.003	0.31%
9	Gabiro SS_KIZIGURO	3.146	2.417	76.83%	2.204	2.738	124.23%
10	Gabiro SS_Ngarama	1.051	0.004	0.38%	0.69	0.002	0.29%
11	Gabiro SS_Nyagatare	4.848	0.194	4.00%	3.503	0.078	2.23%
12	Gahanga SS_Master St	0.525	0.002	0.38%	0.382	0.001	0.26%
13	Gahanga SS_Pylon 20	0.368	0.002	0.54%	0.267	0.001	0.37%
14	Gasogi SS_Inyange	1.085	0.056	5.16%	0.783	0.025	3.19%
15	Gasogi SS_Kabuga	2.58	0.129	5.00%	1.915	0.06	3.13%
16	Gasogi SS_Kanombe	4.357	0.108	2.48%	3.072	0.045	1.46%
17	Gifurwe SS_Gakenke	0.706	0.001	0.14%	0.459	0	0.00%
18	Gifurwe_Kirambo	1.997	0.02	1.00%	1.31	0.016	1.22%
19	Gifurwe_Ntaruka	0.088	0	0.00%	0.057	0	0.00%
20	Gikondo SS_Gasogi(1)	2.942	0.06	2.04%	2.068	0.027	1.31%
21	Gikondo SS_Gikondo H	1.377	0.004	0.29%	0.921	0.002	0.22%
22	Gikondo SS_Kigali so	4.034	0.067	1.66%	2.796	0.028	1.00%
23	Gikondo SS_Kimihurur	0.779	0.002	0.26%	0.52	0.001	0.19%
24	Gikondo SS_Nyarurama	0.439	0.001	0.23%	0.292	0	0.00%

25	GikondoSS_Kigali Nor	5.112	0.142	2.78%	3.665	0.063	1.72%
26	Gikondo_Industrial	2.542	0.043	1.69%	1.749	0.018	1.03%
27	JAbana SS_Rutongo	2.514	0.174	6.92%	1.931	0.104	5.39%
28	Jabana SS_Deutsch we	0.821	0.01	1.22%	0.568	0.005	0.88%
29	Jabana SS_Kigali	2.275	0.018	0.79%	1.568	0.008	0.51%
30	Jabana SS_Sucrerie	0.541	0	0.00%	0.366	0	0.00%
31	Jabana SS_Utexirwa	2.454	0.045	1.83%	1.731	0.022	1.27%
32	Kabarondo SS_KKK	2.556	0.065	2.54%	1.863	0.026	1.40%
33	Kararondo SS_Zaza	4.99	0.277	5.55%	3.904	0.131	3.36%
34	Karongi SS_Gisovu fe	0.481	0.002	0.42%	0.344	0.001	0.29%
35	Karongi SS_Kibuye fe	2.869	0.061	2.13%	2.149	0.029	1.35%
36	Karongi SS_Mugonero	0.366	0.001	0.27%	0.261	0	0.00%
37	Kibogora SS_Nyamashy	0.464	0.001	0.22%	0.323	0	0.00%
38	Kibogora SS_Rwakina	0.574	0.001	0.17%	0.399	0.001	0.25%
39	Kigoma SS_Butare	7.035	0.504	7.16%	6.319	0.358	5.67%
40	Kigoma SS_Gatumba fe	4.308	0.136	3.16%	3.465	0.075	2.16%
41	Kigoma SS_Ntongwe	3.618	0.171	4.73%	2.991	0.098	3.28%
42	Kilinda SS_Birambo	0.384	0	0.00%	0.265	0	0.00%
43	Kilinda SS_HOSPITAL	0.028	0	0.00%	0.019	0	0.00%
44	Mt Kigali SS_KANAZI	4.962	0.368	7.42%	5.044	0.362	7.18%
45	Mt Kigali SS_Kiyumba	3.497	0.071	2.03%	3.127	0.05	1.60%
46	Mt Kigali SS_Nyamira	1.313	0.006	0.46%	0.983	0.003	0.31%
47	Mt Kigali SS_Nyarura	0.629	0.006	0.95%	0.474	0.003	0.63%
48	Mukungwa 30KV BB_Jan	0.498	0.002	0.40%	0.353	0.001	0.28%
49	Mukungwa 30KV BB_RWA	0.027	0.018	66.67%	0.019	0.017	89.47%
50	Mukungwa SS_Remera	0.793	0.002	0.25%	0.564	0.001	0.18%
51	Mukungwa SS_camp bel	2.548	0.02	0.78%	1.839	0.025	1.36%
52	Mururu I 6.6KV_Ruziz	0	0.051		0	0.07	
53	Mururu1 SS_Mashyuza	2.272	0.043	1.89%	1.694	0.022	1.30%
54	Mururu1 SS_SHAGASHA	2.12	0.008	0.38%	1.529	0.004	0.26%
55	Musha SS_Gigawatt ev	0	0.355		0	0.44	
56	Musha SS_Karenge	2.194	0.137	6.24%	1.661	0.07	4.21%
57	Musha SS_REDMI	0.335	0.001	0.30%	0.224	0.001	0.45%
58	Musha SS_Rwamagana	2.833	0.132	4.66%	2.08	0.063	3.03%
59	Musha SS_Steelrwa	3.671	0.014	0.38%	2.466	0.006	0.24%
60	Ndera SS-KSEZ1	2.725	0.025	0.92%	1.868	0.011	0.59%
61	Ntaruka SS_Ruhengeri	1.27	0.065	5.12%	0.805	0.023	2.86%
62	Ntaruka SS_cyanika	1.92	0.015	0.78%	1.201	0.005	0.42%
63	Ntendezi SS_kibogora	0.544	0.082	15.07%	0.35	0.086	24.57%
64	Ntendezi_Mururu1	0.583	0.002	0.34%	0.381	0.002	0.52%

65	Nyabarongo_30KV BB_N	0.088	0	0.00%	0.058	0	0.00%
66	Nyabihu SS 30KV_Gici	0.421	0.973	231.12%	0.264	0.978	370.45%
67	Nyabihu SS_Rubavu	2.766	0.046	1.66%	2.076	0.023	1.11%
68	Nyabihu SS_Musanze	2.629	0.008	0.30%	1.91	0.004	0.21%
69	Nyabihu SS_Ngororero	2.183	0.039	1.79%	1.653	0.02	1.21%
70	Nzove SS_Abattoir	1.341	0.032	2.39%	1.063	0.018	1.69%
71	Nzove SS_SKOL	2.6	0.03	1.15%	2.004	0.016	0.80%
72	Rubavu Network	7.259	0.105	1.45%	4.705	0.063	1.34%
74	Rukarara 30KV_Rukara	0	0.1		0	0.098	
75	Rukarara 30KV_Rukara	0	0.054		0	0.053	
76	Rukarara 30KV_Rukara	0	0.001		0	0.001	
77	Rukarara II SS_Rukar	8.837	0.401	4.54%	6.533	0.212	3.25%
78	Rulindo SS_Base	0.963	0.005	0.52%	0.636	0.002	0.31%
79	Rulindo SS_Byumba	7.129	0.539	7.56%	5.52	0.26	4.71%
80	Rulindo SS_Gasiza	0.559	0.001	0.18%	0.367	0	0.00%
81	Rulindo SS_MUSASA	1.108	0.736	66.43%	0.799	0.71	88.86%
82	Rwinkwavu SS_Akagera	1.779	0.26	14.61%	1.526	0.175	11.47%
Total MV		168.29	9.676	5.75%	124.285	8.02	6.45%

Table 1: The simulation results reflecting the status of the MV lines with the loading and power losses on each feeder

II.5. Demand Forecasting

Electricity Demand as defined in the Energy Sector Strategic Plan (ESSP) for 2018/19-2023/24 presents the status of, and plans for, the energy sector, covering its three subsectors: electricity, biomass, and petroleum. In this report we focus on electricity side only.

Indicators	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
New On-Grid Connections	163,914	148,201	160,466	173,624	187,472	202,734
On-Grid Connection Rate	34.5%	38%	41.5%	45%	48.5%	52%
New Off-Grid Connections	283,507	220,262	271,266	255,706	274,286	293,938
Off-Grid Connection Rate	17%	23%	30%	36%	42%	48%
Households Connected (Million)	1.5	1.8	2.3	2.7	3.2	3.7
Households Connection Rate	51.5%	61%	71.5%	81%	90.5%	100%
Households Projection (Million)	3.1	3.2	3.3	3.5	3.6	3.7

Table 2: Electricity Demand as defined in the Energy Sector Strategic Plan (ESSP) for 2018/19-2023/24

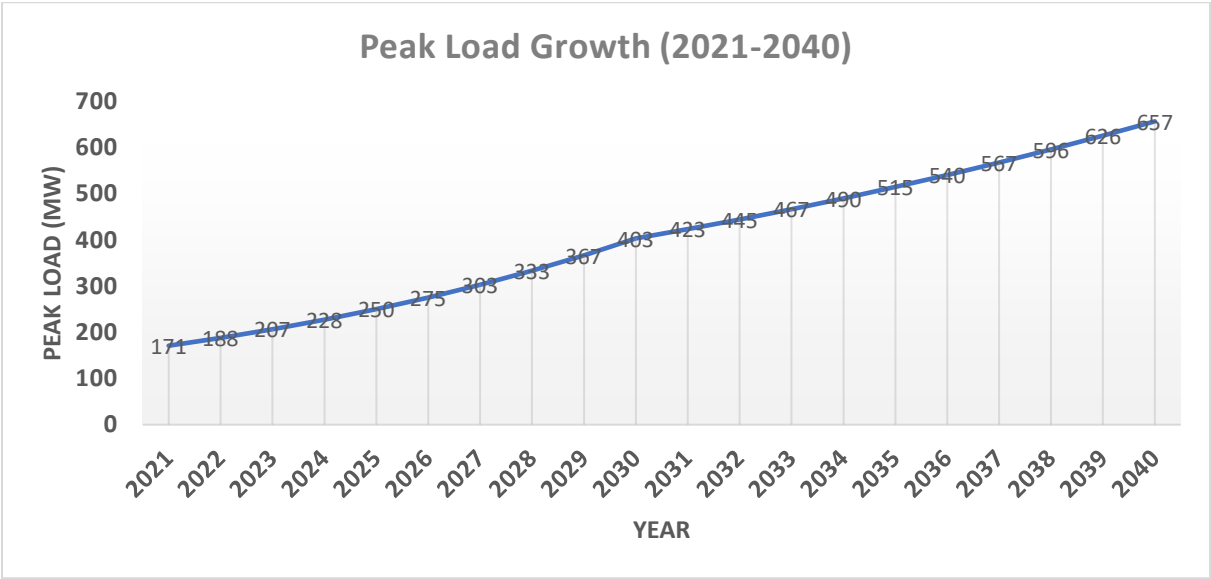
Source: ESSP 2018/19-2023/24 and NISR 4th PHC report 2012.

As stated in table 1, forecast of electricity demand include household’s electricity demand as the main consumer of electricity produced in Rwanda. Thus, after 2024 will be a new plan for connecting off-grid connected households to grid electricity.

Peak Demand projection 2021 to 2040 with reference to LCPDP

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Max Load(MW)	171	188	207	228	250	275	303	333	367	403	423	445	467	490	515	540	567	596	626	657

Table 3: Peak Demand projection 2021 to 2040 with reference to LCPDP



Source: LCPD, 2022

LCPDP has considered 10% of growth from 2021 to 2030 and a 5% growth from 2031 to 2040. Thus, by 2040 there is a requirement of 657MW peak demand while from the same report, there is a plan of reaching 657MW of installed capacity.

II.6. Assessment of Existing Networks

The demand forecast used in this analysis is typically based on deterministic methods using historical peak loading. The purpose is to ensure that the feeders can supply customer demands and maintain the feeder voltages within established standards. Some reserve capacity on each feeder is also desirable to allow for new loads to be added on the feeder and enable operational flexibility to switch sections of one feeder onto an adjacent feeder for

outage restoration and maintenance. Additionally, an assessment of current feeder and substation reliability, condition of grid assets, asset loading, and operations is performed along with a comparative assessment of current operating conditions against prior forecasts.

The above Distribution assets are serving below entire network divided in five hubs comprising utility branches structured to the Country administrative boundaries:

- I. Kigali Hub (Nyarugenge Branch, Kanombe Branch, Kacyiru Branch, Kicukiro Branch, Rulindo Branch, Bugesera Branch, Gicumbi Branch and Jabana Branch).
- II. Northern Hub (Gakenke, Musanze, Rubavu, Burera, Nyabihu and Ngororero)
- III. Southern Hub (Muhanga, Nyanza, Huye, Gisagara, Nyamagabe and Nyaruguru)
- IV. Eastern Hub (Rwamagana, Kayonza, Ngoma, Kirehe, Gatsibo and Nyagatare) and
- V. Western Hub (Karongi, Rutsiro, Nyamasheke and Rusizi)

II.7. Planning challenges and Recommendations

During the data collection when developing this distribution master plan, it was observed that essential network planning data is not always readily available such as the loading capacity of distribution transformers, the productive use sectors such as mining and other bulk loads which are going to be established in many areas are not able to approximate the exact load in their business plans. For a better planning of electricity distribution network, REG has taken initiatives such as installation of smart meters on distribution transformers while approximation of load capacity for productive use sectors will be done gradually based on best practices from existing similar projects.

To improve the efficiency and effectiveness of the network planning process, it is essential that as built network of the whole country is conducted and being updated regularly to have the updated database which will guide future and increase the quality of results. The As- built status of distribution network is as follows:

	REG Electricity Network digitization level					
	Overall Network Digitization					70-80%
A	Kigali coverage					
	Branches	Reported (actual)	Digitized/database	Digitized/Coverage in	Gap	Last Update
1 Jabana						
1.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Pylons are missing	Data under processing
1.2	MV	139.51	133	95.33366784	As-built is ongoing	
1.3	Distribution T	220	161	73.18181818	As-built is ongoing	
1.4	LV	318.85	218.5	68.52752078	As-built is ongoing	
2 Kacyiru						
2.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Some Pylon are missing	Data under processing
2.2	MV	234.19	75.81	32.37115163	As-built is ongoing	
2.3	Distribution T	213	136	63.84976526	As-built is ongoing	
2.4	LV	384.82	209.1	54.33709267	As-built is ongoing	
3 Nyarugenge						
3.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Pylons are missing	December,2022
3.2	MV	100.42	78	77.67377017	New Extensions are not yet mappe	
3.3	Distribution T	182	112	61.53846154	New Extensions are not yet mappe	
3.4	LV	367.73	341.8	92.94863079	New Extensions are not yet mappe	
4 Kicukiro						
4.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Pylons are missing	December,2022
4.2	MV	119.58	84.1	70.32948654	New Extensions are not yet mappe	
4.3	Distribution T	179	113	63.12849162	New Extensions are not yet mappe	
4.4	LV	426.16	302.6	71.00619486	New Extensions are not yet mappe	
5 Kanombe						
5.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Pylons are missing	As-built will be ready by the end of June
5.2	MV	148.08	130.7	88.26310103	Planned as built soom	
5.3	Distribution T	203	129	63.54679803	Planned as built soom	
5.4	LV	377.5	354.4	93.8807947	Planned as built soom	
6 Remera						
6.1	HV	Line route Fully covere	Line route Fully covere	Line route Fully covere	Pylons are missing	As-built is ongoing(ready end of may)
6.2	MV	181.27	128.55	70.91631268	Planned as built soom	
6.3	Distribution T	224	142	63.39285714	Planned as built soom	
6.4	LV	333.55	289.8	86.88352571	Planned as built soom	

S/n	Eastern Province Coverage					Last Update
	Branches	Reported (actual)	Digitized/datab	Coverage	Gap	
1	Bugesera					
1.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	December,2019
1.2	MV	516.35	428.4	82.96698	New extension are not yet mapped	
1.3	Distribution Tx	343	294	85.71429	New extension are not yet mapped	
1.4	LV	1321.39	969.7	73.38484	New extension are not yet mapped	
2	Rwamagana					
2.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	May,2021
2.2	MV	292	271	92.80822	New extension are not yet mapped	
2.3	Distribution Tx	199	191	95.9799	New extension are not yet mapped	
2.4	LV	712.38	685.2	96.18462	New extension are not yet mapped	
3	Kayanza					
3.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	May,2021
3.2	MV	328.49	306	93.15352	New extension are not yet mapped	
3.3	Distribution Tx	227	193	85.02203	New extension are not yet mapped	
3.4	LV	463.64	438.2	94.51298	New extension are not yet mapped	
4	Ngoma					
4.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	November,2021
4.2	MV	484.42	292.9	60.46406	New extension are not yet mapped	
4.3	Distribution Tx	202	178	88.11881	New extension are not yet mapped	
4.4	LV	571.28	305.7	53.51141	New extension are not yet mapped	
5	Kirehe					
5.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	October,2020
5.2	MV	489.77	378.3	77.24034	New extension are not yet mapped	
5.3	Distribution Tx	338	272	80.47337	New extension are not yet mapped	
5.4	LV	547.15	491.5	89.82911	New extension are not yet mapped	
6	Gatsibo					
6.1	HV	Fully covered	Fully covered	Fully covered	No as-built (Line route)	March,2020
6.2	MV	430.08	375.1	87.21633	New extension are not yet mapped	
6.3	Distribution Tx	271	252	92.98893	New extension are not yet mapped	
6.4	LV	672	530	78.86905	New extension are not yet mapped	
7	Nyagatare					
7.1	HV	Line route Fully	Line route Fully	Line route	No as-built (Line route)	June,2020
7.2	MV	606.67	453.9	74.81827	New extension are not yet mapped	
7.3	Distribution Tx	684	306	44.73684	New extension are not yet mapped	
7.4	LV	1317.08	598.4	45.43384	New extension are not yet mapped	

S/n	Northern Province Coverage					
	Branches	Reported (actual)	Digitized/GIS data	Coverage	Gap	Last Update
1 Rulindo						
1.1	HV	Line route Fully c	Line route Fully co	Line route Fu	No as-built (Line route)	September,2021
1.2	MV	408.73	256.1	62.65750006	New extension are not yet mappe	
1.3	Distribution Tx	233	167	71.67381974	New extension are not yet mappe	
1.4	LV	675.66	401.3	59.39377794	New extension are not yet mappe	
2 Gicumbi						
2.1	HV	Line route Fully c	Line route Fully co	Line route Fu	New extension are not yet mappe	May,2022
2.2	MV	606.23	439	72.41476007	New extension are not yet mappe	
2.3	Distribution Tx	316	292	92.40506329	New extension are not yet mappe	
2.4	LV	781.53	376.11	48.12483206	New extension are not yet mappe	
3 Gakenke						
3.1	HV	Line route Fully c	Line route Fully co	Line route Fu	No as-built (Line route)	November,2021
3.2	MV	268.95	245.1	91.1321807	New extension are not yet mappe	
3.3	Distribution Tx	189	184	97.35449735	New extension are not yet mappe	
3.4	LV	320.19	314.3	98.16046722	New extension are not yet mappe	
4 Musanze						
4.1	HV	Line route Fully c	Line route Fully co	Line route Fu	No as-built (Line route)	December,2021
4.2	MV	257.41	218.12	84.73641273	New extension are not yet mappe	
4.3	Distribution Tx	235	220	93.61702128	New extension are not yet mappe	
4.4	LV	557.39	539.6	96.80833887	New extension are not yet mappe	
5 Burera						
5.1	HV	Line route Fully c	Line route Fully co	Line route Fu	No as-built (Line route)	February,2022
5.2	MV	325.69	305	93.64733335	New extension are not yet mappe	
5.3	Distribution Tx	244	240	98.36065574	New extension are not yet mappe	
5.4	LV	851.92	768.8	90.24321533	New extension are not yet mappe	

S/n	Western Province Coverage						Last Update
	Branches	Reported (actual)	Digitized/GIS database	Coverage %	Comments	Gap	
1 Karongi							
1.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Only Line route	No as-built yet	
1.2	MV	251.93	183.5	72.83769301	Only Line route	No as-built yet	
1.3	Distribution Tx	189	65	34.39153439	Only Line route	No as-built yet	
1.4	LV	705.28	218.61	30.99620009	Only Line route	No as-built yet	
2 Ngororero							
2.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered		No as-built yet	
2.2	MV	234.14	224.35	95.81874092	Only Line route	No as-built yet	
2.3	Distribution Tx	203	127	62.56157635	Only Line route	No as-built yet	
2.4	LV	595.64	217.3	36.48176751	Only Line route	No as-built yet	
3 Nyabihu							
3.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Only Line route	No as-built yet	
3.2	MV	250.99	237.46	94.60934699	Only Line route	No as-built yet	
3.3	Distribution Tx	141	137	97.16312057	Only Line route	No as-built yet	
3.4	LV	356.17	345	96.86385715	Only Line route	No as-built yet	
4 Nyamaheke							
4.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Only Line route	No as-built yet	
4.2	MV	325.47	205.8	63.23163425	Only Line route	No as-built yet	
4.3	Distribution Tx	190	114	60	Only Line route	No as-built yet	
4.4	LV	729.8	627.9	86.03727049	Only Line route	No as-built yet	
5 Rusizi							
5.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Only Line route	No as-built yet	
5.2	MV	292.81	206.9	70.66015505	Only Line route	No as-built yet	
5.3	Distribution Tx	243	133	54.73251029	Only Line route	No as-built yet	
5.4	LV	572.79	349.4	60.99966829	Only Line route	No as-built yet	
6 Rutsiro							
6.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Only Line route	No as-built yet	
6.2	MV	338.71	266.8	78.76944879	Only Line route	No as-built yet	
6.3	Distribution Tx	194	184	94.84536082	Only Line route	No as-built yet	
6.4	LV	401.63	297.28	74.01837512	Only Line route	No as-built yet	
7 Rubavu							
7.1	HV	Line route Fully covered	Line route Fully covered	Line route Fully covered	Fully covered	No as-built yet	
7.2	MV	304.5	221.99	72.90311987	Only Line route	No as-built yet	
7.3	Distribution Tx	242	147	60.74380165	Only Line route	No as-built yet	
7.4	LV	607.87	215.9	35.51746262	Only Line route	No as-built yet	

S/n	Southern Province Coverage					Last Update
	Branches	Reported (actual)	Digitized/databse	Coverage	Gap	
1	Kamonyi					
1.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	October,2022
1.2	MV	214.34	172.64	80.54492862	New extension are not yet mapped	
1.3	Distribution Tx	153	109	71.24183007	New extension are not yet mapped	
1.4	LV	379.71	372.79	98.17755656	New extension are not yet mapped	
2	Muhanga					
2.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	October,2022
2.2	MV	221.97	167.1	75.2804433	New extension are not yet mapped	
2.3	Distribution Tx	136	97	71.32352941	New extension are not yet mapped	
2.4	LV	601.41	282.8	47.02282968	New extension are not yet mapped	
3	Ruhango					
3.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	Sep-20
3.2	MV	558	557.44	99.89964158	New extension are not yet mapped	
3.3	Distribution Tx	217	202	93.0875576	New extension are not yet mapped	
3.4	LV	1300	1222.67	94.05153846	New extension are not yet mapped	
4	Nyanza					
4.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	October,2020
4.2	MV	237.33	217.33	91.57291535	New extension are not yet mapped	
4.3	Distribution Tx	208	159	76.44230769	New extension are not yet mapped	
4.4	LV	416.59	385.26	92.47941621	New extension are not yet mapped	
5	Huye					
5.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	Sep-20
5.2	MV	281.49	169.9	60.35738392	New extension are not yet mapped	
5.3	Distribution Tx	174	126	72.4137931	New extension are not yet mapped	
5.4	LV	569.6	428.7	75.2633427	New extension are not yet mapped	
6	Gisagara					
6.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	April, 2021
6.2	MV	400.51	315.17	78.69216749	New extension are not yet mapped	
6.3	Distribution Tx	216	212	98.14814815	New extension are not yet mapped	
6.4	LV	615.67	610.9	99.2252343	New extension are not yet mapped	
7	Nyamagabe					
7.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	Sep-20
7.2	MV	244.96	240.25	98.0772371	New extension are not yet mapped	
7.3	Distribution Tx	160	86	53.75	New extension are not yet mapped	
7.4	LV	371.6	231.04	62.17438105	New extension are not yet mapped	
8	Nyaruguru					
8.1	HV	Line route Fully	Line route Fully	Line route Fully covered	No Pylons (Lines Covered)	November,2020
8.2	MV	260.96	257.37	98.62431024	New extension are not yet mapped	
8.3	Distribution Tx	197	177	89.84771574	New extension are not yet mapped	
8.4	LV	512.7	413.8	80.70996684	New extension are not yet mapped	

Table 4:Status of As- built of distribution network

III. PLANNING OF ELECTRICITY SUPPLY IN DIFFERENT HUBS/ZONES

III.1. Kigali City

III.1.1. Introduction

Kigali City is rapidly urbanizing, and with the changing dynamics of population, demand, lifestyles and socio-economic conditions of its residents, an integrated and inclusive urban planning to achieve sustainable economic growth and social well-being. The economy of the City of Kigali has experienced positive GDP growth in the last decade averaging **6.5%**. The city is projected to continue growing between **6.5% and 10%** for the next three

decades pertaining to enormous investments taking place especially in the service, trade, and manufacturing sectors.

Given the migration trend to Kigali, the pressure of urbanization and development on the city and after cross-referencing with other ongoing studies (IGC), the resident population of Kigali City will reach about **3.8 million by 2050** according to the high population growth scenario from IPAR studies.

Electricity infrastructures among others underpin the economic, social, and environmental performance of life in cities. They are the basic spatial infrastructure grids, which, quite literally, provide the fundamental conduits through which modern cities operate.

With the current electricity access averaging at 96.0% in Kigali City with Kicukiro at 99.0%, Gasabo at 92.0%, Nyarugenge at 96.0%, Rwanda Energy Group (REG) through its subsidiary companies (EUCL & EDCL) is targeting to achieve **100% electricity access in Kigali City by 2024**, increase the productive use of electricity through demand simulation incentives.

With the above-mentioned ambitious targets, the electrical load is expected to grow in the following trend

III.1. 2. Anticipated Major load on Kigali Hub Network (2023-2028)

Load Category	Total Load (MW) (2023-2028)	Additional Loads						Status End June- 2023	Planned Connection Feeder	Substation
		2023	2024	2025	2026	2027	2028			
Big Industries		3.82	4.43	4.65	2.37	3.1	2.1			
Rwanda Engineering and Manufacturing Corporation (REMCO)	3	1.6	0.3	0.4	0.2	0.3	0.2	Under operation	Freezone 1/Freezone 2	Ndera
Extension of Aldango Ltd Refineries	0.3	0.1	0.1	0.1	0	0	0	Extension not started yet	Freezone 1/Freezone 2	Ndera
Extension of SKOL Brewery Industry	0.5	0.2	0.2	0.1	0	0	0	Extension not started yet	Nzove	Nzove
Extension of Inyange Industries	0.45	0.1	0.2	0.15	0	0	0	Extension not started yet	Inyange	Gasogi
Relocation of Ruliba Clays (Nyagasambu)	0.7	0.1	0.2	0.2	0.2	0	0	Under construction	Kabuga	Gasogi
Kigali Gaz Plant (Kigali Industrial Freezone)	0.83	0.1	0.33	0.2	0.2	0	0	Under construction	Freezone 1/Freezone 2	Ndera
Rwanda Vaccine Manufacturing (Kigali Industrial Freezone)	3.02	0.12	0.1	1.2	0.8	0.5	0.3	Under construction	Freezone 1/Freezone 2	Ndera
Rusororo Gaz Plant	0.9	0.1	0.2	0.2	0.3	0.1	0	Under construction	Kabuga	Gasogi
N&M (Manufacturing of basic iron and steel)	1.2	0.2	1	0	0	0	0	Under construction	Skol	Nzove
Others	9.57	1.2	1.8	2.1	0.67	2.2	1.6			
Commercial complexes + Big Offices +Market	31.42	2.7	5.5	7.46	8.06	4.2	3.5			
Nzovu Mall (Former MINJUST)	1.2	0.1	0.1	0.5	0.5			Under design phase	Kimihurura/KBC	Gikondo
Mall du Plateau	0.7	0.1	0.2	0.2	0.2			Under design phase	Kigali South/North	Gikondo
West Gate Commercial Complex	0.6	0	0	0.3	0.3			Under design phase	Kigali	Jabana
CATCHUP Commercial Building (opposite UTC)	0.6	0	0	0.3	0.3			Not yet started	Kigali South/North	Gikondo

Kigali International Financial and Business center	2.6	0.4	1	0.6	0.6			Not yet started	Kigali South/North	Gikondo
Kigali Catholic Cathedral (Former 1930 prison plot)	1.6	0	0.4	0.6	0.6			Not yet started	Kigali South/Kigali	Gikondo/Jabana
LANDMARK Building (Kiyovu, Adjacent to Belgium Embassy)	0.4	0.1	0.3	0	0			Under construction	Kigali South/North	Gikondo
World Vision Rwanda Head Office Building (Kacyiru, nearby Umubano hotel)	1.06	0	0.2	0.43	0.43			Not yet started	Kinyinya	Birembo
RSSB Building (Former plot of centre culturel Franco-Rwandais)	1.06	0	0.2	0.43	0.43			Not yet started	Kigali South/North	Gikondo
HUAFEIT Multi-use Building (Ubumwe cell, nearby the construction site of RURA)	0.6	0	0.2	0.2	0.2			Not yet started	Kigali North	Gikondo
Petrocom Business centre (Kiyovu, in front of St Michel)	0.8	0.4	0.4	0	0			Under Construction	Kigali South	Gikondo
World Bank office building (Kiyovu, adjacent to SONARWA)	1	0.2	0.4	0.2	0.2			Not yet started	Kigali South	Gikondo
DH6 Building (Kiyovu, Between RURA and State House)	0.4	0.2	0.2	0	0			Not yet started	Kigali South	Gikondo
Kigali Innovation City (KIC) Masoro	10	0.2	0.6	2.1	2.5	2.1	2.5	Under construction	Free zone 1/2	Ndera
Others	8.8	1	1.3	1.6	1.8	2.1	1			
Hotels & Apartments	7.05	4.15	1.9	0.5	0.5	0	0			
Sheraton Hotel	1.6	1.2	0.4	0	0			Operational	Kigali South/North	Gikondo
Torch Africa	0.2	0.2	0	0	0			Operational	Kigali North	Gikondo
Pacific Hotel	0.25	0.25	0	0	0			Operational	Gasogi	Gikondo
New Century park	0.2	0.2	0	0	0			Operational	Kibagabaga-Nyarutarama	Birembo
Kiyovu Hotels & Apartments	0.6	0	0.2	0.2	0.2			Not yet started	Kigali South/Ministerie	Gikondo
Asia Shine Hotel (Kiyovu, adjacent to hill view hotel)	0.4	0.1	0.3	0	0			Under construction	Kigali South/Ministerie	Gikondo
DND Triangle (Nyarutarama-Kibiraro)	0.4	0.1	0.3	0	0			Under construction	Kibagabaga-Nyarutarama	Birembo
Others	3.4	2.1	0.7	0.3	0.3					

Hospital and Clinics	3.9	1.9	1.1	0.5	0.4	0	0			
Extension of King Faisal Hospital	1	0.8	0.2	0	0			Operational	Kinyinya	Birembo
Extension of Kanombe Military Hospital	0.4	0.3	0.1	0	0			Operational	Kanombe	Gasogi
Legacy Hospital	1	0.4	0.3	0.2	0.1	0	0			
Masaka Eye Hospital	1.5	0.4	0.5	0.3	0.3			Under construction	New Masaka	Gasogi
Small Industries (SMEs) & Modern Markets	10.43	1.5	1.33	5.2	2.4	0	0			
Kimironko Market Expansion	0.8	0	0	0.4	0.4			Under design	Kimironko	Birembo
NAEB Storage facility	1.03	0	0.23	0.4	0.4			Under design	Gasogi	Gikondo
Extension of Nyamirambo Market	0.6	0	0.2	0.2	0.2			Under design	Nyamirambo	Mt.Kigali
Kigali Hospitality Management Institute(in IPRC Kigali)	0.7	0	0.1	0.3	0.3			Not yet started	Gasogi	Gikondo
ADC_Kigali Data Center	3	0.2	0	2.8	0			Under design	NECC1/NECC2	Gikondo
Others	4.3	1.3	0.8	1.1	1.1					
Real Estate Projects	11.41	2.26	3.05	1.7	2	0.9	1.5			
Next Generation Housing Estate-Bumbogo	0.6	0.2	0.2	0.1	0.1			Under construction	Gikomero	Ndera
Kigali Green City-Kinyinya	2.8	0	0.3	0.5	1	0.5	0.5	Under construction	Deutchwelle	Jabana
Bwiza Riverside Homes ADHI (Karama)	0.5	0.1	0.2	0.1	0.1			Under construction	Nyabugogo	Nzove
Mpazi Rehousing Project (Cyahafi)	0.5	0.1	0.2	0.1	0.1			Under construction	Nyamirambo	Mt.Kigali
Satellite City (Gahanga near industrial zone)	0.5	0.1	0.2	0.1	0.1			Under construction	Master steel	Gahanga
Girinzu Umutuzo Urban Village (Gahanga Kagasa)	0.25	0.1	0.15	0	0			Under construction	Master steel	Gahanga
Ndera affordable housing project (Ndera-Kibenga)	0.16	0.16	0	0	0			Under construction	Kanombe	Gasogi
Kimisange housing development project (Kimisange-Bwerankori)	0.25	0.1	0.15	0	0			Under construction	Nyarurama	Mt.Kigali
Inzozzi Hill Estate (Nyamirambo-Rugarama)	0.4	0.2	0.2	0	0			Under construction	Nyamirambo	Mt.Kigali

Others	5.45	1.2	1.45	0.8	0.6	0.4	1			
Airport & Stadium Expansion	5.2	0.6	1.9	1.3	0.6	0.4	0.4			
Extension of Amahoro Stadium	4	0.5	1.5	1	0.4	0.3	0.3	Under construction	Nyarutarama/Remera	Birembo
Extension of Kigali PELE Stadium	1.2	0.1	0.4	0.3	0.2	0.1	0.1	Under construction	Nyamirambo	Mt.Kigali
Transport	15.3	0.7	1.6	3.5	3.1	3.7	2.7			
E-mobility (VIVO,etc)	10.1	0.3	0.8	2.5	2.5	2.5	1.5	Under construction	Nyarutarama/Remera	Birembo
Kigali cable car	3	0	0.2	0.5	0.3	1	1	Under design	Kimironko	Ndera/Birembo
Charging and swaping stations	2.2	0.4	0.6	0.5	0.3	0.2	0.2	started	All kigali feeders	All Kigali SS
Water Treatment plants	5.1	0.8	1	1.38	0.8	0.45	0.67			
Sewage water treatment Plant (Masaka-Kicukiro)	1.5	0.3	0.2	0.5	0.5	0	0	Under construction	Kabuga	Gasogi
Kimisagara water treatment plant	0.9	0.1	0.2	0.6	0	0	0	Under		
Others	2.7	0.4	0.6	0.28	0.3	0.45	0.67			
Streetlights+ CCTV Cameras	0.5	0.2	0.2	0.1	0.1					
Streetlights on newly constructed roads	0.5	0.2	0.2	0.1	0.1			Continous construction	All kigali feeders	All Kigali SS
Total Anticipated load Growth (MW) 2023-2028	90.31	18.63	22.01	26.29	20.33	12.75	10.87			

Table 5: Anticipated Major load on Kigali Hub Network (2023-2028)

III.1.3. Status of Existing Electricity Infrastructure after anticipated Major loads (2023-2028)

The major electricity infrastructures here are HV substations (as source of power for distribution network) and MV feeders supplying the different loads and associated cabins.

The majority of MV feeders in Kigali are not overloaded with the load increment by 2028, however some of the feeders need to be upgraded/ reconducted to facilitate loads transfer in case of faults in MV lines or during maintenance activities that require power shutdowns (either MV lines or one of the substations). The network reconfiguration is required to balance feeder loads.

Some of Kigali HV substations will be overloaded either by 2025 or 2028. The upgrade of those substations or construction of new HV substations is required.

KIGALI							
SUBSTATION	Total capacity (MVA)	Nr of Power Trx	Current Highest Peak [MW]	Load Increament (2023-2025)	Projected total demand by 2025	Load Increament (2026-2028)	Projected total demand by 2028
BIREMBO	20	1x20	22.8	5.47	28.27	8.48	36.75
GAHANGA	20	1x20	5.26	1.26	6.52	14.96	21.48
GASOGI	30	2x15	13.6	3.26	16.86	5.06	21.92
GIKONDO	45	3x15	29.98	7.20	37.18	11.15	48.33
JABANA 1	20	2x10	16.87	4.05	20.92	6.28	27.19
MONT KIGALI	20	1x20	19.75	4.74	24.49	7.35	31.84
NDERA	40	2x20	12.1	4.84	16.94	19.10	36.04
NZOVE	20	1x20	9.33	3.73	13.06	4.70	17.76
TOTAL	215	13	129.69	34.55	164.24	77.07	241.32

Table 6: Loading status of HV substations due to load increment by 2025 and by 2028

SUBSTATION	Existing Transfo MVA	Feeder	Conductor Size	Maximum Current (A)	Max Power Capacity (MW)	Highest Peak Power [MW]	% Loading at Peak (Calculated)	Load Increment on MV Feeders	% Feeder Loading increment (2023-2028)
BIREMBO	1*20	Kbgbg/Nyarutarama	ACSR 120/20 mm²	410	8.52	3.7	43.43%	2.22	69.48%
		Kibagabaga/Remera	ACSR 120/20 mm²	410	8.52	4.7	55.16%	2.82	88.26%
		Rubungo1	ACSR 120/20 mm²	410	8.52	4.8	56.34%	2.88	90.14%
		Kinyinya	ACSR 120/20 mm²	410	8.52	9.6	112.68%	4.8	169.01%
Total					34.08	22.8		13.68	
GAHANGA	1*20	Master Steel	ACSR 70/12 mm²	290	6.03	3.89	64.51%	2.334	103.22%
		Pylon 20	ACSR 70/12 mm²	290	6.03	1.37	22.72%	0.822	36.35%
Total					12.06	5.26		3.156	
GASOGI	2*15	Inyange	ACSR 70/12 mm²	290	6.03	2.3	38.14%	1.38	61.03%
		Kabuga (Rusororo)	ACSR 120/20 mm²	410	8.52	2.3	27.00%	1.38	43.19%
		Masaka	ACSR 120/20 mm²	410	8.52	3	35.21%	1.8	56.34%
		Kanombe (Mulindi)				3.5		2.1	
		Rutunga				1.9		1.14	
		Nyagasambu				0.6		0.36	
Total					23.07	13.6		8.16	
GIKONDO	3*15	Kicukiro Pylone 20	ACSR 120/20 mm²	410	8.52	5.65	66.31%	2.26	92.84%
		Gikondo Haut	ACSR 70/12 mm²	290	6.03	1.94	32.17%	1.164	
		Kigali North	ACSR 120/20 mm²	410	8.52	3	35.21%	1.8	56.34%
		Kigali South	ACSR 120/20 mm²	410	8.52	4.77	55.99%	1.908	78.38%
		Kimihurura	ACSR 150/25 mm²	410	8.52	3.12	36.62%	1.872	58.59%
		Kimihurura pompage	ACSR 120/20 mm²			1.94		1.164	
		Nyarurama	ACSR 70/12 mm²	290	6.03	0.33	5.47%	0.198	8.76%
		Ministerie1	CU/XLPE/PVC 1* 240 mm²	596	12.39	5.4	43.58%	3.24	69.73%
		Ministerie2	CU/XLPE/PVC 1* 240 mm²	596	12.39	0	0.00%	0	0.00%
	Sonatube	ACSR 120/20 mm²			3.83		2.298		
Total					70.92	29.98		13.606	
JABANA 1	2 *10	D.Welle	ACSR 120/20 mm²	410	8.52	4.81	56.46%	2.886	90.33%
		Kigali	ACSR 120/20 mm²	410	8.52	3.38	39.67%	2.028	63.47%
		Rutongo	ACSR 70/12 mm²	290	6.03	3.91	64.84%	2.346	103.75%
		Sucrerie	CU/XLPE/PVC 1*50 mm²	210	4.36	0.22	5.05%	0.132	8.07%
		Utexrwa	ACSR 70/12 mm²	290	6.03	4.55	75.46%	2.73	120.73%
Total					33.46	16.87		10.122	
MONT KIGALI	1*20	Kanazi	ACSR 120/20 mm²	410	17.04	9.36	54.93%	5.616	87.89%
		Kiyumba	ACSR 120/20 mm²	410	17.04	4.62	27.11%	2.772	43.38%
		Nyamirambo	ACSR 120/20 mm²	410	17.04	4.38	25.70%	2.628	41.13%
		Rebero	ACSR 70/12 mm²	290	12.05	1.39	11.54%	0.834	18.46%
Total					63.17	19.75		11.85	
NDERA	2*20	Rubungo/Birembo	ACSR 120/20 mm²	410	8.52	2.1	24.65%	2.1	49.30%
		Free zone 1	ACSR 120/20 mm²	410	8.52	8.1	95.07%	8.1	190.14%
		Gikomero	ACSR 120/20 mm²	410	8.52	1.9	22.30%	1.9	44.60%
Total					25.56	12.1		12.1	
NZOVE	1*20	Abattoir1	ACSR 120/20 mm²	410	8.52	2	23.47%	1.2	37.56%
		Abattoir2	ACSR 120/20 mm²	410	8.52	1.73		1.038	
		Nzove (Skol)	ACSR 120/20 mm²	410	8.52	5.6	65.73%	3.36	105.16%
Total					25.56	9.33		5.598	

Table 7: The major substations and MV feeders supplying the load in Kigali area

****Highlighted in red are the MV feeders whose loading is above 80% by 2028 i.e. heavy or overloaded MV feeders...

NB: Loading of MV feeders depends on the configuration executed.

III.1.5. Major projects to improve the loading on some feeders:

Kimironko Feeder:

- Upgrade sections Le printemp-Zindiro from 70sqmm from 120sqmm to facilitate load transfer

Gasogi Feeder:

- Transfer of current load on Gasogi to pylon 20 from Gahanga substation
- Extension of pylon 20 cabin with a double busbar to facilitate load transfer between pylon 20 feeder and Gasogi feeder

Master Steel Feeder:

- Upgrade of conductor size of the feeder from 70mm² to 120mm²

Kigali North & South Feeders:

- Construction of MV link from Abattoir cabin in Nyabugogo to Minplan Cabin to allow power flow from Jabana or Nzove substations into cabins feeding the city center
- Ensure proper functioning of Minisiterie 1& 2 feeders to facilitate in load transfer.

Free zone 1:

- Transfer of load to Freezone 2 whose loading is too low
- Transfer of Load from Bumbogo cabin

Kigali feeder:

- Upgrade of this feeder (replacement of old 120/20 ACSR by new 150/50ACSR)

UTEXRWA Feeder:

- Upgrade of this feeder (replacement of old 120/20 ACSR by new 150/50ACSR)

KINYINYA feeder:

- Network reconfiguration can solve this issue.

Kibuye Feeder:

- Load transfer at Gihira pylon for utilization of power from Rubavu and Nyabihu substation

III.1.6. Zoning of Main Feeders from Substations in Kigali

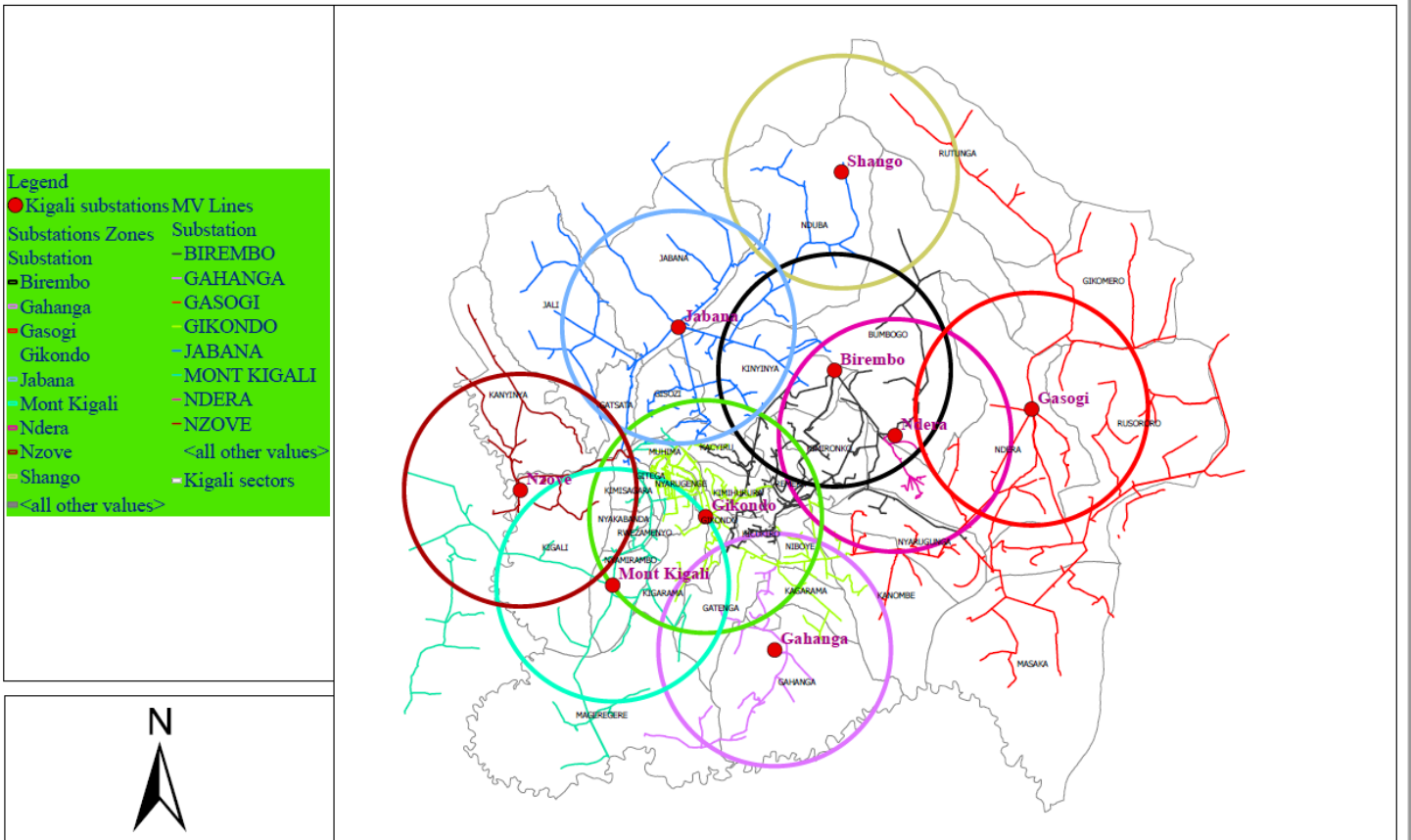
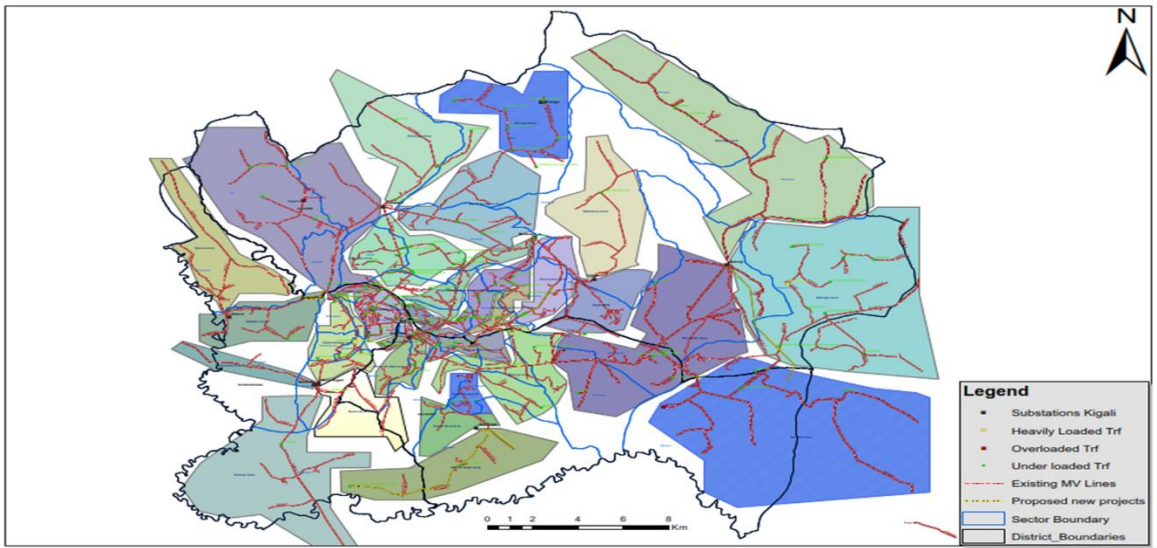
The distribution network is growing significantly to accommodate the increasing load and reinforcements to improve on the quality of power supply. The figure below illustrates the zone supplied by each MV feeder from main substations.

In Kigali, 22 zones were identified following the existing feeders, substations as well as cabins. Details are on the table below:

S/N	Name	Feeders	Substation
1	Kigali zone	Kigali	Jabana 1
2	Nzove zone	Skol	Nzove
3	Abatoir zone	Abatoir	Nzove
4	Kiyumba zone	Kiyumba	Mont Kigali
5	Nyamirambo zone	Nyamirambo	Mont Kigali
6	Mageragere zone	Kanazi	Mont Kigali
7	Gahanga zone	Master Steel	Gahanga
8	Gatenga zone	Pylon 20	Gahanga, Gikondo
9	Kigali SEZ	Gikomero	Ndera
10	Kanombe zone	Kanombe, Kabuga	Gasogi
11	Kimironko zone	Kimironko	Birembo
12	Rutongo zone	Rutongo	Jabana
13	Utexrwa zone	Utexrwa	Jabana 1
14	Deutsche Welle	Deutsche	Shango
15	Kinyinya zone	Kinyinya	Birembo
16	Nyarutarama zone	Kibagabaga-Nyarutarama	Birembo
17	Kigali North-South Zone	Kigali North, Kigali South	Gikondo dispatch
18	Kabuga zone	Kanombe	Gasogi
19	Gikondo Haut zone	Gikondo Haut	Gikondo
20	Pylon 20 zone	Gasogi	Gikondo
21	Former Park Industriel	Parc Industriel	Gikondo
22	Kimihurura zone	Kimihurura	Gikondo

Table 8: Zoning of Main Feeders from Substations in Kigali

Note: These zones will be changed after Kigali network reconfiguration and new shango substation



III.1.7. Initiatives to reinforce power supply in Kigali area (Each to be described separately)

- Replacement of Power transformers at Gikondo Substation, 3*15MVA with new big ones (3*30MVA)
- Extension of Birembo Substation with a new 20MVA transformer
- Extension of Nzove substation with a new 20MVA transformer
- Extension of Gahanga substation with a new 20MVA, with an upgrade of Master steel feeder
- Link of new Shango Substation to distribution Network
- Rehabilitation of Low Voltage U.G Network in Nyarugenge (Kiyovu and the CBD)
- Renovation of existing Electro-Mechanical MV/LV Cabins in Kigali
- Construction of switching MV/LV Cabins
- Reconductoring and Construction of MV links to facilitate configuration (Load transfer between feeders)
- Network strengthening projects that include construction of Switching cabins with remote control via SCADA and associated distribution lines 25 cabins under the new multi donor project)
- Rehabilitation of LV network and renovation of cabins in in Nyarugenge
- Upgrade and extension of MV lines to solve voltage drop issues
- Upgrade of existing LV lines
- Upgrade of single-phase network

Zones	Interventions	Justification of needs	Budget Estimation (USD)	Priority/ Expectation
KSEZ	Construction of new MV switching Cabin near CMU&ALU, 6.5km 15kV line from Gasogi SS and 2.8km UG 15kV line from Ndera SS	BioNetch Load (4.5MW) and Kigali Innovation City (5MW), production increase of existing Industries	650,000	2025
	Construction of approximately 6.5km 15kV Overhead line from Gasogi SS to the new MV cabin		1,500,000	2025
	Construction of approximately 2.8km 15kV UG line from Ndera SS to the new MV cabin		400,000	2025
	Construction of MV line 3km approx. to link Gikomero feeder to Shango S/S	Gikomero feeder is much radially extended and once is	450,000	2026
NZOVE	Upgrade of Nzove S/S with second transformer of 20MVA	This substation to supply Nzove IP	1,500,000	2026
	Construction of MV feeders dedicated to Nzove Industrial Park	To have dedicated feeders to NZOVE IP from NZOVE S/S	300,000	2026

	30/15kV, 5MVA substation at Shyorongi and Upgrade MV lines	To facilitate load transfer between Nzove SS and Rulindo SS. (Supplying Kanyinya, Shyorongi and Rusiga Sectors by either Nzove SS or Rulindo Substation	3,200,000	2027
	Reconductoring of SKOL feeder from NZOVE SS	To have a capacity to carry the existing loads (mainly Skol and WASAC) and also the load for Nyabarongo II under construction	250,000	2024
MASAKA	Construction of new 110/15kV substation 2x20MVA	Currently the primary susbtation to supply this Zone is Gasogi SS, but looking how fast this area is being developed, this is the right time to think for a new HV substation in the area	4,500,000	2027
	Construction of smart MV switching cabin in Masaka	To facilitate & improve switching operations for critical areas in Masaka	2,000,000	2025
KINYINYA	Upgrade of Birembo S/S with second transformer of 20MVA	The existing transformers are currently loaded at 85% and Kigali Green City being developed in Kinyinya shall be supplied from Birembo S/S	1,800,000	2024
	Reconductoring of UTEXRWA feeder from Jabana (70 to 120sqmm) Jabana ss to Utexrwa cabin	The existing conductors should be limitation to supply load of Kinyinya areas, Gisozi agakiro, UDL Estate, etc	900,000	2026
	Upgrade of 1x10MVA Jabana transformer to 20MVA	The existing transformers are currently loaded up to	1,800,000	2026
	Upgrade of Kigali Feeder from Jabana S/S	The conductor of this feeder are old, therefore, once Jabana is Upgraded this line should be also upgraded to supply abbatoir loads from Jabana	1,100,000	2026

Table 9: Other interventions per zone in Kigali

Summary of Key Network strengthening projects in Kigali

S/N	Designation	Total	Nyarugenge	Jabana	Kacyiru	Remera	Kicukiro	Kanombe	Required Budget	Available Budget (USD)	Source of Funds	Status	Budget GAP (USD)
1	MV Links (km)	40.2	4.3	1.5	13.7	6.1	8.8	5.9	3,899,917	3,899,917	RUEAP/EIB	Under Procurement	-
1.1	U.G	22.4	3.1	0.0	5.9	4.3	6.9	2.1					
1.2	Overhead	17.9	1.2	1.5	7.7	1.8	1.9	3.8					
2	LV U.G Lines (km)	93.5	44.1	0	0	0	0	0	12,949,813	12,949,813	RUEAP/AFDB	Under procurement	-
			0	0	49.4	0	0	0	14,202,114		NA	Under Procurement	14,202,114.0
3	Switching Cabins	12.0	4	0	3	2	0	3	14,854,076	10,154,076	RUEAP/AFDB	Under procurement	4,700,000
4	Renovation of Masonary cabins	22.0	17	0	2	0	3	0	1,514,980	1,514,980	RUEAP/AFDB	Under procurement	-
5	Power Quality Improvement (Voltage drop)												
5.1	Extension of MV line (km)	137.8	60.5	7.8	13.2	14.8	18.7	22.8	10,757,351	1,772,653	RUEAP/AFDB	Under procurement	8,984,698
5.2	Installation of new transformers	115	39.0	13.0	14.0	13.0	18.0	18.0					
5.3	0	369.5	125.3	36.1	77.0	31.6	65.5	34.0					
6	Upgrade of Single phase												
6.1	MV Lines (km)	31.5	0.0	7.0	0.0	6.0	8.0	10.5	1,332,171	1,332,171	RUEAP/AFDB	Under procurement	0
6.2	LV Lines (km)	78.0	15.0	14.0	12.0	18.0	7.0	12.0					
6.3	Transformer replacement	21.0	0	6	0	4	5	6					
	TOTAL								59,510,421	31,623,610			27,886,812

Table 10: Summary of Key Network strengthening projects in Kigali

Power Quality Improvement: Voltage drop issues

Branch	REQUIRED SCOPE, JUNE 2022			CONSIDERED SCOPE UNDER RUEAP PROJECT		
	MV line extension	Installation of new transformer	Upgrade of LV network	MV line extension	Installation of new transformer	Upgrade of LV network
Remera	14.8	13	31.6	4.1	4	12
Kacyiru	13.2	14	77	3.35	4	39
Kanombe	22.75	18	34	5.5	9	18.5
Kicukiro	18.7	18	65.5	1.2	1	1
Jabana	7.8	13	36.1	2.7	3	5.3
Nyarugenge	60.5	39	125.3	0	0	0
TOTAL	137.75	115	369.5	16.85	21	75.8
Remaining Scope (Gap)	120.9	94	293.7			

Table 11: Power Quality Improvement: Voltage drop issues

Upgrade of Single phase to Three Phase Network

Branch	1 phase MV	1 phase Tx	1 phase LV
Remera	7	5	24
Kacyiru	0	0	18
Kanombe	11.1	6	12
Kicukiro	10	5	11
Jabana	9	7	17
Nyarugenge	0	0	19
Scope Required	37.1	23	101
Considered scope (RUEAP)	37.1	23	101
Remaining Scope	0	0	0

Table 12: Upgrade of Single phase to Three Phase Network

III.2. Southern Region

III.2.1. Introduction

The Southern electrical network is composed of Muhanga, Nyanza, Ruhango, Huye, Kamonyi, Gisagara, Nyamagabe and Nyaruguru. Main feeders supplying the southern area are Gatumba, Butare, Rukarara II, Ntongwe and Kiyumba. Butare and Rukarara II feeders are very long supplying Ruhango, Nyanza, Huye, Nyaruguru, Gisagara and Nyamagabe districts. The length of the two long feeders shall be reduce after the commissioning of the double circuit MV line from the new Gisagara substation.

Other projects to reinforce the network in Southern area are underway including establishment of necessary infrastructures such as Muhanga SS and Huye Industrial Park substation

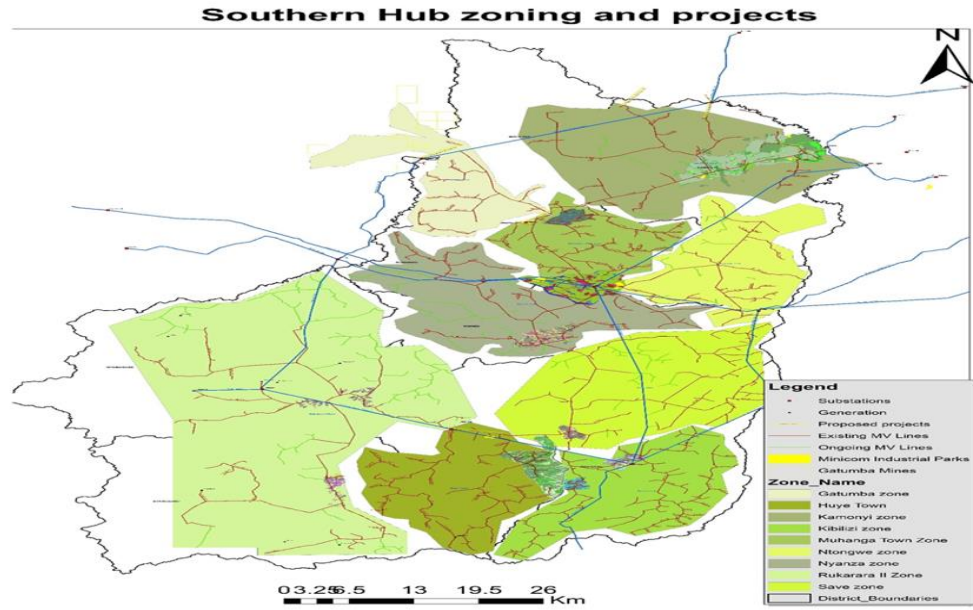
In addition to the mentioned substations, new lines and interconnection projects have been planned to be implemented including Kiyumba- Musasa, Huye SS-Rukarara 2, Nyabarongo 1 SS-Gatumba, Double Circuit Muhanga SS-Gatumba, Double Circuit Huye SS-Rukarara 2-Butare and Gisagara SS-Butare.

III.2.2. Zones in Southern Hub and zoning factors

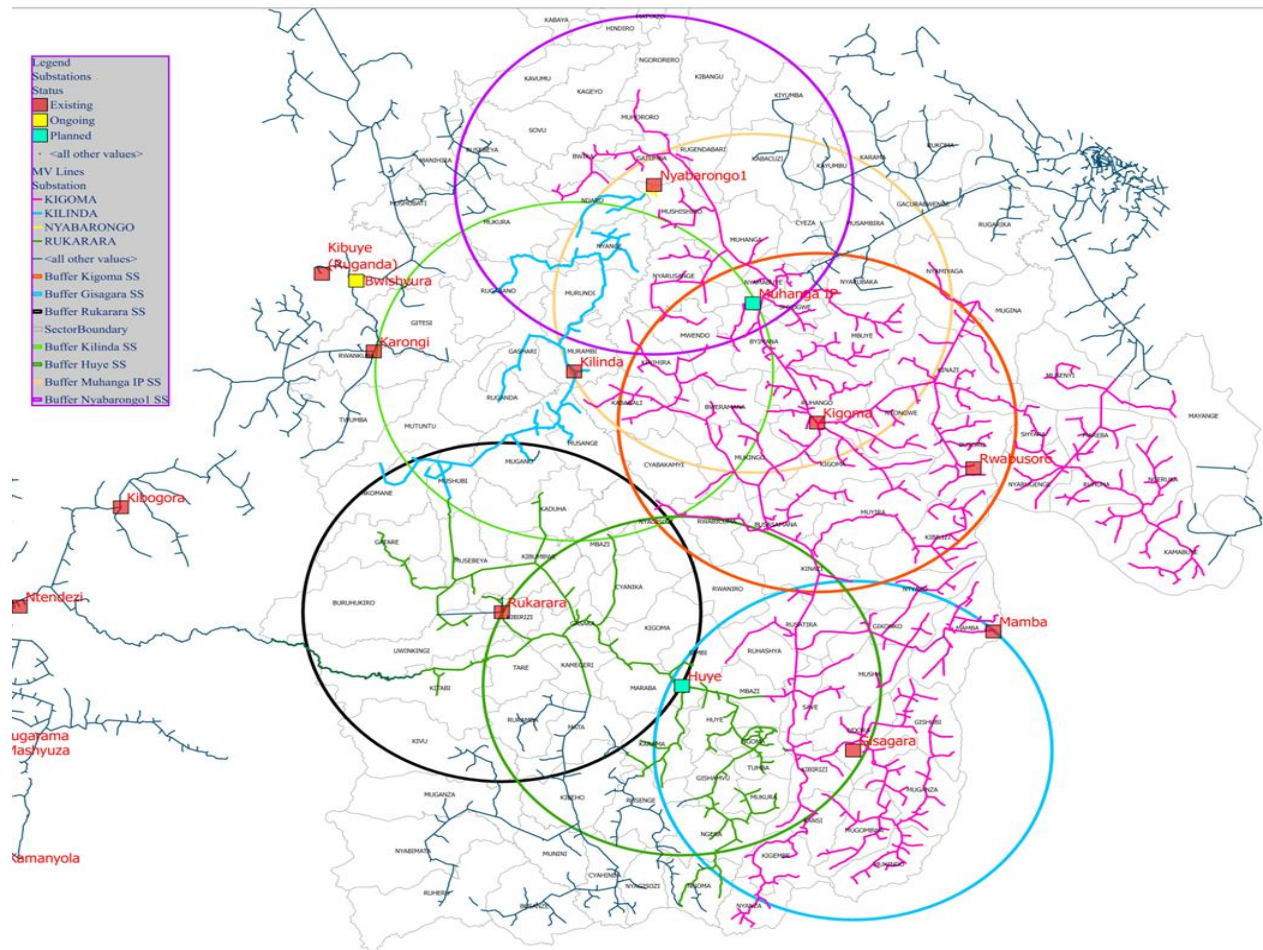
Nine (9) Zones have been identified following the location of feeders in Southern Hub and considering key pulling factors as highlighted in the table below:

S/N	Zone Name	Source	District	Feeders	Pulling Factors
1	Kamonyi zone	Mont Kigali SS, Muhanga SS	Kamonyi	Kiyumba	District town, beverages processing
2	Huye Town	Huye SS	Huye	Butare	Secondary city, SEZ
3	Nyanza zone	Kigoma SS	Nyanza	Butare	District town, Milk processing industry
4	Gatumba zone	Muhanga SS, Kigoma SS	Muhanga	Gatumba	Mining area, Ngororero Town
5	Muhanga Town Zone	Muhanga SS, Nyabarongo 1 SS	Muhanga	Gatumba	SEZ, Muhanga Town
6	Ntongwe zone	Kigoma SS	Ruhango	Ntongwe	Cassave processing, residential
7	Rukarara II Zone	Rukarara	Nyaruguru	Rukarara 2	District town, Tea factories
8	Save zone	Huye SS	Gisagara	Butare	Urban Centre
9	Kibilizi zone	Gisagara	Gisagara	Butare	Urban Centre

Table 14: Zones in Southern Hub and zoning factors



Map of Zoning



III.2.3. Anticipated Major load in Southern Region

SUBSTATION	FEEDER	Load Category	Total Load 2023- 2028(MW)
KIGOMA	BUTARE	Youth Center	0.1
		Head Craft Center	0.1
		Maternity	0.1
		Banana Processing Plant	0.1
		Meat processing Plant	0.1
		Maize Milling Plant	0.1
		Markets	0.1
		Water Pump Stations	0.2
		Streetlights	0.2
		Others	0.3
		Yearly Total Load Increment (MW)	1.4
Mont Kigali	KIYUMBA	AGAKIRO RO BISHENYI	0.6
		KAMUHANDA INDUSTRIAL ZONE	1
		KAGANGAYIRE INDUSTRIAL AREA	5
		Anjia Cement factory	0.3
		Yearly Total Load Increment (MW)	6.9
KIGOMA	BUTARE	Extension of Industrial at Bweramana	0.3
		New Hotel under construction	0.1
		Extension Agakiro	0.3
		Water Treatment plants	0.2
		Street lights	0.1
		Others	0.3
		Yearly Total Load Increment (MW)	1.3
Rukarara	RukararaII	Six food processing Factories	0.3
		Upgraded Street lights on the main road Kigali-Kanyaru (huye part)	0.1
		Four big Commercial Buildings in HUYE city	0.3
		New Hotel 5star	0.1
		Others	0.3
		Yearly Total Load Increment (MW)	1.1
KIGOMA Mont kigali	GATUMBA	Commercial Buildings in Muhanga city	0.4
		New Hotels under construction	0.2
		New Modern Markets	0.3
		ANjia Cement factory	7

		Ceramics	3
		New streetlights	0.4
		Water Treatment plants	0.3
	KIYUMBA	Kiyumba and Kabgayi hospitals	0.1
		New streetlights	0.3
		TVT Kiyumba under consrtuction	0.1
		Others	0.3
	Total Load Increment (MW)		14.4
	RUKARARA	RUKARARA II	Tea factories
Coffee Washing stations			0.1
Commercial Banks			0.1
Street lights			0.1
Others			0.3
Yearly Total Load Increment (MW)			0.9
KIGOMA	Butare	Mark cable industry	1
		New Hotel	0.1
		Nyanza Modern Market and car parking	0.1
		Busogwe Water Treatment Plant	0.1
		Streetlights	0.3
		Nyanza District Stadium	0.1
		Others	0.3
		Yearly Total Load Increment (MW)	1.9
RUKARARA	RUKARARA II	Big Commercial Buildings in Nyaruguru	0.1
		New Hotel under construction	0.1
		Tea factories	0.3
		Water Treatment plants	0.3
		Streetlights	0.1
		Others loads	0.3
		Yearly Total Load Increment (MW)	1.2
SOUTHERN TOTAL LOAD			24.5

Table 13: Anticipated Major load in Southern Region

III.2.4. Substation loading after anticipated Major load growth (2021-2023) in Southern Hub

SOUTHERN							
KIGOMA	10	1x10	9.3	8.23	17.53	5.26	22.79
KILINDA	1.6	1x1.6	0.54	0.13	0.67	0.20	0.87
RUKARARA	20	2x10	15.09	3.62	18.71	5.61	24.33
GISAGARA	20	1x20	1.94	0.47	2.41	0.72	3.13
TOTAL	51.6	5	26.87	12.45	39.32	11.80	51.11

Table 14: Feeder loading after anticipated Major load growth (2021-2023) in Southern Hub

The anticipated major contributors to load increment in the south are Anjia Cement factory, Ceramics manufacturing plant and Mark Cable factory)

Heavy or Over loaded feeders are not observed after addition of the anticipated loads. However, Kigoma and Rukarara substations (highlighted in red) will be overloaded and should be upgraded.

III.2.5. Projects proposals for Network reinforcement in the Southern Region

Summary of Key Network strengthening projects in Southern Region

S/N	Designation	Total	Huye	Nyanza	Ruhango	Kamonyi	Nyaruguru	GISagara	Nyamagabe	Muhanga	Required Budget	Available Budget (USD)	Source of Funds	Status	Budget GAP (USD)
1	Power Quality Improvement (Voltage drop)														
1.1	Extension of MV lines	73.8	18.5	1.3	5.3	9.2	4.5	1.0	14.5	19.5	8,178,158	3,328,564	RUEAP/AFDB	Under Tender Preparation	4,849,594
1.2	Insertion of New Transformers (with protective devices & LVDB)	98.0	19.0	3.0	16.0	16.0	11.0	7.0	10.0	16.0					
1.3	LV Network upgrade/strengthening	485.4	89.3	18.8	137	44.5	21.5	20.5	41	113					
2	Switching Cabins	7.0	4	0	0	1	0	0	0	2	5,211,957	2,711,957	RUEAP/AFDB	Under Tender Preparation	2,500,000
3	Upgrade of Single phase														
3.1	MV Lines (km)	10.2	0.0	3.2	0.0	6.0	1.0	0.0	0.0	0.0	4,055,669	4,055,669	RUEAP/AFDB	Under Tender Preparation	-
3.2	LV Lines (km)	278.2	0.0	15.0	50.7	26.0	0.0	59.0	60.0	67.5					
3.3	Transformer replacement	239.0	15	41	21	12	1	119	15	15					
	TOTAL										17,445,784	10,096,190			7,349,594

Table 15: Summary of Key Network strengthening projects in Southern Region with scope under RUEAP.

Power Quality Improvement: Voltage drop issues

Branch	REQUIRED SCOPE, JUNE 2022			CONSIDERED SCOPE UNDER RUEAP PROJECT		
	MV line extension	Installation of new transformer	Upgrade of LV network	MV line extension	Installation of new transformer	Upgrade of LV network
Nyanza	1.25	3	18.8	1.8	2	2.7
Huye	18.5	19	89.3	3.5	4	26.9
Muhanga	19.5	16	112.5	6.2	11	82.8
Nyaruguru	4.5	11	21.5	5.5	6	17
Kamonyi	9.2	16	44.5	1	4	5.5
Gisagara	1	7	20.5	1.5	2	19.5
Ruhango	5.3	16	137.3	6.7	9	13.1
Nyamagabe	14.5	10	41	5	5	23
TOTAL	73.75	98	485.4	31.2	43	190.5
Remaining Scope (Gap)	42.55	55	294.9			

Table 16: Power Quality Improvement: Voltage drop issues with scope under RUEAP

Upgrade of Single phase to Three Phase Network

Branch	1 phase MV	1 phase Tx	1 phase LV
Nyanza	8.2	41	15
Huye	3.4	15	0
Muhanga	4.8	15	67.5
Nyaruguru	15	1	0
Kamonyi	12	12	26
Gisagara	13.2	119	59
Ruhango	7.8	21	50.7
Nyamagabe	9	15	60
Scope Required	73.4	239	278.2
Considered scope (RUEAP)	73.4	238	265.8
Remaining Scope	0	1	12.4

Table 17: Upgrade of Single phase to Three Phase Network with scope under RUEAP

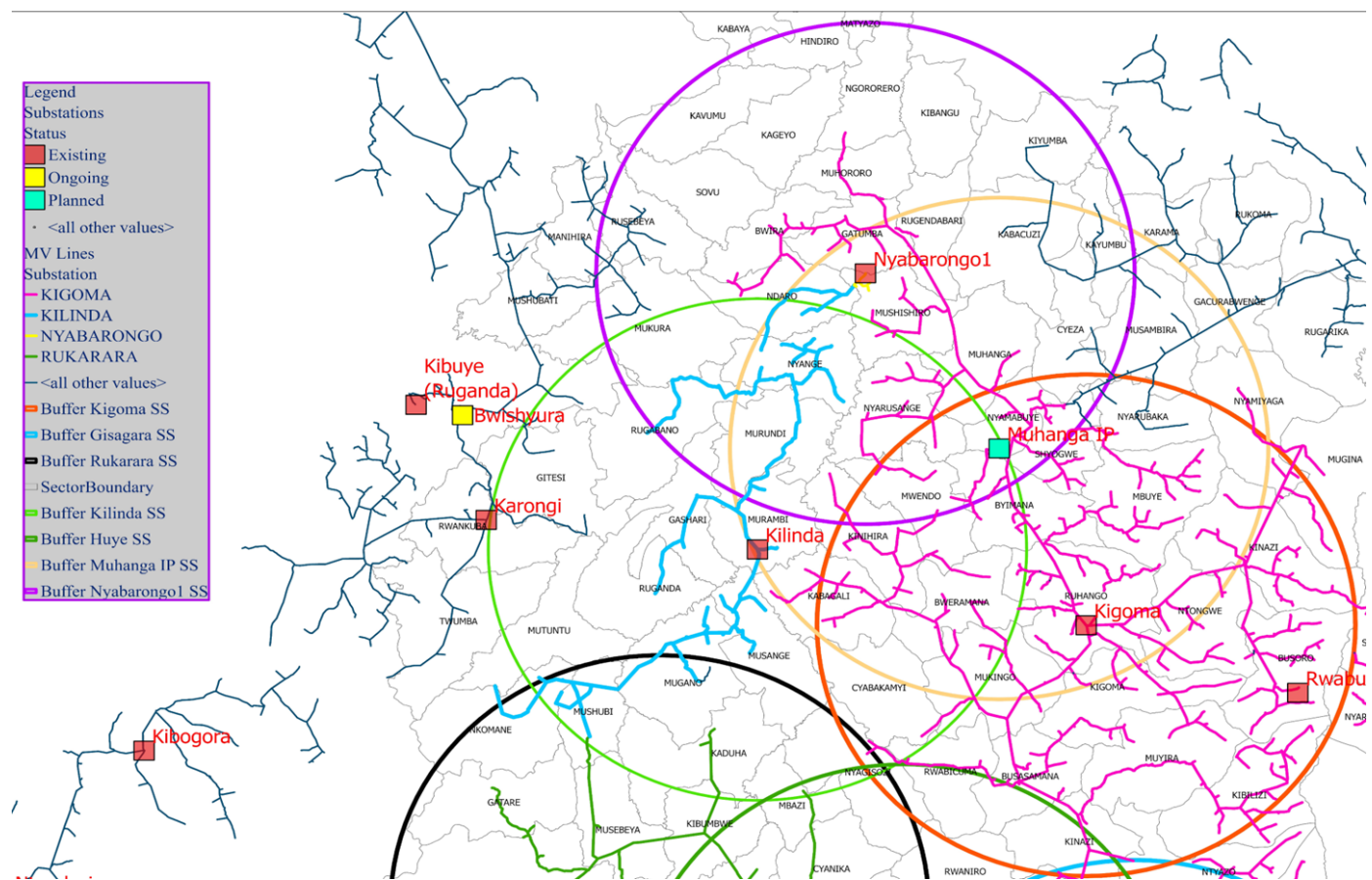
III.2.6 Muhanga zone

Much attention was paid to Muhanga zones due to Industrial Zones being developed in Muhanga district, currently there are two being factories constructed and that are on stage of pre-commissioning and commissioning tests of around 7MW and 3MW respectively this load increase will impose changes in network configurations and improvements. In addition to that , Muhanga town is being developed as one of the secondary cities in Rwanda. The short and medium solution is for having Nyaborongo 1 substation completed by 2023 and also to transfer loads of Kigoma

Substation to Gisagara substation and other possible substations. However, the recommended long-term solution is to construct Muhanga Substation near of load center which is Muhanga Industrial park and also to upgrade Kigoma substation from 10MVA to 20MVA by 2025 and to 40MVA by 2030.

Load Category	Current	Additional Loads			Total by (2025)
		2023	2024	2025	
Existing loads in Urban areas (with Demand growth rate of 12% per year)	3.75	0.45	0.504	0.564	5.3
Existing loads in other areas (with Demand growth rate of 10% per year)	1.82	0.18	0.20	0.22	2.4
Anjia Cement factory	0	6	1.5	0	7.5
Ceramics	0	1.5	0.5	0	3
Seven Hills	0	0.3	0.3	0.4	1
FIFA stadium	0	0	0.4	1.6	2
Southern Districts Hotel	0	0	0.1	0.9	1
Mineral processing plant (Golden tree)	0	0	0	0.5	0.5
Baziri (manufacturer sanitary appliances)	0	0	0.3	0	0.3
Mining	0	0	0	0.5	0.5
Total Projected New load(MW)	5.57	8.2	4.1	4.8	23

Table 18: Anticipated load in Muhanga



III.3. Northern Region

III.3.1. Introduction

The Northern network is composed of Gakenke, Musanze, Rubavu, Burera, Nyabihu and Ngororero.

According to the National Land Use and Development Master Plan 2050, the North-Western Part of the country has been proposed to be one of the Central Growth Poles of Rwanda with designation of Musanze and Rubavu Districts as secondary Cities. Consequently, the urban development master plans for this area have been revised to match the fastest growing urbanization with land requirement. This did not only affect the land and urbanization sectors but also requires adjustments with associated infrastructure development including electricity network.

Major factories and industrial parks are being developed in the north-western part of the country which in turn puts stress on existing electricity infrastructure. Therefore, the plan to extend and

strengthen the network in that corridor is of paramount importance to catch up with the fast-growth demand at present and in a near future.

REG has initiated projects to reinforce the existing electricity network capacity not only to be able to satisfy the increase in power demand, but also to secure reliability of power with flexibility of operations with a plan to export electricity to neighbor countries.

Several projects to strengthen the existing transmission and distribution lines and associated substations have been completed and many more are in pipeline.

Among them, the construction of Rubavu, Nyabihu and Musanze SS will reduce the load on Gisenyi feeder which is mostly supplying the hub. In addition, new MV lines and switching cabins in Musanze and Rubavu will also be constructed.

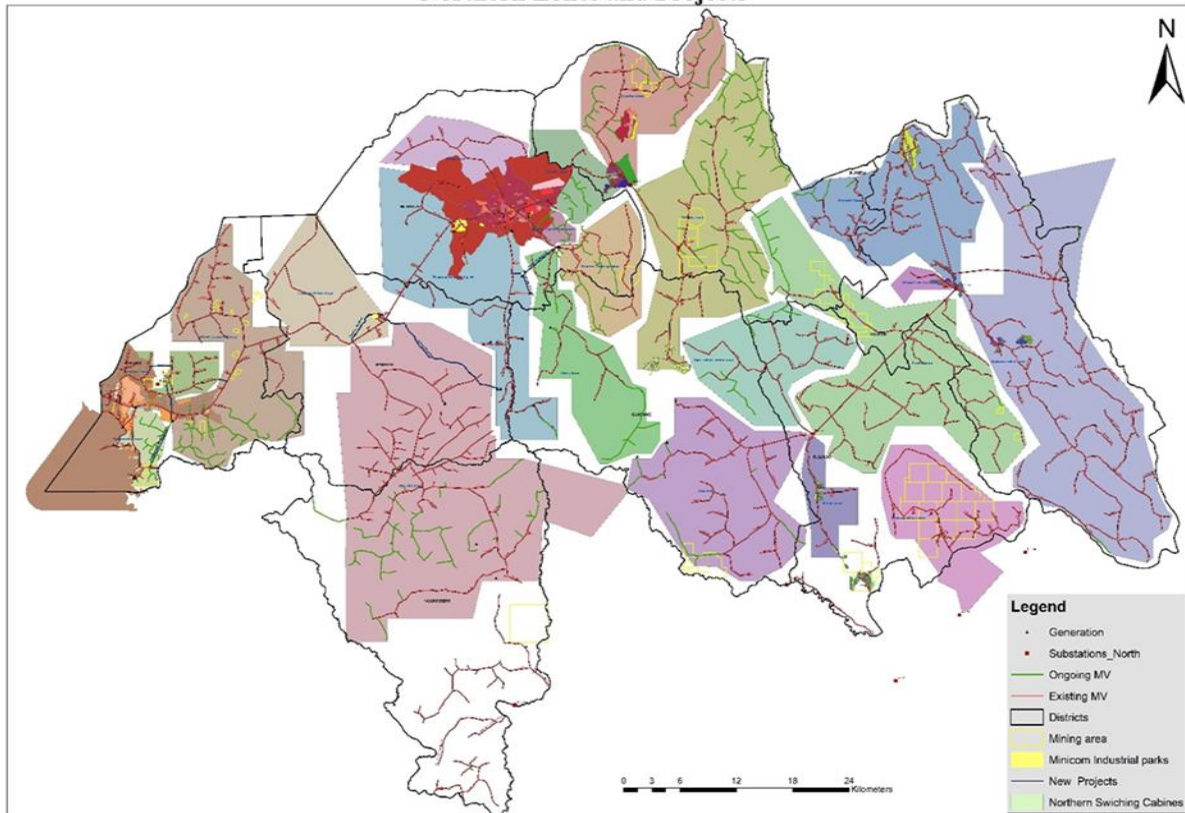
III.3.2. Zones in Northern Hub Network and key zoning factors

In this hub, 21 zones have been proposed based on incoming and outgoing feeders of available substations.

Table 19: Zones in Northern Hub Network and key zoning factors

S/N	Name	Feeder	District	Key factors for zoning
1	Kinigi zone	Kinigi	Musanze	Touristic hub
2	Musanze Industrial park	Gisenyi	Musanze	SEZ, Urban area
3	Rubavu Town	Poids Lourds	Rubavu	Secondary city, proposed cement factory
4	Rubavu Industrial zone	Gisenyi	Rubavu	Rubavu SEZ, Urban area, crusher plants
5	Nyamyumba zone	Kigufi,Gihira	Rubavu	Brewery, Mining,Hotels, Residential
6	Jenda-Kabatwa Zone	Gisenyi	Nyabihu	Residential, Nyabihu SEZ
7	Nyabihu zone	Gisenyi	Nyabihu	Kabaya urban area, residential, tea factory
8	Ntaruka zone	Ntaruka	Musanze	Residential, Kinoni urban area,Musanze urban
9	Muhoza zone	Cyanika	Musanze	Residential, agriculture
10	Janja Zone	Janja	Gakenke	Residential
11	Remera-Kivuruga zone	Remera	Gakenke	Residential,Mining
12	Cyanika zone	Cyanika	Burera	Cross-border trade, rurembo urban area,mining
13	Gifurwe zone	Gifurwe	Burera	Mineral processing, Butaro UGHE, Hospital
14	Ruli zone	Musasa	Gakenke	Residential, Mining
15	Mbogo zone	Base	Rulindo	urban centre,manufacturing
16	Base urban centre zone	Base	Rulindo	urban centre
17	Tumba zone	Byumba	Gicumbi	Mining area (Miyove), Residential
18	Gicumbi Town	Byumba	Gicumbi	District Town, Kaniga urban centre, Bungwe centre
19	Byumba sector zone	Byumba	Gicumbi	Urban area
20	Rukomo urban zone	Bumba Town	Gicumbi	Rukomo urban area, Kageyo centre
21	Rutongo Mines zone	Rutongo	Rulindo	Mining area, Hospital, residential

Northern Zones and Projects



III.3.3. Anticipated feeder loading in Northern Hub

Table 20: Anticipated feeder loading in Northern Hub

Anticipated major load in NORTHERN REGION						
Substation	Feeder	Load Category	Total Load 2023-2025 (MW)	Additional Loads in each year		
				2023	2024	2025
Rubavu Branch						
Camp Belge	Gisenyi	Five big Commercial Buildings in Gisenyi city	1	0.5	0.3	0.2
		New Hotel under construction	0.1	0.1		
		Gisenyi Modern Market	0.1	0.1		
		Cement Factory	1	0.5	0.3	0.2
Rubavu	Rubavu	Water Treatment plants	0.2	0.2		
		Extension of Rubavu Air port	0.2		0.1	0.1
		Street lights	0.3	0.1	0.1	0.1
		Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	3.2	1.6	0.9	0.7
Musanze Branch						
Camp Belge	Gisenyi	Cement Factory	1		0.5	0.5
		Small Industries (SMEs) & Modern Markets	1	0.2	0.6	0.2
		Water Treatment plants under upgrade	0.3	0.1	0.1	0.1
		Real Estate Projects	0.1	0.1		
		Extension Musanze industrial	3	1	1	1
Ntaruka	Kinigi	KINIGI Model village	0.1	0.1	0	
Ntaruka	Kinigi	Street lights on newly constructed roads Kinigi, Cyanika and Nyakinama	0.3	0.1	0.1	0.1
		Others	0.4	0.1	0.1	0.2
		Yearly Total Load Increment (MW)	5.4	1.8	2	1.6
Nyabihu Branch						
Camp Belge	Gisenyi	GITWA Pumping station	0.1	0.1		
		KORA Pumping station	0.1	0.1		
		Other loads	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	0.5	0.3	0.1	0.1
Burera Branch						
Gifurwe		Electrify Cyanika dairy	0.1	0.1		

	Cyanika	Electrify Burera stadium	0.4	0.2	0.1	0.1
		New touristic zone in Kidaho	0.1		0.05	0.05
		Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment(MW)	0.8	0.4	0.2	0.2
Gakenke & Rulindo Branch						
Rulindo	Gasiza	Street lights Ruli, Muhondo, Rushashi,Karambo and Janja sectors.	0.1	0.1		
Rulindo	Base	Electrification projects Electrify Ruhanga,Kiraho and Butereri sites in Busengo sector.	0.5	0.2	0.2	0.1
Gifurwe	Gakenke	Electrify Buranga,Rwakirari,Rugimbu and Buhuga sites in Kivuruga sector.	0.1	0.05	0.05	
Mukungwa HPP	Remera	Electrify Buranga,Rwakirari,Rugimbu and Buhuga sites in Kivuruga sector.	0.2	0.1	0.1	
Rulindo	Base	Electrify Rutabo and Murambi centers in Gashenyi sector.	0.1		0.05	0.05
Mukungwa HPP	Janja	Electrify Gashyamba,Mugandu,Karama, Kivune,Ga	0.2		0.1	0.1
Camp Belge	Gisenyi	Electrify Gashyamba,Mugandu,Karama, Kivune,Ga	0.1	0	0.05	0.05
Mukungwa HPP	Janja	Electrify Murambi,Nyundo,Munanira, and Rure	0.2	0.05	0.1	0.05
Camp Belge	Gisenyi	Electrify Murambi,Nyundo,Munanira, and Rure	0.1	0.025	0.05	0.025
		Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	0.9	0.4	0.3	0.2
		Northern Hub Total Load (MW)	10.8	4.5	3.5	2.8

III.3.4. Substation and Feeders loading after anticipated major Loads (2023-2028) in the Northern Region

Expected load increment on NORTHERN NETWORK SUBSTATIONS									
SUBSTATION	Existing Transfo MVA	Feeder	Conductor Size	Maximum Current (A)	Max Power Capacity (MW)	Peak Power [MW]	%Loading at Peak (Calculated)	Load Increment on Feeders(MV) as per the anticipated major loads	% Feeder Loading increment (2023-2028)
RULINDO	2*10MVA	BASE	ACSR 70/12 mm ²	290	12.05	0.61	5.06%	0.244	7.09%
		BYUMBA	ACSR 70/12 mm ²	290	12.05	3.01	24.98%	1.204	34.97%
		GASIZA	ACSR 70/12 mm ²	290	12.05	0.42	3.49%	0.168	4.88%
		GATUNA	ACSR 70/12 mm ²	290	12.05	2.28	18.92%	0.912	26.49%
		MUSASA	35/6 mm ² Cu	145	6.027	0.57	9.46%	0.228	13.24%
Total					54.227	6.89		2.756	
CAMP BELGE	None	MUSANZE	ACSR 120/20 mm ²	410	17.04	2.9	17.02%	1.16	23.83%
		KINIGI	ACSR 70/12 mm ²	290	12.05	1.88	15.60%	0.75	21.84%
		MUKUNGWA	ACSR 70/12 mm ²	290	12.05	3.73	30.95%	1.49	43.34%
		NTARUKA	ACSR 70/12 mm ²	290	12.05	1.8	14.94%	0.72	20.91%
		PRIME CEMENT	ACSR 120/20 mm ²	410	17.04	3.44	20.19%	1.38	28.26%
Total					70.23	13.75			
RUBAVU	1*10MVA	GIHIRA (RUBAVU)	ACSR 120/20 mm ²	410	17.04	5.3	31.10%	2.12	43.54%
		Goma	ACSR 120/20 mm ²	410	17.04	2.49	14.61%	0.996	20.46%
Total					34.08	7.79		3.116	
GIFURWE	1*10MVA	GAKENKE	ACSR 70/12 mm ²	290	12.05	0.43	3.57%	0.172	5.00%
		KIRAMBO	ACSR 70/12 mm ²	290	12.05	1.33	11.04%	0.532	15.45%
		NTARUKA	ACSR 70/12 mm ²	290	12.05	4.4	36.51%	1.76	51.12%
Total					36.15	6.16		2.464	
NYABIHU	2*20MVA	GICIYE	ACSR 120/20 mm ²	410	17.04	11.63	68%	0	68.24%
		NGORORERO	ACSR 120/20 mm ²	410	17.04	1.52	9%	0.76	13.38%
		RUBAVU	ACSR 120/20 mm ²	410	17.04	1.71	10%	0.855	15.05%
		CAMP BELGE (MUSANZE)	ACSR 120/20 mm ²	410	17.04	0.55	3%	0.275	4.84%
Total					68.17	15.41		1.89	
MUKUNGWA	1*15MVA	RENERA	ACSR 70/12 mm ²	290	12.05	1.6	13.28%	0.64	18.59%
		JANIA	ACSR 70/12 mm ²	290	12.05	1.9	15.77%	0.76	22.07%
		MUKUNGWA	ACSR 120/12 mm ²	410	17.04	4.3	25.23%	2.58	40.37%
		RWAZA	ACSR 70/12 mm ²	290	12.05	2.1	17.43%	0.84	24.40%
Total					53.19	9.9		4.82	
NTARUKA	1*10MVA	CYANIKA	ACSR 120/20 mm ²	410	17.04288	4.8	%	1.92	39.43%
		NTARUKA	ACSR 70/12 mm ²	290	12.05	1.75	14.52%	0.7	20.33%
Total					29.09	6.55		2.62	

Table 21: Feeder loading after anticipated major Loads (2023-2028) in the Northern Region

Anticipated load increment on MV Feeders in the North is small, mostly contributed by access projects. No Heavy or Over loaded feeders are observed after addition of the anticipated loads. However, the overloaded substations are highlighted (red in the table below);

Table 22: Feeder loading after anticipated major Loads (2023-2028) in the Northern Region

NORTHERN							
SUBSTATION	Total capacity (MVA)	Nr of Power Trx	Current Highest Peak [MW]	Load Increment (2023-2025)	Projected total demand by 2025	Load Increment (2026-2028)	Projected total demand by 2028
RULINDO	20	2x10	6.89	1.10	7.99	1.92	9.91
GATUNA	5	1x5	2.5	0.40	2.90	0.70	3.60
RUBAVU	10	1x10	7.79	1.56	9.35	3.37	12.71
GIFURWE	10	1x10	6.16	0.99	7.15	1.71	8.86
NYABIHU	40	2x20	15.41	2.47	17.88	4.29	22.17
MUKUNGWA	15	1x15	8.5	2.04	10.54	3.79	14.33
NTARUKA	10	1x10	5.3	0.85	6.15	1.48	7.62
TOTAL	110	8	52.55				

III.3.5. Projects proposals for Network reinforcement in the Northern Region

Summary of Key Network strengthening projects in the Northern Region

S/N	Designation	Total	Musanze	Nyabihu	Gicumbi	Rulindo	Gakenke	Burera	Ngororero	Rubavu	Required Budget	Available Budget (USD)	Source of Funds	Status	Budget GAP (USD)
1	Power Quality Improvement (Voltage drop)														
1.1	Extension of MV lines	192.2	37.4	19.4	22.1	27.7	7.0	47.7	6.1	24.9	13,074,641	9,695,492	RUEAP/AFDB	Under Tender Preparation	3,379,149
1.2	Insertion of New Transformers (with protective devices & LVDB)	156.0	28.0	16.0	16.0	42.0	10.0	28.0	4.0	12.0					
1.3	LV Network upgrade/strengthening	551.5	96	90.4	52.5	67.5	26.7	109	19.1	90.5					
2	Switching Cabins	3.0	1	0	0	0	0	0	0	2	4,253,525	4,253,525	RUEAP/AFDB	Under Tender Preparation	-
3	Upgrade of Single phase														
3.1	MV Lines (km)	167.5	1.5	0.0	7.5	152.0	4.0	0.0	2.5	0.0	6,270,674	1,613,417	RUEAP/AFDB	Under Tender Preparation	4,657,257
3.2	LV Lines (km)	236.3	0.0	0.0	74.4	25.8	1.8	0.0	44.8	89.5					
3.3	Transformer replacement	192.0	1	0	52	30	46	0	25	38					
TOTAL											23,598,840	15,562,434			8,036,406

Table 23: Summary of Key Network strengthening projects in the Northern Region

Power Quality Improvement: Voltage drop issues

Branch	REQUIRED SCOPE, JUNE 2022			CONSIDERED SCOPE UNDER RUEAP PROJECT		
	MV line extension	Installation of new transformer	Upgrade of LV network	MV line extension	Installation of new transformer	Upgrade of LV network
Musanze	37.4	28	96	34.4	26	100.1
Burera	47.65	28	108.8	51	20	165
Gicumbi	22.1	16	52.5	9.7	9	27.5
Rulindo	27.7	42	67.5	11	7	13.2
Gakenke	7	10	26.7	7.5	6	13.5
Nyabihu	19.4	16	90.4	5.7	4	18
Rubavu	24.9	12	90.5	28	17	53
Ngororero	6.05	4	19.1	9.5	3	1.8
TOTAL	192.2	156	551.5	156.8	92	392.1
Remaining Scope (Gap)	35.4	64	159.4			

Table 24: Power Quality Improvement: Voltage drop issues

Upgrade of Single phase to Three Phase Network

Branch	1 phase MV	1 phase Tx	1 phase LV
Musanze	1.5	1	0
Burera	0	0	0
Gicumbi	7.5	52	74.4
Rulindo	152	30	25.8
Gakenke	4	46	1.8
Nyabihu	0	0	0
Rubavu	0	38	89.5
Ngororero	2.5	25	44.8
Scope Required	167.5	192	236.3
Considered scope (RUEAP)	10.4	138	56.3
Remaining Scope	157.1	54	180

Table 25: Upgrade of Single phase to Three Phase Network

III.4. Eastern Region

III.4.1. Introduction

The Eastern network comprises of Rwamagana, Kayonza, Ngoma, Kirehe, Gatsibo and Nyagatare Districts.

The Eastern area is the host of the proposed railway connecting countries of the Northern Corridor. In addition to that, it is an area where critical projects are being implemented which require enough power to sustain businesses amongst which irrigation, Milk collection Centres, Mining and Special Economic Zones in Nyagatare and Rwamagana Districts.

Important projects are underway in Gatsibo and Nyagatare including but not limited to Gabiro Commercial farm project and East African Granite Industries and there is no doubt that these planned and ongoing projects will put stress on existing electricity infrastructure while the entire area is currently supplied mainly by KKK and Zaza feeders.

Network reinforcement projects are ongoing, and others are planned to include the construction of Gicumbi SS, Nyagatare SS and Kirehe SS. Important feeders will be drawn from those Substations to reinforce network in the Eastern area.

III.4.2. Zones in Eastern Hub and key factors for zoning

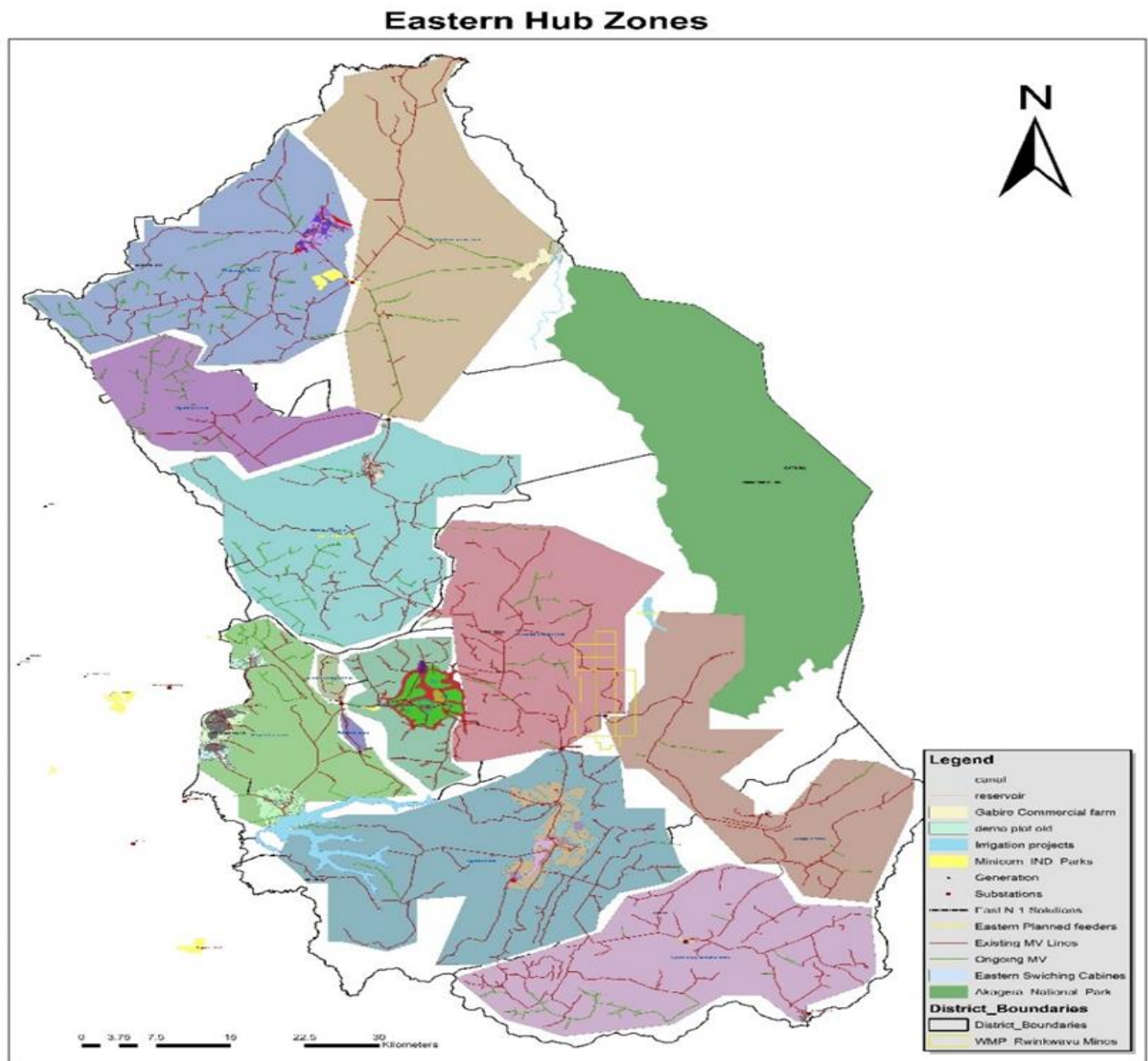
Twelve (12) zones have been proposed in line with available feeders and substations in the Eastern Hub. Key factors for zoning were also mentioned as found on the table below:

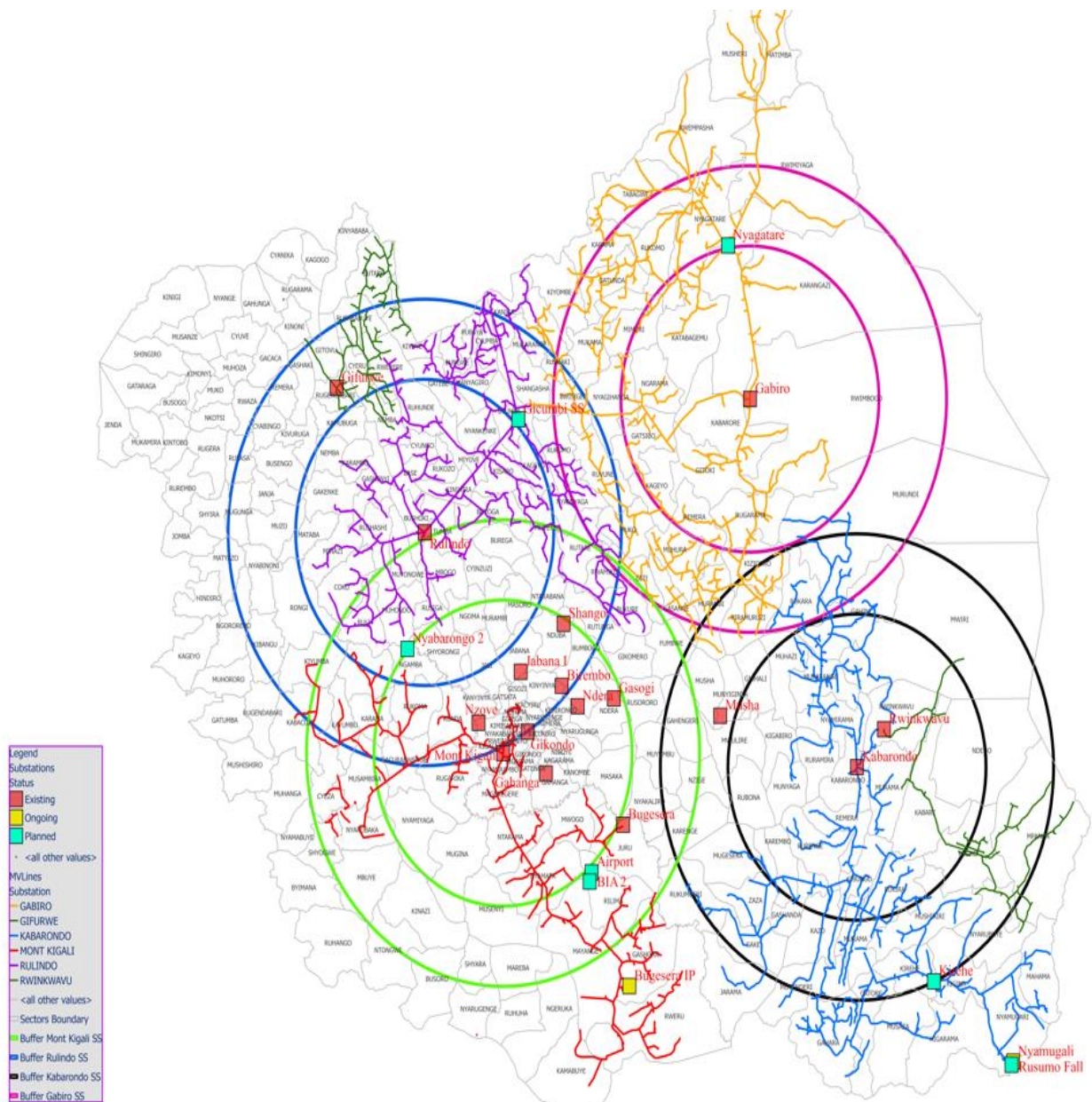
Table 26: Zones in Eastern Hub and key factors for zoning

S/N	Name	District	Feeder	Key factors
1	Nyagatare Town Zone	Nyagatare	KKK	District Town, SEZ, irrigation at Karangazi
2	Nyagatare farms zone	Nyagatare	KKK	Gabiro commercial farm, other farms, cross-border
3	Ngarama zone	Gatsibo	KKK	Irrigation in warufu marsh, urban area
4	Ruramira-Gahini zone	Kayonza	KKK	Rwinkwavu Mines, Urban areas, irrigation
5	Kabarore zone	Gatsibo	KKK	Gatsibo District town, urban centres
6	Akagera zone	Kirehe	Akagera	Nasho irrigation facilities, Akagera Hotel
7	Nyarubuye-Mahama zone	Kirehe	Zaza	Rusumo one Stop Border Residential, refugees' camps
8	Ngoma zone	Ngoma	Zaza	Ngoma District Town, Mugesera Lakeshores MP
9	Rwamagana Town zone	Rwamagana	Rwamagana	District town, SEZ
10	Musha-Ntunga zone	Rwamagana	Rwamagana	Mines, residential
11	Muyumbu zone	Rwamagana	Karenge, Kanombe	Karenge, Muyumbu, Nyakaliro and Nyagasambu urban

12	Rubona zone	Rwamagana	Rubona solar	Mwulire Gigawatt project for residential
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The map for zoning is found as follow:





III.4.3. Major Anticipated loads on Electricity Distribution Network in Eastern Region

Anticipated major load in Eastern Hub						
SUBSTATION	FEEDER	Load Category	Total Load 2023-2025 (MW)	Additional Loads in each year		
				2023	2024	2025
Gatsibo Branch						
Kabarondo & Gabiro	KKK, Kiziguro & Nyagatare	Streetlights KAGITUMBA KAYONZA	0.2		0.1	0.1
Gabiro	Kiziguro	Water Pumps-WASAC	4.36	1.36	2	1
		Yearly Total Load Increment (MW)	4.56	1.36	2.1	1.1
Kayonza Branch						
Kabarondo	Zaza	Streetlights KAYONZA- RUSUMO	0.2	0.1	0.1	
Kabarondo	KKK	Water treatment plant WASAC Ndego KAYONZA	0.5	0.2	0.2	0.1
Gabiro	Kiziguro	Irrigation BRAMIN	0.4	0.1	0.1	0.2
Kabarondo	KKK	Kayonza Industrial Zone	0.4	0.1	0.1	0.2
		Yearly Total Load Increment (MW)	1.5	0.5	0.5	0.5
Kirehe Branch						
Kabarondo	Zaza	RUSUMO BORDER cross border market	0.1	0.1		
		KIYANZI stone crusher KIREHE	0.1	0.1		
		Muhazi water pumps -WASAC	0.25	0.25		
		AFRIGAS LIMITED	0.3		0.1	0.2
		Yearly Total Load Increment (MW)	0.75	0.45	0.1	0.2
Ngoma Branch						
Kabarondo	Zaza	Street lights KIBUNGO- RAMIRO	0.2	0.1	0.1	
		Sake water supply	1.5			1.5
		Yearly Total Load Increment (MW)	1.7	0.1	0.1	1.5
Nyagatare Branch						
Gabiro	Nyagatare	KAGITUMBA BORDER cross border market	0.1	0.1		

		MIRAMA meat Plant NYAGATARE	0.2		0.1	0.1
		Nyagatare Golf	0.1			0.1
		NYAGATARE Industrial zone RUTARAKA	3.7		0.9	2.8
		GABIRO Airport extension	0.2		0.1	0.1
		Water treatment plant WASAC CYONDO NYAGATARE&GIHENGGERI	0.9	0.5	0.2	0.2
		GABIRO Agribusiness Hub	1	0.3	0.3	0.4
		INYANGE MILK POWDER	3	0.4	1.5	1.1
		Karangazi commercial farm	1		0.3	0.7
		Yearly Total Load Increment (MW)	10.2	1.3	3.4	5.5
Rwamagana Branch						
Musha	SteelRwa	Rwamagana Industrial Park	1.3	0.4	0.4	0.5
		Yearly Total Load Increment (MW)	1.3	0.4	0.4	0.5
	TOTAL		20.01	4.11	6.4	9.3

Table 27: Major Anticipated loads on Electricity Distribution Network in Eastern Region

III.4.4. Substation and Feeder loading after anticipated Major load growth (2023-2028) in Eastern Region

SUBSTATION	Existing Transfo MVA	Feeder	Conductor Size	Maximum Current (A)	Max Power Capacity (MW)	Peak Power [MW]	% Loading at Peak (Calculated)	Load Increment on Feeders(MV) as per the anticipated major loads	% Feeder Loading increment (2022-2024)
GABIRO	2 *10	Nyagatare	ACSR 120/20 mm ²	410	17.04	3.7	21.71%	13.00	98%
		Kiziguro	ACSR 120/20 mm ²	410	17.04	1.6	9.39%	0.80	14%
		Ngarama	ACSR 120/20 mm ²	410	17.04	1.6	9.39%	0.96	15%
Total					51.12	6.9		14.76	0.42
RWINKWAVU	1*6	Akagera	ACSR 70/12 mm ²	290	12.05	1.41	11.70%	0.56	16%
		Redemi	ACSR 35/6 mm ²	145	6.03	0	0.00%	0.00	0%
Total					18.08	1.41		0.56	
MUSHA	1*20	Rwamagana	ACSR 70/12 mm ²	290	12.05	2.5	20.75%	1.00	29%
		Karenge	ACSR 70/12 mm ²	290	12.05	2	16.60%	0.80	23%
		Redemi	ACSR 70/12 mm ²	290	12.05	0.3	2.49%	0.12	3%
		Rubona	ACSR 70/12 mm ²	290	12.05	6.9	57.26%	0.35	60%
		Steelrwa	ACSR 120/20 mm ²	410	17.04	8.9	52.23%	3.56	73%
Total					65.24	20.6		8.24	
KABARONDO	1*10	Kabarondo, Kayonza (KKK)	ACSR 70/12 mm ²	290	12.05	3.62	30.04%	0.18	32%
		ZAZA	ACSR 70/12 mm ²	290	12.05	3.03	25.15%	0.15	26%
Total					24.1	6.65		0.33	
BUGESERA		Industrial Park				0.62		5.37	
Total						0.62		5.372	

Table 28: Feeder loading after anticipated Major load growth (2023-2028) in Eastern Region

Only Nyagatare feeder will be overloaded. Musha and Kabarondo S/S will be overloaded by 2025, whereas Gabiro will be overloaded by 2028. This Justify the need of Nyagatare IP and Kirehe substations. Musha and Kabarondo shall be also upgraded.

EASTERN							
GABIRO	20	1x20	6.9	1.66	8.56	14.07	22.62
RWINKWAVU	6	1x6	1.41	0.71	2.12	0.51	2.62
MUSHA	20	2x20	20.6	10.30	30.90	7.42	38.32
KABARONDO	10	1x10	6.65	3.33	9.98	2.39	12.37
BUGESERA	20	1x20	0.62	0.62	1.24	0.30	1.54
TOTAL	76	5	36.18	16.61	52.79	24.68	77.47

Table 29: Substations loading after anticipated Major load growth (2023-2028) in Eastern Region

III.4.5. Network Strengthening Projects and Investment Proposal in Eastern Hub

Summary of Key Network strengthening projects in the Eastern Region

S/N	Designation	Total	Rwamagana	Kayonza	Gatsibo	Bugesera	Nyagatare	Kirehe	Ngoma	Required Budget	Available Budget (USD)	Source of Funds	Status	Budget GAP (USD)
1	Power Quality Improvement (Voltage drop)													
1.1	Extension of MV lines	46.3	8.6	10.1	1.9	20.0	4.0	13.6	4.2	6,721,613	4,859,072	RUEAP/AFDB	Under Tender Preparation	1,862,541
1.2	Insertion of New Transformers (with protective devices & LVDB)	52.0	6.0	8.0	4.0	26.0	4.0	0.0	1.7					
1.3	LV Network upgrade/strengthening	474.2	165	61.5	3	81.9	60.5	0	102.8					
2	Switching Cabins	7.0	1	0	0	3	2	0	1	8,961,061	2,111,061	RUEAP/AFDB	Under Tender Preparation	6,850,000
3	Upgrade of Single phase													
3.1	MV Lines (km)	400.0	11.5	63.7	74.0	0.0	110.9	68.6	71.3	17,402,480	12,062,229	RUEAP/AFDB	Under Tender Preparation	5,340,251
3.2	LV Lines (km)	874.4	33.6	109.6	209.0	0.0	153.1	144.1	225.0					
3.3	Transformer replacement	461.0	13	68	83	0	123	89	85					
	TOTAL									33,085,155	19,032,362			14,052,793

Table 30: Summary of Key Network strengthening projects in the Eastern Region

Power Quality Improvement: Voltage drop issues

Branch	REQUIRED SCOPE, JUNE 2022			CONSIDERED SCOPE IN RUEAP		
	MV line extension	Installation of new transformer	Upgrade of LV network	MV line extension	Installation of new transformer	Upgrade of LV network
Kayonza	10.1	8	61.5	2.5	6	44.4
Gatsibo	1.9	4	3	12.15	8	22.5
Bugesera	20	26	81.9	3.35	8	28
Nyagatare	4	4	60.5	1.5	6	58
Rwamagana	8.6	6	164.5	2.5	20	150.05
Ngoma	1.7	4	102.8	2.5	2	8.4
Kirehe	0	0	0	3	2	33.48
TOTAL	46.3	52	474.2	27.5	52	344.83
Remaining Scope (Gap)	18.8	10	129.37			

Table 31: Power Quality Improvement: Voltage drop issues

Upgrade of Single phase to Three Phase Network

Branch	1 phase MV	1 phase Tx	1 phase LV
Kayonza	63.7	68	109.6
Gatsibo	74	83	209
Bugesera	0	0	0
Nyagatare	110.9	123	153.1
Rwamagana	11.5	13	33.6
Ngoma	71.3	85	225
Kirehe	68.6	89	144.1
Scope Required	400	461	874.4
Considered scope (RUEAP)	243.7	325	680
Remaining Scope	156.3	136	194.4

Table 32: Upgrade of Single phase to Three Phase Network

III.5. WESTERN REGION

III.5.1. Introduction

The network in Western Part of the country is not as challenged as for other hubs. This mainly because in the western part there are considerably enough generation and transmission projects including substations and feeders. The feeders are not too long with exception of Kibuye feeder which extends from Karongi to Rutsiro and does not have any other source of power supply.

Following the fact that the western part accommodates important urban nodes with designation of Rusizi District as secondary city, and industries such as tea factories in Shagasha, Gisovu, Gisakura and cement production industries, the western part may be challenged by lack of alternative power supply due to single supply from one feeder.

In addition to that, Rwanda envisages to export power to neighboring countries bordering the western Hub but the current infrastructures in Rubavu and Mururu need to be upgraded

REG has started initiatives to upgrade the existing electricity infrastructure at Mururu and in this master plan, several N-1 Solutions to serve as contingency plan to some of the feeders have been proposed.

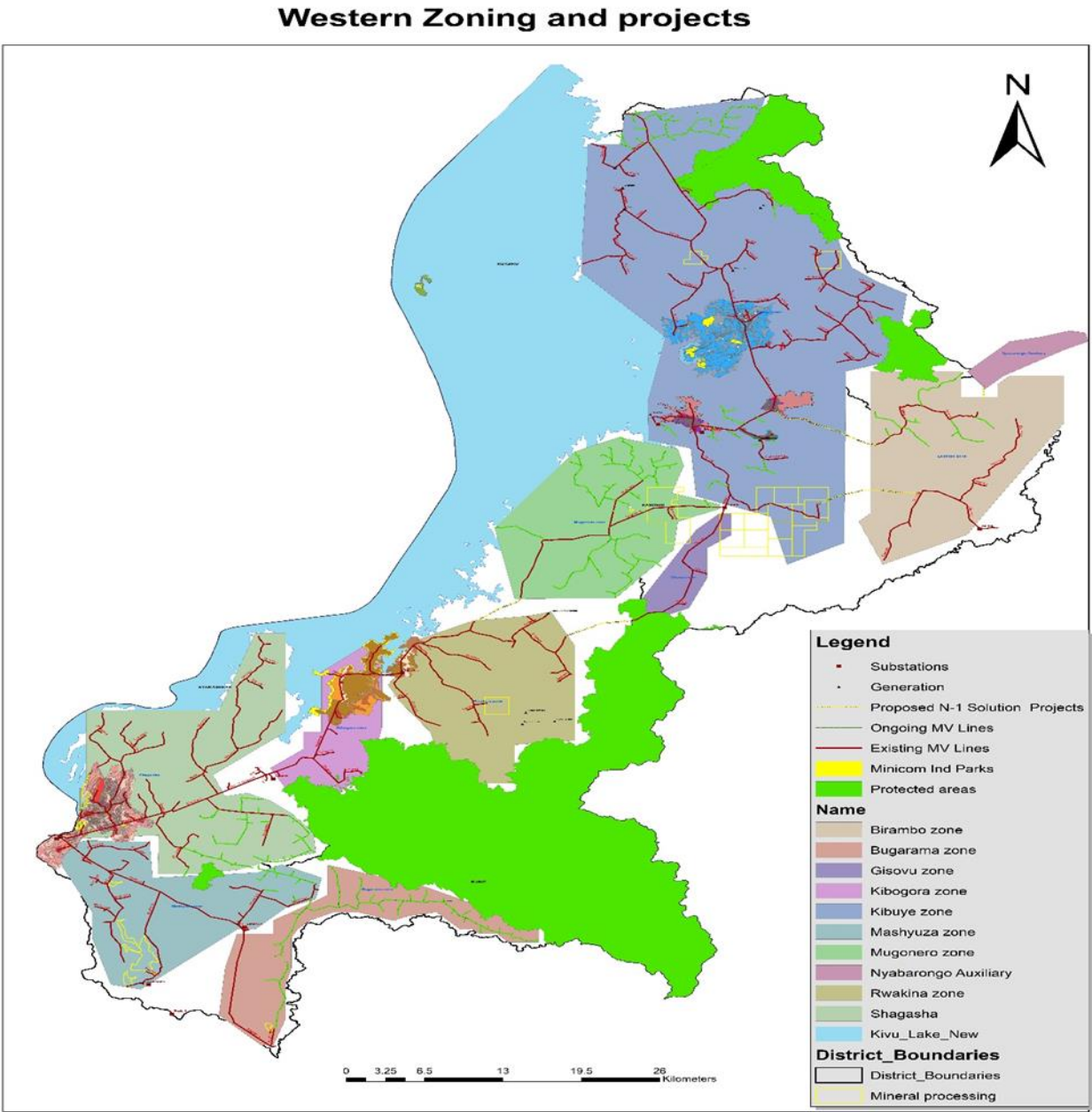
III.5.1. Zones in Western hub and projects.

In the western hub, only 10 zones were identified based on the feeders and electricity generation infrastructure available. In addition, key zones were founded based on the pulling factors available and planned to be established in the western hub as per the following table:

S/N	Feeder	District	Name	Keyfactors
1	Kibogora	Nyamasheke	Kibogora zone	Urban centre
2	Shagasha-Mururu	Rusizi	Shagasha zone	Tea Factory, Rusizi District Town, SEZ
3	Kibuye	Rutsiro, Karongi	Kibuye zone	Urban areas, residential, Hotels,Bisesero Mines
4	Birambo	Nyamasheke	Birambo zone	Residential
5	Nyabarongo Auxiliary	Ngororero	Nyabarongo Auxiliary	Mining area
6	Gisovu	Karongi	Gisovu zone	Tea factory,Mineral processing
7	Mugonero	Karongi,Nyamasheke	Mugonero zone	residential, industrial quarry and crushing plant
8	Rwakina	Nyamasheke	Rwakina zone	Residential, factory,pyramide minerals processing
9	Karongi	Karongi	Bwishyura	Gasmeth Energy ltd
10	Bugarama	Rusizi	Bugarama zone	cross-Border, Residential
11	Mashyuza	Rusizi	Mashyuza zone	Cement factory, residential

Table 33: Zones in Western hub and projects.

Map for zoning in western Hub is as the following:



III.5.3. Anticipated Major Load on Electricity Distribution network in Western Hub

Anticipated major load in WESTERN HUB						
Substation	Feeder	Load Category	Total Load (2023-2025)	Additional Loads in each year		
				2023	2024	2025
Rusizi Branch						
Mururu I	Shagasha	Two big Commercial Buildings in Rusizi-Kamembe	0.2	0.1	0.1	
Mururu I	Shagasha	Two New Hotels under construction	0.2	0.1	0.1	
Mashyuza	Bugarama	Bugarama cross Border Market	0.1	0.1		
Mashyuza	Bugarama	COTCORI Rice Factory Extension	0.1	0.1		
Mashyuza	Cimerwa	CIMERWA Factory Extension	2	0.5	0.5	1
Mashyuza	Mashyuza	Gikundamvura Water Treatment Plant	0.2	0.2		
Mururu I	Shagasha	Banana beer processing factory-Nkungu	0.1	0.1		
Mururu I	Shagasha	Construction Rusizi Port	0.3	0.1	0.1	0.1
Mururu I	Shagasha	Rusizi Airport Extension plus Surrounding lights	0.2	0.1	0.1	
Mururu I	Shagasha	Giheke-Ruhwa public road lighting	0.2	0.1	0.1	
Mururu I	Shagasha	Rusizi Industrial Park(8MW)	2.3	0.3	1	1
Mururu I	Shagasha	Street Lights in Rusizi city (kurya 1-kurya 4)	0.1	0.1		
Mururu 1	Mashyuza	Public Lighting from Rusizi/Mururu to Ruhwa Border(47KM)	0.5		0.1	0.4
Mururu 1	Mashyuza	Bweyeye Military Hospital	0.25	0.05	0.15	0.05
Mururu 1	Shagasha	Ibagiro rya Rusizi	0.25	0.02	0.1	0.13
Mururu 1	Shagasha	Rusizi town Houses(skyscrapers) being constructed	0.5		0.05	0.45
		Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	7.8	2.07	2.5	3.23
Rutsiro Branch						
Karongi	Kibuye	Two big Commercial Buildings in Rutsiro	0.2		0.1	0.1

	Kibuye	New Hotel under construction	0.1	0.1		
	Kibuye	Nkora Modern Market/ lake Port	0.1	0.1		
	Kibuye	Mineral processing plant	0.1	0.1		
	Kibuye	Street lights	0.2	0.1	0.1	
	Kibuye	Car Parking	0.2		0.1	0.1
	Kibuye	External Light Nyamagumba Genocide Memorial	0.1		0.1	
	Kibuye	Transit Center/Mushubati	0.1		0.5	0.5
	Kibuye	Water pumps-WASAC	2.93	0.5	0.5	1.93
	Kibuye	Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	4.33	1	1.5	2.73
Karongi Branch						
Karongi	Kibuye	4 Hotel under constraction+4 not yet started but they have construction permits anytime they may construct	0.2		0.1	0.1
	Kibuye	Two New Hotels under construction	0.1	0.1		
	Kibuye	Affrines Factory (ship assembling)	0.1		0.1	
	Kibuye	Stadium and District head office planned to be constructed in 2021/2022	0.4	0.2	0.1	0.1
	Kibuye	Electrification of HHs and Productive Uses in 10 sectors of Ruganda, Murundi, Gitesi,Rubengera, Bwishyura, RUGABANO, Murambi, Gishyita, Mubuga, Rwankuba	0.7	0.2	0.2	0.3
	Kibuye	construction of port in Karongi	0.4	0.2	0.1	0.1
	Kibuye	Increasing the power in Rubengera hand craft	0.1	0.1		
	Kibuye	KOPAKAMA coffee factory	0.1	0.1		
	Kibuye	Kiziba refugee camp	0.1		0.05	0.05
	Kibuye	WASAC water pumps	1.6	0.5	0.5	0.6
	Kibuye	Uzaform Bricks Ltd	0.1		0.05	0.05

Karongi, Kirinda	Kibuye, Birambo, Mugonero	Electrification of HHs and Productive Uses in 10 sectors of Ruganda, Murundi, Gitesi, Rubengera, Bwishyura, RUGABANO, Murambi, Gishyita, Mubuga, Rwankuba	0.7	0.1	0.5	0.1
Karongi	Mugonero	Rwacoff Mubuga Coffee Washing station	0.05		0.05	0
Karongi	Kibuye	GAMETH ENERGY Ltd	4.8		1.2	3.6
Kirinda	Mugonero	Kabazi Facility Storage	0.1		0.02	0.08
	Kibuye	Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	9.87	1.6	3.67	4.6
Nyamasheke Branch						
KIBOGORA	NYAMASHEKE	World vision Building; Ibigabiro Building, Kibogora Hospital Extension (Maternity), Inzu yabajyanama b ubuzima	0.1	0.1		
	NYAMASHEKE	Street lights(Kabeza-Murwa and roads in Ninzi, Gashirabwoba-Bushenge Hospital, Bushenge centre, Ntendezi centre)	0.3	0.1	0.1	0.1
	NYAMASHEKE	Electrification of Nyamasheke Prison	0.1		0.05	0.05
	NYAMASHEKE	Street Light (Karongi-Nyamasheke-Rusizi)	0.3		0.2	0.1
	NYAMASHEKE	Others	0.3	0.1	0.1	0.1
		Yearly Total Load Increment (MW)	1.1	0.3	0.45	0.35
		Total Load Increment in WESTERN HUB(MW)	24.1			

Table 34: Anticipated Major Load on Electricity Distribution network in Western Hub

III.5.4. Substation loading after anticipated Major load growth (2023-2028) in Western Hub

WESTERN							
KARONGI	10	1x10	3.42	4.82	8.24	2.47	10.71
KIBUYE	3.15	1x3.15	0.6	1.10	1.70	0.41	2.10
KIBOGORA	6	1x6	1.2	0.24	1.44	0.35	1.79
MURURU 1	10	1x10	3.41	1.36	4.77	1.72	6.49
NTENDEZI	10	1x10	1.2	0.29	1.49	0.54	2.02
BUGARAMA	15	1x15	9.5	0.76	10.26	1.23	11.49
TOTAL	54.15	6	19.33	8.57	27.90	6.71	34.61

Table 35: Substation loading after anticipated Major load growth (2023-2025) in Western Hub

III.5.5. Key Anticipated Major load growth (2023-2028) in Western Hub

Load Category	Expected load (MW)	Timeline	Status end June-2023	Feeder	Substation
Big & small Industries	20				
Anjia cement factory in Muhanga district	7	2023	Under commissioning	Gatumba	Kigoma
Ceramics in Muhanga district	3	2023	Under commissioning	Gatumba	Kigoma
Inyange Milk powder in Nyagatare in Nyagatare district	3	2024	Under construction	Nyagatare	Gabiro
Upgrade of Imana steel in Bugesera district	7	2024	Under procurement	IP	Bugesera
Gasmeth Energy Ltd in Karongi district	4.8	2025	Under construction	Kibuye	Karongi

AVIPRO Poultry Production in Bugesera district	1.5	2025	Under design	Kanazi	Mt Kigali/Bugesera
Water Treatment plant and Irrigation projects	18.6				
Kivu belt Water Supply System (Phase1) in Karongi&Rutsiro districts	5.8	2026	Under feasibility study	Kibuye	Karongi
Muhazi Water Supply System (Phase 1) in Gatsibo district	4.3	2026	Under feasibility study	Kiziguro	Gabiro
MUVUMBA Irrigation project (28 pumping stations) in Nyagatare	6.2	2027	Under feasibility study	Nyagatare	Gabiro
MPANGA Irrigation Project in Kirehe district	2.3	2023	Operational but not at full	Akagera	Rwinkwavu
Total (2023-2028)	38.6				

Table 36: Key contributors of load increment 2023-2028 upcountry (western in REG)

From the table 32, the key contributors of load increment for western are Gasmeth and Kivu belt water supply system. These loads require network strengthening such upgrade of Karongi substation and as well as Kibuye/Ruganda substation.

III.5.6. Network Strengthening Projects and Investment Proposals in Western Region

Designation	Total	Rusizi	Karongi	Rutsiro	Nyamasheke	Required Budget	Available Budget (USD)	Source of Funds	Status	Budget GAP (USD)
Power Quality Improvement (Voltage drop)										
Extension of MV lines	226.0	26.7	37.3	63.2	98.8	15,201,828	9,390,225	RUEAP/AFDB	Under Tender Preparation	5,811,603
Insertion of New Transformers (with protective devices & LVDB)	138.0	21.0	22.0	24.0	71.0					
LV Network upgrade/strengthening	682.1	89	76.1	165	352					
Switching Cabins	6	4	1	0	1	4,141,073	1,741,073	RUEAP/AFDB	Under Tender Preparation	2,400,000
Upgrade of Single phase										
MV Lines (km)	47.2	0.0	14.0	3.8	29.4	3,316,903	2,649,211	RUEAP/AFDB	Under Tender Preparation	1,332,171
LV Lines (km)	178.8	75.8	10.0	0.0	93.0					
Transformer replacement	149.0	41	11	62	35					
TOTAL						22,659,804	13,780,509			9,543,774

Table 37: Network Strengthening Projects and Investment Proposals in Western Region

Power Quality Improvement: Voltage drop issues

Branch	REQUIRED SCOPE, JUNE 2022			CONSIDERED SCOPE UNDER RUEAP PROJECT		
	MV line extension	Installation of new transformer	Upgrade of LV network	MV line extension	Installation of new transformer	Upgrade of LV network
Rusizi	26.7	21	89	21	11	68
Karongi	37.3	22	76.1	11	12	44
Nyamasheke	98.75	71	352	66.05	42	251
Rutsiro	63.2	24	165	20.5	10	133.5
TOTAL	225.95	138	682.1	118.55	75	496.5
Remaining Scope (Gap)	107.4	63	185.6			

Table 38: Power Quality Improvement: Voltage drop issues

Upgrade of Single phase to Three Phase Network

Branch	1 phase MV	1 phase Tx	1 phase LV
Rusizi	0	62	75.8
Karongi	14	34	10
Nyamasheke	29.4	40	93
Rutsiro	3.8	62	0
Scope Required	47.2	198	178.8
Considered scope (RUEAP)	30.9	198	86.2
Remaining Scope (GAP)	16.3	0	92.6

Table 39: Upgrade of Single phase to Three Phase Network

IV. On-Grid Access Program Countrywide (RUEAP)

Table 40: On-Grid Access Program Countrywide (RUEAP)

District	Sector	Total connections	MV	LV	Trf	Funder
Gisagara	Gikonko, Gishubi, Kansi, Kibirizi, Kigembe, Mamba, Muganza, Mugombwa, Mukindo, Musha, Ndora, Nyanza, Save	8,143	55.7	233.0	98.0	AfDB
Huye	Gishamvu, Huye, Karama, Kigoma, Maraba, Mbazi, Mukura, Ngoma, Ruhashya, Simbi, Tumba	27,156	146.0	357.0	149.0	
Nyamagabe	Buruhukiro, cyanika, gasaka, Gatare, Kaduha, kamegeri, kibirizi, kibumbwe, kitabi, Mbazi, musange, musebeya, nkomane, Tare, Uwinkingi	9,130	97.5	212.0	83.0	
Nyanza	Busasamana, Busoro, Cyabakamyi, Kibilizi, Kigoma, Mukingo, Muyira, Ntyazo, Nyagisozi, Rwabicuma	11,945	68.0	326.0	154.0	
Nyaruguru	Busanze, Cyahinda, Kibeho, kivu, Mata, muganza, Munini, Nyabimata, nyagisozi, Ruheru, Ruramba	4,253	34.0	126.0	34.0	

Ruhango	Bweramana,Byimana,Kabagali,Kinazi,Kinihira,Mbuye,Mwendo,Ntongwe,Ruhango	9,213	72.0	216.3	67.0	
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Gakenke	Busengo;Coko;Cyabingo;Gakenke;Gashenyi;Janja;Kamubuga;Karambo;KivurugaMataba;Minazi;Mugunga;Muhondo;Muyongwe;Muzo;Nemba;Ruli;Rusasa;Rushashi	12,841	71	218	130	OFID/SFD
Muhanga	Cyeza,Kabacuzi,Kiyumba,nyabinoni,nyamabuye,nyarusange,rongi,Rugendabari,Shyogwe	20,947	103	357	160	
Kamonyi	Gacurabwenge,Karama,Kayenzi,Kayumbu,Mugina,Musambira,Ngamba,Nyamiyaga,Nyarubaka,Rugarika,Rukoma,Runda	32,570	136.7	727.1	231	
Bugesera	Gashora,Juru,Mareba,Mayange,Musenyi,Mwogo,Ntarama,Nyamata,Rilima,Ruhuha	19,866	170.8	400	74	EIB
Gatsibo	Gatsibo,Gitoki,Kabarore,Kageyo,Kiramuruzi,Kiziguro,Muhura,Murambi,Nyagihanga,Remera,Rugarama,Rwimbogo	22,021	120	543	87	
Kayonza	Gahini,Kabare,Kabarondo,Mukarange,Murama,Murundi,Mwiri,Ndego,Nyamirama,Rukara,Ruramira,Rwinkwavu	20,256	113	440.2	90	
Kirehe	Gahara,Gatore,Kigarama,kagina,Kirehe,mahama,Mpanga,Musaza,Mushikiri,Nasho,Nyamugari,Nyarubuye	16,375	102	163	84	

Ngoma	Gashanda,Jarama,Kazo,Kibungo,Mu gesera,Murama,Mutenderi,Remera,R ukira,Rukumberi,Rurenge,Sake,Zaza	13,734	123	320	95	
Nyagatare	Gatunda,Karama,karangazi,Kiyombe, Matimba,Mimuri,Mukama,Musheri, Nyagatare,Rukomo,Rwempasha,Rwi miyaga,tabagwe	14,754	126	242.5	67	
Rwamagana	Fumbwe,Gahengeri,Gishali,karenge, Kigabiro,Muhazi,Munyaga,Munyigin ya,Musha,Muyumbu,Mwulire,Nyakal iro,Nzige,Rubona	12,205	132	296	107	
Ngororero	Bwira,Gatumba,Hindiro,Kabaya,kage yo,kavumu,Matyazo,Muhanda,Muhor oro,Ndaro,Nyange,Sovu	22,052	180	604	244	WB
Nyabihu	Mukamira,Jenda,Bigogwe,Kabatwa, Kintobo,Rugera,Rurembo,Shyira,Jom ba,Muringa,Rambura,Karago	26,923	164	384	148	
Rubavu	Bugeshi,Busasamana,Cyanzarwe,Gis enyi,Kanama,Kanzenze,Mudende,Ny akiriba,Nyamyumba,Nyundo,Rubavu ,Rugerero	17,228	136	245	66	
Gicumbi	Bukure;Bwisige;Byumba;Cyumba;Gi ti;Kageyo;Manyagiyo;Miyove;Mukar ange;Muko;Mutete;Nyamiyaga;Nyan kenke;Rubaya;Rukomo;RushakiRutar e;Ruvune;Rwamiko;Shangasha	15,225	155.5	245.9	81	

Musanze	Busogo;Cyuve;Gacaca;Gashaki;Gataraga;Kimonyi;Kinigi;Muhoza;Musanze; Muko, Nkotsi;Nyange;Remera;Rwaza;Shingiro	17,090	151.1	236.0	128	
Rulindo	Base; BushokiBuyoga;Cyinzuzi;Cyungo;Kinihira;Kisaro;Masoro;Mbogo;Murambi;Ngoma;Ntarabana;Rukozo;Rusiga Shyorongi;Tumba	11,361	124.2	375.4	69	
Burera	Bungwe; Butaro;Cyanika;Cyeru;Gahunga;Gatebe;Gitovu;Kagogo;Kinoni;Kinyababa;Kivuye;Nemba;Rugarama;Rugengabari;Ruhunde;Rusarabuye;Rwerere	17,171	146.7	283.0	144	
Karongi	Bwishyura,Gishyita,Gitesi,Mubuga,Murambi,Murundi,Mutuntu,Rubengera,Rugabano,Rwankuba,Twumba	28,885	207.0	407.2	118	AFD
Rusizi	Bugarama,Butare,Bweyeye,gashonga,Giheke,Gihundwe,Gikundamvura,Gitambi,Kamembe,Mururu,Nkanka,Nkombo,Nkungu,Nyakarenzo,Nzahaha,Rwimbogo	28,939	357.0	260.6	69	
Rutsiro	Boneza,Gihango,Kigeyo,Kivumu,Manihira,Mukura,murunda,Musasa,Mushonyi,Mushubati,Nyabirasi,Ruhango,Rusebeya	31,958	287	344	77	
Nyamasheke	Bushekeri,Gihombo,Karengera,Kirimbi,Macuba,Nyabitekera,Shangi	26,145	342.3	703.6	211	

TOTAL		498,386	3,919.9	9,265.3	3,065	
TOTAL COST	361,701,635USD					

V. DISTRIBUTION NETWORK STRENGTHENING PROJECTS - INVESTMENT PROPOSAL

Following the above-mentioned contingency plans targeted to improve the power quality, reduce losses, and improve reliability indices of Rwandan grid, an investment proposal is developed.

The investment plan has been confined to power supply sources, MV lines, DTs, switching and control equipment. The proposed (2023-2030) investment plan and synced with the system studies carried out based on the priority parameters as illustrated in the table below.

Table 41: The proposed (2023-2030) investment plan and synced with the system studies carried out based on the priority parameters

S/N	Component	Required Budget (MUSD)	Committed Budget (MUSD)	Budget Gap (MUSD)
1	Connection of Nyabarongo 1 substation to the distribution network	4,298,352.00	4,298,352.00	-
2	Introduction of DMS & GIS Mapping	30,000,000.00	30,000,000.00	-
3	Completing installation of smart metering for all distribution transformers and medium/large customers.	4,500,000.00	4,500,000.00	-
4	Upgrade of Kalisimbi Network from 6.6kV line to 30kV	2,000,000.00	2,000,000.00	-
5	Installation of MV switching substations, upgrade of existing cabins and construction of medium voltage line in secondary cities of Rwanda	17,749,179.00	17,749,179.00	-

6	Improvement of Voltage drop issues	54,045,073.92	29,046,006.89	24,999,067.03
7	Upgrade of Single phase-Country wide	33,379,887.29	22,050,208.00	11,329,679.29
8	Rehabilitation of LV Underground-(Kigali & Secondary Cities)	32,042,536.84	15,000,000.00	17,042,536.84
9	Construction of Switching cabins in Kigali and other districts	28,954,076.02	10,154,076.02	18,800,000.00
10	Improvement of existing Radial network to meshed distribution networks (loop ties-MV lines)	20,571,692.30	12,071,692.30	8,500,000.00
11	Rehabilitation and upgrade of low voltage network (Musanze, Huye and Rubavu)	6,500,000.00	-	6,500,000.00
12	Construction of new 30kV feeders from Ongoing and planned Substations (gicumbi, huye, Muhanga, kirehe, bugesera IP, Rubavu, and Shango)	1,643,720.00	-	1,643,720.00
13	Upgrade of MV Feeders (reconductoring)	7,248,800.00	-	7,248,800.00
14	Installation of Cut-out and Surge arrestors combinations to Improve protection of distribution transformers	6,500,000.00	-	6,500,000.00
15	30/15kV, 5MVA substation at Shyorongi and Upgrade MV lines	2,500,000.00	-	
16	Construction of smart MV switching cabin in Masaka	2,000,000.00	-	
17	Construction of MV feeder D/C dedicated to Nzove Industrial Park	300,000.00	-	

18	Reconductoring of UTEXRWA feeder from Jabana (70 to 120sqmm) Jabana ss to Utexrwa cabin	900,000.00	-	
19	Upgrade of Kigali Feeder from Jabana S/S	1,100,000.00	-	
20	Construction of new MV swiching Cabin near CMU&ALU, 6.5km 15kV line from Gasogi SS and 2.8km UG 15kV line from Ndera SS	3,800,000.00	-	
21	Rehabilitation of Mashyuza substation	3,000,000.00	-	3,000,000.00
22	Rehabilitation of Poids lourds substation (30/15kV transformer 6MVA and associated MV switchgear	3,000,000.00		3,000,000.00
23	Overhead to Underground Network in Kigali Developed Urban Areas (Kicukiro, kibagabaga, kacyiru, Masaka, gisozi, etc)	53,816,037.13	-	53,816,037.13
24	Retrofitting fiber optic on already constructed MV lines	35,832,528.00	-	35,832,528.00
	TOTAL	355,681,882.51	146,869,514.21	208,812,368.30

VI. MOVING FROM OVERHEAD NETWORK TO UNDERGROUND IN DEVELOPED AREAS OF KIGALI CITY

Apart from Kiyovu, Kacyiru, Kimihurura and Gacurilo developed areas that were previously selected and considered under RUEAP (only LV voltage network, others developed areas have been selected to be included in the distribution network master plan;

The selected areas/zones are:

- Kibagabaga I &II
- Kimironko near former Prison

- Bibare_Kimironko
- Kicukiro Niboyi
- Gisozi near Fawe
- Nyarugunga-Kanombe
- Nyamirambo
- Masaka



Moving from overheard to Underground_in developed areas of Kigali city_ Estimated budget

ZONES		MV_UG (km)	LV_UG (km)	Cabin (RMU)	LV DBs	Services Connection	Total (USD)
I.	KICUKIRO_Niboyi	7.95	48.15	8	169	1,348	9,707,376
II.	GISOZI_near Fawe	2.97	14.1	4	49	395	3,048,065
III.	KIBAGABAGA I	2.07	16.35	2	57	458	3,166,815
IV.	KIBAGABAGA II	6.3	27.3	4	96	764	5,668,469
V.	KIMIRONKO_Bibare	2.52	24.6	5	86	689	4,853,759
VI.	KIMIRONKO_near prison	2.76	16.65	3	58	466	3,376,524
VII.	MASAKA	0.822	11.4	2	40	319	2,184,250
VIII.	NYAMIRAMBO	1.65	10.2	4	36	286	2,235,031
IX.	KANOMBE_Nyarugunga	0.72	8.85	2	31	248	1,740,555
TOTAL		27.76	177.6	34	622	4,973	35,980,844

VII. DISTRIBUTION PROJECTS WITH FUNDS

Table 42: Distribution projects with Funds

SN	Project Name	Project Scope	Project Objective	Estimated Budget (USD)	Financier	Status	Anticipated completion
2a	Distribution Projects (Funded)						
1	Connection of Nyabarongo 1 substation to the distribution network	Installation of 110/30kV, 20MVA transformer and a feeder from Nyabarongo 1 substation and load transfer from Gatumba and Ngororero feeders to the new feeders from Nyabarongo 1	Shorten MV feeders (Gatumba & Ngororero) and alternative supply of power in the area	GoR		Ongoing	Sep-23
2	Completing installation of smart metering for all distribution transformers and medium/large customers.	Installation of smart meters on all Distribution transformers	Provide means to further measure the energy dispatched and billed	4,500,000	RUEAP/WB	Under Procurement	Dec-24
3	Construction of MV Switching cabins, construction, and upgrade of medium and low voltage (Overhead & Underground) lines in Kigali	Construction of 10 switching cabins, 40.21km of MV (U.G & O.H), 37.9km of LV Underground in Kacyiru and Kimihurura area	Increased efficiency of the supplied energy	22,225,768	RUEAP/EIB	Under Procurement	Dec-25

4	Renovation of Low voltage underground cables & MV/LV cabins in Nyarugenge	Rehabilitation of 44.1km of LV Underground and 17 MV/LV cabins in Nyarugenge	Increased efficiency and reliability in the area supplied	15,000,000	RUEAP/AFDB	Under Procurement	Dec-24
5	Upgrade of operating voltage i.e. 6.6kV line to 30kV	Upgrade of Kalisimbi Network from 6.6kV line to 30kV i.e. three existing substations with construction of 6.92km of MV underground	Increased efficiency and reliability in the area supplied	2,000,000	RUEAP/AFDB	Under Procurement	Jun-25
SN	Project Name	Project Scope	Project Objective	Estimated Budget (USD)	Financier	Status	Anticipated completion
2a	Distribution Projects (Funded)						
6	Installation of MV switching substations, upgrade of existing cabins and construction of medium voltage line in secondary cities of Rwanda	Construction of 15 new 30kV switching substations located in the different secondary cities of Rwanda i.e. in Rusizi (3), Musanze (1), Rubavu (2), Bugesera (1), Huye (3), Muhanga (2), Nyagatare (2), rehabilitation of 3 existing cabins in Rusizi and construction of associated MV lines (overhead and Underground)	Increased efficiency and reliability in the area supplied	17,749,179	RUEAP/AFDB	Under Procurement	Jun-25
7	Refurbishment of Distribution Network (in areas with voltage drop issues)	Refurbishment of 383km of MV lines and 1720km of LV lines	Increased efficiency and reliability in the area supplied	29,046,007	RUEAP/AFDB	Under Procurement	Jun-25
8	Upgrade of Single to three phase network-Countrywide	Upgrade of 395.5km of MV lines, 1189.3km of LV and replacement of 922 transformers in the entire network	Increased efficiency of the supplied energy	22,050,208	RUEAP/AFDB	Under Procurement	Dec-25

9	Advanced Distribution Management System	Equip both NCC and DNCC Control rooms with SCADA/EMS/GIS and SCADA/ADMS/GIS Platforms respectively main and backup sites, Installation of Feeder automation Devices (Auto-Reclosers, Automatic Load break switches, Fault detectors and associated RTUs & associated telecom equipment	Improve reliability and safety through better visualization of distribution networks status and use of switching plan tools	30,000,000	RUEAP/AFDB	Under Procurement	Dec-25
TOTAL				146,869,514			

VIII. PROJECTS UNDER FUNDS MOBILIZATION

Table 43: Projects under Funds Mobilization

SN	Project Name	Project Scope	Project Objective	Estimated Budget (USD)	Possible Financier (s)	Status	Anticipated completion
2b	Distribution Projects (Un-Funded)						
1	Rehabilitation and upgrade of low voltage network (Musanze, Huye and Rubavu)	Rehabilitation and Upgrade of 50km, 0.4kV Overhead Distribution Lines in Musanze Town	Increased efficiency and reliability in the area supplied	2,500,000	JICA/Indian Exim	Proposal submitted	TBD. Conditional to availability of funds of funds
		Rehabilitation and Upgrade of 30km, 0.4kV Overhead Distribution Lines in Huye Town		1,500,000		Proposal submitted	TBD. Conditional to availability of funds of funds
		Rehabilitation and Upgrade of 50km, 0.4kV Overhead Distribution Lines in Rubavu Town		2,500,000		Proposal submitted	TBD. Conditional to availability of funds of funds

2	Construction of 30/15kV Substations and associated feeders connections to limit extension of 15kV network	Construction of three 30/15kV Substations and associated feeders connections at Nyagatovu (Rwamagana), Karumuna (Bugesera), Ruyenzi (Kamuhanda), Shyrongi (Rulindo) and Ruyenzi (Kamonyi) to create redundancy supply between the 30kV and 15kV network	Increased efficiency and reliability in the area supplied	12,500,000	JICA/Indian Exim	Proposal submitted	TBD
SN	Project Name	Project Scope	Project Objective	Estimated Budget (USD)	Financier	Status	Anticipated completion
2b	Distribution Projects (Un-Funded)						
3	Construction of MV Switching Cabins in districts where switching is taking place on poles (Nyabihu, Rubavu, Bugesera, Nyamasheke & Kigali)	Construction of new MV Switching Cabins in districts where switching is taking place on poles (Nyabihu, Rubavu, Bugesera, Nyamasheke & Kigali)	Increased efficiency and reliability in the area supplied	6,300,000	JICA/Indian Exim	Proposal submitted	TBD

4	Upgrading existing feeders	139.4km of different MV lines constructed with 35sqmm cable size will be upgraded to 70sqmm or 120 sqmm i.e. (20km on Kibuye feeder, 35.4km on Rukarara feeder in Nyaruguru district, 29.1 on Rukarara feeder in Gisagara and Huye Districts, 54.9km in Gakenke district.	Increased efficiency and reliability in the area supplied	7,248,800	JICA/Indian Exim	Proposal submitted	TBD
5	Construction of new MV line loop ties/links to improve on the existing Radial Network-Upcountry	Construction of new MV line loop ties/links to improve on the existing Radial Network-Upcountry	Increased efficiency and reliability in the area supplied	8,500,000	Korea Exim Bank/Indian Exim	Proposal submitted	TBD
6	Construction of new 30kV feeders from Ongoing and planned Substations	Construction of new 30kV feeders i.e. 2.5km from Ongoing Gisagara substation, 2km from planned Gicumbi Substation, 5.5km from planned Huye substation, 3km from planned Muhanga substation, 3km from planned Nyagatare substation, 6km from planned Kirehe substation	Increased efficiency and reliability in the area supplied	1,643,720	JICA/Indian Exim	Proposal submitted	TBD
SN	Project Name	Project Scope	Project Objective	Estimated Budget (USD)	Financier	Status	Anticipated completion
2b	Distribution Projects (Un-Funded)						
7	Installation of Cut-out and Surge arrestors combinations to Improve protection of distribution transformers	Installation of Cut-out and Surge arrestors combinations on distribution transformers	Improve protection of distribution transformers and reduce failure rate of transformers	6,500,000	Korea Exim Bank	Proposal submitted	TBD
	Total			195,212,368			

IX. CONCLUSIONS AND RECOMMENDATIONS

Based on the inputs from the REG branches and Hubs, validated data, assessment of the existing distribution network, and the reliability analysis, recommendations are made for system modifications and improvements. Costs associated with each recommendation and presented in several phases so that work may continue at a pace that is determined by fund availability to execute the work.

An attempt was made to prioritize the project proposed; however, there will undoubtedly be adjustments in the order and priority by which the investments will be implemented.

Although the development plan entails the identification of system deficiencies and reinforcement required, for automation and smart operation of the distribution network, there is need to heavily invest in smart grid infrastructure development with functionalities.

Besides the proposed required interventions in distribution network, below are additional recommendations:

- To perform network re-configuration especially in Kigali network to ensure optimal utilization of power transformers at Substations.
- As the distribution of electricity is more through LV than through MV & HV. Therefore, it is important to carry out system studies for LV networks t. This was not done due to time constraints and the non-available of required LV data. Therefore, Once the entire distribution network will be captured in the GIS the system studies will be carried out including the LV network in near future.
- To always include the scope of construction of MV feeders/lines to link the substation to the existing MV network in the scope of new HV substations.
- Consistence update of network data/information in GIS and customer mapping,
- Planning Engineers to be trained at advanced level in power system studies tools (software); Power factory, PSSE, etc
- Keep doing network zoning quarterly and update DMP once a year (by End of June)
- To revise investment plan to align investment with criticality of required interventions.
- ACSR 120/20 as minimum conductor size for overhead MV lines and 1x120 UG cable in Kigali

- To strengthen distribution network (upgrade old assets and reconductoring of conductors/cables)
- To deeply re-assess the proposal of moving from overhead to underground of electricity facilities/ infrastructure.
- Keep investing in smart grids (intelligent switching devices, monitoring and control solutions/technologies, etc)