



## Rwanda Electricity Sector Access Programme

March 2009

**Volume II: Technical  
Annex**







# **Rwanda Electricity Sector Access Programme**

## **Volume II: Technical Annex**

**March 2009**



# Table of Contents

<b>1</b>	<b>Least Cost Technology Selection Model</b>	<b>5</b>
1.1	Least Cost Technology Selection Model Assumptions	5
1.2	Least Cost Technology Selection Model Results	8
<b>2</b>	<b>Details and Results of Geospatial Database</b>	<b>10</b>
2.1	Overview of Geospatial Database	10
2.2	Results of Geospatial Prioritisation	15
2.3	Potential Micro-hydro Developments	27
<b>3</b>	<b>Cost Estimates for Programme Components</b>	<b>29</b>
<b>4</b>	<b>Electricity Sector Operations and Financing Model</b>	<b>30</b>
4.1	Sector Operating and Financing Model Assumptions	30
4.2	Results from Sector Operations and Financing Model	34

## Tables

<b>Table 1.1: Generation Assumptions in Technology Selection Model</b>	<b>5</b>
<b>Table 1.2: Cost Assumptions for Diesel Mini-grid Electrification</b>	<b>6</b>
<b>Table 1.3: Cost Assumptions for Micro-hydro Mini-grid Electrification</b>	<b>6</b>
<b>Table 1.4: Cost Assumptions for Household Solar PV Electrification</b>	<b>7</b>
<b>Table 1.5: Technology Sizing and Costs</b>	<b>8</b>
<b>Table 1.6: Least Cost Off-grid Option and Evaluation Relative to Grid Electrification</b>	<b>9</b>
<b>Table 2.1: Planning Cell Characteristics—Area, Population, Density and Connections Backlog</b>	<b>10</b>
<b>Table 2.2: Presence of Social Institutions in Planning Cells</b>	<b>11</b>
<b>Table 2.3: Grid Prioritisation Scoring Summary</b>	<b>12</b>
<b>Table 2.4: Economic Characteristics—Settlement Classification, Electricity Take-up Rates, and Least-cost Technology</b>	<b>13</b>
<b>Table 2.5: Physical Characteristics—Distance to Nearest Cell, Presence of Micro-hydro Resource and MV Per Connction</b>	<b>14</b>
<b>Table 2.6: Summary of New Grid Connections by Sector and Type (2009–2013)</b>	<b>15</b>
<b>Table 2.6: Micro-hydro Sites Identified for Potential Development to 2013</b>	<b>27</b>

Table 2.7: Connection Decision for Priotised Micro-hydro Sites	28
Table 3.1: Targeted Cost Efficiencies to 2012 and 2020 (MV Line, MV/LV Transformers, LV Line and Service Connections)	29
Table 4.1: Macroeconomic Assumptions	30
Table 4.2: System Operating Assumptions	31
Table 4.3: Operating Cost Assumptions	32
Table 4.4: Technical Assistance Assumptions	33
Table 4.5: Projected Demand (2009-2013)	34
Table 4.6: Projected Generation (Existing and New Connections) (2009-2012)	36
Table 4.7: Electricity Sector Operating Cash Flows (2009-2013)	39
Table 4.9: Projected Technical Assistance for Access Programme (2009-2013)	43
Table 4.10: Electricity Access Programme Connections and Costs (2009-2012)	45
Table 4.11: Electricity Access Programme Connections and Costs (2009-2020)	46
Table 4.12: Summary of Sector Funding Needs and Sources (USD million)	48
Table 4.13: Summary of Sector Funding Needs and Sources (RWF million)	49
Table 4.14: Analysis of Economic Costs and Benefits of Access Programme (2009-2020)	50
Table 4.14: Parameters from Analysis of Economic Costs and Benefits of Access Programme	51

# 1 Least Cost Technology Selection Model

## 1.1 Least Cost Technology Selection Model Assumptions

This section presents the assumptions and results of the least cost technology selection model used in planning the electricity access programme.

**Table 1.1: Generation Assumptions in Technology Selection Model**

<b>General Data and Common Assumptions</b>		
Exchange Rate	RWF/USD	<b>550</b>
Discount Rate	Percent	10.0%
Population Growth Rate	Percent p.a.	2.40%
Ave no. of people per HH	ppl / HH	5
Average ElecTariff (including VAT) (RWF)	RWF/kWh	<b>132</b>
Average ElecTariff (USD)	US\$/kWh	0.240
Annual billing cost/conn	US\$/conn	24
Saturation ADMD (After Diversity Maximun Demand)		
Urban	kVA/conn	1.0
Peri-Urban	kVA/conn	0.8
Rural	kVA/conn	0.6
Deep Rural	kVA/conn	0.4
Load Factor	LF	0.50
Power Factor	PF	0.99

**Table 1.2: Cost Assumptions for Diesel Mini-grid Electrification**

**General Data and Common Assumptions - Diesel mini-grid**

Assumed engine lifespan 5 years

**DG costing assumptions**

	DG Code	DG units					
		DG250	DG100	DG80	DG60	DG40	DG20
	DG size [kVA]	250	100	80	60	40	20
Cost of Diesel engine/generator	US\$/kVA	1,000	1,000	1,100	1,100	1,200	1,200
Installation costs (initial)	%	25%	25%	20%	20%	18%	18%
Refurbishment costs	%	30%	30%	30%	30%	30%	30%
Civil works	%	10%	10%	9%	9%	8%	8%
Fuel tank	US\$	2,000	2,000	1,800	1,800	1,500	1,500
<b>Capital investment cost</b>							
Initial DG installed cost	US\$	<b>339,500</b>	<b>137,000</b>	<b>115,320</b>	<b>86,940</b>	<b>61,980</b>	<b>31,740</b>
Refurbishment DG capital cost	US\$	<b>101,850</b>	<b>41,100</b>	<b>34,596</b>	<b>26,082</b>	<b>18,594</b>	<b>9,522</b>
Fuel consumption	liters/kWh	0.55	0.55	0.50	0.50	0.45	0.40
Annual recurrent DG Maint costs	%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

**Mini-grid costing assumptions**

Mini-grid costs as % of "Grid"	%	85%	75%	70%	65%	55%	50%
Annual recurrent costs (O&M LV lines)	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Mini-grid tech losses (Dx)	%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%

**Fuel costing assumptions**

<b>Diesel Price (Kigali)</b>	756	RWF/liter	1.37	UD\$/liter	
		Diesel Cost Zone	Zone Increment	Diesel Price [RWF]	Diesel Price [USD]
Zone 1: Kigali +25km		Zone 1	0%	756	1.37
Zone 2: 25 to 85km		Zone 2	5%	794	1.44
Zone 3: 85 to 145km		Zone 3	10%	832	1.51

**Table 1.3: Cost Assumptions for Micro-hydro Mini-grid Electrification**

**General Data and Common Assumptions - MCH mini-grid**

Assumed Lifespan 20 years

**MCH costing assumptions**

	MCH Code	MCH units				
		MCH250	MCH100	MCH50	MCH25	MCH5
	MCH size [kVA]	250	100	50	25	5
Cost of Microhydro engine/generator Incl. civils, etc)	US\$/kVA	2,500	2,500	2,750	3,000	3,250
<b>Capital investment cost</b>						
Initial MCH installed cost	US\$	<b>625,000</b>	<b>250,000</b>	<b>137,500</b>	<b>75,000</b>	<b>16,250</b>
Annual recurrent MCH Maint costs	%	2.5%	2.5%	2.5%	2.5%	2.5%

**Mini-grid costing assumptions**

Mini-grid costs as % of "Grid"	%	85%	75%	65%	55%	55%
Annual recurrent costs (O&M LV lines)	%	2.0%	2.0%	2.0%	2.0%	2.0%
Mini-grid tech losses (Dx)	%	3.0%	3.0%	3.0%	3.0%	3.0%



**Table 1.4: Cost Assumptions for Household Solar PV Electrification**

**General Data and Common Assumptions - SolarPV**

Assumed Lifespan - Panel	years	20
Assumed Lifespan - Battery	years	3
Assumed Lifespan - Other equipment	years	10

**SolarPV costing assumptions**

		SolarPVunits				
		SolarPV Code	SPV1	SPV0.4	SPV0.2	SPV0.1
Panel size [kVA]		1	0.4	0.2	0.1	0.05
Cost of Panel	US\$	7,000	3,500	3,000	2,350	1,750
Cost of Battery	US\$	3,500	1,750	880	600	180
Cost of Other Equipment (regulators, lamps, accessorie:	US\$	3,500	1,750	880	600	180
<b>Capital investment cost</b>						
Initial Solar PV installed cost	US\$	<b>14,000</b>	<b>7,000</b>	<b>4,760</b>	<b>3,550</b>	<b>2,110</b>
Battery Replacement (every 3 years)	US\$	<b>3,500</b>	<b>1,750</b>	<b>880</b>	<b>600</b>	<b>180</b>
Annual recurrent MCH Maint costs	%	5.0%	5.0%	5.0%	5.0%	5.0%
Load Lost Through Intermittency	%	15%	15%	15%	15%	15%

## 1.2 Least Cost Technology Selection Model Results

This section of the Technical Annex presents the results of the technology selection model. The tables below show results for 20 planning cells out of over 9,000 cells evaluated in the model. The results include the technology choices evaluated, the cost of each option, the least cost off-grid technology, the present value of grid connection, the maximum length of economic MV line, the distance to nearest cell, and the least-cost electrification option select in each cell.

**Table 1.5: Technology Sizing and Costs**

Cell ID UNIQUEID	Technology Choices Evaluated				PV Cost per Technology [USD]				Cost / connection			
	MV/LV Grid	DG	MCH	SolarPV	MV/LV Grid	DG	MCH	SolarPV	MV/LV Grid	DG	MCH	SolarPV
1 CZ9252	GRID	DG20	MCH25	SPV0.1	52,689	128,866	108,236	119,517	1,882	4,602	3,866	4,268
2 CZ9253	GRID				516,172				584			
3 CZ9254	GRID				556,616				584			
4 CZ9255	GRID	DG40	MCH50	SPV0.1	232,303	631,881	303,857	744,766	1,320	3,590	1,726	4,232
5 CZ9256	GRID	DG40	MCH50	SPV0.1	212,364	584,650	290,045	680,820	1,319	3,631	1,802	4,229
6 CZ9257	GRID	DG20	MCH25	SPV0.1	109,904	275,879	143,876	352,513	1,324	3,324	1,733	4,247
7 CZ9258	GRID	DG80	MCH100		441,899	1,346,485	607,150		1,319	4,019	1,812	
8 CZ9259	GRID	DG20	MCH25	SPV0.1	39,691	263,849	105,567	272,603	630	4,188	1,676	4,327
9 CZ9260	GRID	DG40	MCH25	SPV0.1	42,668	348,618	107,618	292,832	627	5,127	1,583	4,306
10 CZ9261	GRID	DG40	MCH50	SPV0.1	82,565	598,272	208,039	566,804	630	4,567	1,588	4,327
11 CZ9262	GRID				873,790				1,322			
12 CZ9263	GRID	DG60	MCH100		385,744	1,139,855	563,051		1,321	3,904	1,928	
13 CZ9264	GRID	DG20	MCH25	SPV0.1	57,033	163,829	112,188	182,944	1,326	3,810	2,609	4,255
14 CZ9265	GRID	DG40	MCH50	SPV0.1	240,725	652,406	309,705	772,117	1,323	3,585	1,702	4,242
15 CZ9266	GRID	DG20	MCH25	SPV0.1	35,483	117,612	99,258	113,647	1,314	4,356	3,676	4,209
16 CZ9267	GRID	DG20	MCH25	SPV0.1	45,188	138,662	105,091	145,124	1,329	4,078	3,091	4,268
17 CZ9268	GRID	DG40	MCH50	SPV0.1	188,669	528,765	273,640	604,754	1,319	3,698	1,914	4,229
18 CZ9269	GRID				1,687,646				1,322			
19 CZ9270	GRID	DG40	MCH50	SPV0.1	184,818	519,749	270,977	592,552	1,320	3,712	1,936	4,233
20 CZ9271	GRID	DG20	MCH25	SPV0.1	118,997	295,031	149,320	381,627	1,322	3,278	1,659	4,240

Table 1.6: Least Cost Off-grid Option and Evaluation Relative to Grid Electrification

		Least Cost non-Grid Technology	Equiv MVmax	Distance to nearest Cell	Grid compatible?	Least Cost Technology
	Cell ID UNIQUEID		m	m	Y / N	
1	CZ9252	SolarPV	2016	716	Y	Grid
2	CZ9253				Y	
3	CZ9254				Y	
4	CZ9255	DG	7625	2,228	Y	
5	CZ9256	DG	7226	2,781	Y	
6	CZ9257	DG	2953	1,540	Y	
7	CZ9258	DG	17515	3,539	Y	
8	CZ9259	DG	6226	1,152	Y	
9	CZ9260	SolarPV	7754	1,152	Y	
10	CZ9261	SolarPV	15002	1,102	Y	
11	CZ9262				Y	
12	CZ9263	DG	14647	2,708	Y	
13	CZ9264	DG	2282	1,597	Y	
14	CZ9265	DG	7811	1,851	Y	
15	CZ9266	SolarPV	2450	1,597	Y	
16	CZ9267	DG	2130	1,651	Y	
17	CZ9268	DG	6759	1,683	Y	
18	CZ9269				Y	
19	CZ9270	DG	6685	1,683	Y	
20	CZ9271	DG	3064	1,974	Y	

## 2 Details and Results of Geospatial Database

### 2.1 Overview of Geospatial Database

This section provides an overview of the information contained in the geospatial database established for the access programme. The tables below provide data on the first 20 records out of the total of over 9,000 sublocations defined in the geospatial model. The full database is available on compact disc upon request.

**Table 2.1: Planning Cell Characteristics—Area, Population, Density and Connections Backlog**

UNIQUEID	Region	District	Sector	Cell Area	Population	Pop Density	#H/H's	H/H density	Existing Conns	BACKLOG
CZ697	East	BUGESERA	Gashora	199725	38	190	8	38	0	8
CZ713	East	BUGESERA	Rweru	775472	95	123	19	25	0	19
CZ1207	East	BUGESERA	Kamabuye	839184	126	150	25	30	0	25
CZ673	East	BUGESERA	Rilima	444109	135	304	27	61	0	27
CZ615	East	BUGESERA	Ntarama	1970890	233	118	47	24	11	36
CZ698	East	BUGESERA	Gashora	762628	144	189	29	38	0	29
CZ606	East	BUGESERA	Ntarama	1574642	186	118	37	24	0	37
CZ609	East	BUGESERA	Ntarama	1545682	183	118	37	24	0	37
CZ634	East	BUGESERA	Ntarama	2466942	292	118	58	24	14	44
CZ642	East	BUGESERA	Ntarama	1970908	233	118	47	24	0	47
CZ1212	East	BUGESERA	Kamabuye	1372700	206	150	41	30	0	41
CZ1205	East	BUGESERA	Kamabuye	1435542	216	150	43	30	0	43
CZ623	East	BUGESERA	Ntarama	2968014	351	118	70	24	16	54
CZ1008	East	BUGESERA	Musenyi	881773	273	310	55	62	0	55
CZ992	East	BUGESERA	Ntarama	2358645	279	118	56	24	0	56
CZ1213	East	BUGESERA	Kamabuye	1499413	226	151	45	30	0	45
CZ658	East	BUGESERA	Ntarama	2430474	287	118	57	24	0	57
CZ1202	East	BUGESERA	Kamabuye	1573642	237	151	47	30	0	47
CZ640	East	BUGESERA	Juru	957419	244	255	49	51	0	49
CZ1175	East	BUGESERA	Kamabuye	1637849	246	150	49	30	0	49

**Table 2.2: Presence of Social Institutions in Planning Cells**

UNIQUEID	Region	District	UNELHEALTH	UNELSCHOOL	UNELADMIN	NGHEALTH	NGSCHOOLS	NGADMIN
CZ697	East	BUGESERA	0	0	0	0	0	0
CZ713	East	BUGESERA	0	1	0	0	0	0
CZ1207	East	BUGESERA	0	0	0	0	0	0
CZ673	East	BUGESERA	0	0	0	0	0	0
CZ615	East	BUGESERA	0	0	0	0	0	0
CZ698	East	BUGESERA	0	0	0	0	0	1
CZ606	East	BUGESERA	0	0	0	0	0	0
CZ609	East	BUGESERA	0	0	0	0	0	0
CZ634	East	BUGESERA	0	1	0	0	0	1
CZ642	East	BUGESERA	0	0	0	0	0	0
CZ1212	East	BUGESERA	0	0	0	0	0	0
CZ1205	East	BUGESERA	0	1	0	0	0	0
CZ623	East	BUGESERA	0	0	0	0	0	0
CZ1008	East	BUGESERA	0	0	0	0	0	0
CZ992	East	BUGESERA	0	0	0	0	0	0
CZ1213	East	BUGESERA	0	0	0	0	0	0
CZ658	East	BUGESERA	0	0	0	0	0	0
CZ1202	East	BUGESERA	0	0	0	0	0	0
CZ640	East	BUGESERA	0	0	0	0	0	0
CZ1175	East	BUGESERA	0	0	0	0	0	0

**Table 2.3: Grid Prioritisation Scoring Summary**

UNIQUEID	Region	District	DISTTONWK 50	DISTTOMCH	DISTMAINRD	DISTSECRD	POINTSSUM	SEQUENCE
CZ697	East	BUGESERA	5600	74074	5898	46	123	8260
CZ713	East	BUGESERA	11190	87539	14043	8348	94	9236
CZ1207	East	BUGESERA	8771	64416	1983	5323	131	7551
CZ673	East	BUGESERA	4119	68581	7872	259	131	7550
CZ615	East	BUGESERA	1230	49052	3613	3499	133	7311
CZ698	East	BUGESERA	5289	73748	5084	225	132	7354
CZ606	East	BUGESERA	3010	51875	684	3671	136	6902
CZ609	East	BUGESERA	3340	52997	437	4571	136	6903
CZ634	East	BUGESERA	2148	50213	2146	5994	136	6839
CZ642	East	BUGESERA	1701	55917	2270	5979	134	7120
CZ1212	East	BUGESERA	10289	64628	2080	5589	131	7552
CZ1205	East	BUGESERA	9174	64946	1505	5893	129	7765
CZ623	East	BUGESERA	2202	55097	2319	7009	134	7119
CZ1008	East	BUGESERA	6242	49603	6113	5409	124	8178
CZ992	East	BUGESERA	4819	50120	3921	5838	128	7864
CZ1213	East	BUGESERA	12263	66870	834	8106	127	7911
CZ658	East	BUGESERA	3194	51603	2263	5180	136	6905
CZ1202	East	BUGESERA	9067	65610	740	6535	128	7867
CZ640	East	BUGESERA	8193	66785	11994	3786	104	9098
CZ1175	East	BUGESERA	8967	66375	3243	5925	119	8514

**Table 2.4: Economic Characteristics—Settlement Classification, Electricity Take-up Rates, and Least-cost Technology**

UNIQUEID	Region	District	Category	TakeUp	PotConn	SatADMD	kVAEst	LCTECH
CZ697	East	BUGESERA	Deep Rural	43%	3	0.40	1	SolarPV
CZ713	East	BUGESERA	Deep Rural	43%	8	0.40	3	SolarPV
CZ1207	East	BUGESERA	Deep Rural	43%	11	0.40	3	Grid
CZ673	East	BUGESERA	Deep Rural	43%	12	0.40	3	Grid
CZ615	East	BUGESERA	Peri-Urban	35%	5	0.80	9	Grid
CZ698	East	BUGESERA	Deep Rural	43%	13	0.40	4	Grid
CZ606	East	BUGESERA	Peri-Urban	35%	13	0.80	10	Grid
CZ609	East	BUGESERA	Peri-Urban	35%	13	0.80	10	Grid
CZ634	East	BUGESERA	Peri-Urban	35%	6	0.80	11	Grid
CZ642	East	BUGESERA	Peri-Urban	35%	16	0.80	12	Grid
CZ1212	East	BUGESERA	Deep Rural	43%	18	0.40	5	Grid
CZ1205	East	BUGESERA	Deep Rural	43%	19	0.40	5	Grid
CZ623	East	BUGESERA	Peri-Urban	35%	8	0.80	13	Grid
CZ1008	East	BUGESERA	Peri-Urban	35%	19	0.80	14	Grid
CZ992	East	BUGESERA	Peri-Urban	35%	19	0.80	14	Grid
CZ1213	East	BUGESERA	Deep Rural	43%	19	0.40	6	Grid
CZ658	East	BUGESERA	Peri-Urban	35%	20	0.80	15	Grid
CZ1202	East	BUGESERA	Deep Rural	43%	20	0.40	6	Grid
CZ640	East	BUGESERA	Deep Rural	43%	21	0.40	6	Grid
CZ1175	East	BUGESERA	Deep Rural	43%	21	0.40	6	Grid

**Table 2.5: Physical Characteristics—Distance to Nearest Cell, Presence of Micro-hydro Resource and MV Per Connction**

UNIQUEID	Region	District	Dist to Nearest Cell	Existing GRID in cell	IDSITEMCH_50	DISTALLMCH 300	SUITABLE (for MCH)	MV PER CONN	# Conns (Backlog * Takeup)
CZ697	East	BUGESERA	816	No	NGA-21	42850	No	272	3
CZ713	East	BUGESERA	1944	No	ONG-13	50029	No	243	8
CZ1207	East	BUGESERA	676	No	SNR-41	36717	No	61	11
CZ673	East	BUGESERA	608	No	NGA-21	38876	No	51	12
CZ615	East	BUGESERA	1216	Yes	ONG-13	17848	No	243	12
CZ698	East	BUGESERA	816	No	ONG-13	42485	No	63	12
CZ606	East	BUGESERA	823	No	NGA-21	22176	No	63	13
CZ609	East	BUGESERA	1111	No	NGA-21	23136	No	85	13
CZ634	East	BUGESERA	1340	Yes	ONG-13	18851	No	223	15
CZ642	East	BUGESERA	1225	No	ONG-13	24568	No	77	16
CZ1212	East	BUGESERA	671	No	SNR-41	37399	No	37	18
CZ1205	East	BUGESERA	676	No	SNR-41	37350	No	36	19
CZ623	East	BUGESERA	1225	Yes	ONG-13	23782	No	153	19
CZ1008	East	BUGESERA	1239	No	ONG-13	18756	No	65	19
CZ992	East	BUGESERA	1222	No	ONG-13	18909	No	64	19
CZ1213	East	BUGESERA	1003	No	SNR-41	40088	No	53	20
CZ658	East	BUGESERA	1233	No	ONG-13	20317	No	62	20
CZ1202	East	BUGESERA	713	No	OKA-08	38029	No	36	21
CZ640	East	BUGESERA	529	No	NGA-21	39461	No	25	21
CZ1175	East	BUGESERA	1037	No	OKA-08	39491	No	49	21
CZ1203	East	BUGESERA	1341	No	SNR-41	39927	No	64	21



## 2.2 Results of Geospatial Prioritisation

Table 2.6 presents a summary of the geospatial planning of new grid connections by sector, separately identifying connections in areas where the grid will be extended (“greenfields connections”) and areas where there are existing MV networks (“brownfields connections”). The results presented in Table 2.6 are based on the least-cost roll-out of new connections, and will be modified to achieve the Government’s target of reaching all sectors with the national electricity network by 2012.

**Table 2.6: Summary of New Grid Connections by Sector and Type (2009–2013)**

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
BUGESERA	Gashora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Juru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Kamabuye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Mareba	0	0	0	0	0	0	0	0	0	40	0	0	0	0	40
BUGESERA	Mayange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Musenyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Mwogo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Ngeruka	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Ntarama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Nyamata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Nyarugenge	0	0	0	0	63	0	0	0	133	242	0	0	0	133	305
BUGESERA	Rilima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Ruhuha	0	0	0	0	336	0	0	0	111	89	0	0	0	111	425
BUGESERA	Rweru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUGESERA	Shyara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURERA	Bungwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURERA	Butaro	0	0	0	0	304	0	0	0	0	0	0	0	0	0	304
BURERA	Cyanika	0	677	350	332	217	317	395	108	137	168	317	1072	458	469	385
BURERA	Cyeru	0	0	0	95	0	0	0	59	79	234	0	0	59	174	234
BURERA	Gahunga	0	673	625	293	0	112	8	60	106	134	112	681	685	399	134
BURERA	Gatebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURERA	Gitovu	0	0	64	0	0	0	0	0	107	216	0	0	64	107	216
BURERA	Kagogo	0	160	225	226	0	0	416	169	72	93	0	576	394	298	93
BURERA	Kinoni	0	0	56	0	0	0	0	445	286	284	0	0	501	286	284
BURERA	Kinyababa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURERA	Kivuye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURERA	Nemba	0	0	0	82	0	0	0	0	40	9	0	0	0	122	9
BURERA	Rugarama	0	870	0	0	0	0	514	107	111	115	0	1384	107	111	115
BURERA	Rugengabari	0	178	0	0	0	492	313	76	79	81	492	491	76	79	81
BURERA	Ruhunde	0	0	0	49	332	0	0	0	0	4	0	0	0	49	336
BURERA	Rusarabuge	0	0	0	331	459	0	0	16	169	42	0	0	16	500	501
BURERA	Rwerere	0	0	0	0	0	0	0	0	0	39	0	0	0	0	39

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
GAKENKE	Busengo	0	0	0	0	197	0	0	0	0	0	0	0	0	0	197
GAKENKE	Coko	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Cyabingo	0	145	760	127	134	0	0	10	61	74	0	145	770	188	208
GAKENKE	Gakenke	0	0	0	616	483	0	0	0	244	56	0	0	0	860	539
GAKENKE	Gashenyi	0	0	0	91	609	0	0	0	197	18	0	0	0	288	627
GAKENKE	Gatonde	0	0	53	237	1376	0	0	0	4	20	0	0	53	241	1396
GAKENKE	Janja	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Kamubuga	0	0	332	375	357	0	259	89	153	76	0	259	421	528	433
GAKENKE	Karambo	0	65	79	66	355	0	0	5	11	15	0	65	84	77	370
GAKENKE	Kivuruga	0	0	236	381	771	0	0	0	15	41	0	0	236	396	812
GAKENKE	Mataba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Minazi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Muhondo	0	0	0	0	0	0	0	0	0	49	0	0	0	0	49
GAKENKE	Muyongwe	0	0	0	0	352	0	0	0	93	7	0	0	0	93	359
GAKENKE	Muzo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Nemba	0	302	164	0	0	0	464	104	70	266	0	766	268	70	266
GAKENKE	Ruli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GAKENKE	Rusasa	0	82	365	348	172	0	0	6	32	56	0	82	371	380	228
GAKENKE	Rushashi	0	0	0	0	42	0	0	0	0	0	0	0	0	0	42
GASABO	Bumbogo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GASABO	Gatsata	0	0	0	0	0	1646	94	98	100	105	1646	94	98	100	105
GASABO	Gikomero	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GASABO	Gisozi	248	0	0	0	0	743	56	58	60	62	991	56	58	60	62
GASABO	Jabana	0	219	384	0	0	0	1382	88	548	135	0	1601	472	548	135
GASABO	Jali	0	0	106	259	147	0	280	777	318	325	0	280	883	577	472
GASABO	Kacyiru	0	0	0	0	0	797	45	48	50	51	797	45	48	50	51
GASABO	Kimihurura	0	0	0	0	0	576	34	36	36	38	576	34	36	36	38
GASABO	Kimironko	0	0	0	0	0	596	35	37	38	38	596	35	37	38	38
GASABO	Kinyinya	0	0	0	0	0	601	526	63	66	70	601	526	63	66	70
GASABO	Ndera	0	0	0	226	0	0	0	713	41	52	0	0	713	267	52
GASABO	Nduba	0	0	0	0	125	0	0	0	69	93	0	0	0	69	218
GASABO	Remera	0	0	0	0	0	423	25	28	29	30	423	25	28	29	30
GASABO	Rusororo	0	0	149	670	466	0	0	792	52	88	0	0	941	722	554
GASABO	Rutunga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
GATSIBO	Gasange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Gatsibo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Gitoki	0	0	0	0	0	0	0	0	0	113	0	0	0	0	113
GATSIBO	Kabarore	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Kageyo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Kiramuruzi	0	0	0	0	159	0	0	0	103	924	0	0	0	103	1083
GATSIBO	Kiziguro	0	0	0	0	0	0	0	0	606	384	0	0	0	606	384
GATSIBO	Muhura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Murambi	0	0	0	0	0	0	0	0	92	6	0	0	0	92	6
GATSIBO	Ngarama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Nyagihanga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Remera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GATSIBO	Rugarama	0	0	0	0	185	0	0	0	470	477	0	0	0	470	662
GATSIBO	Rwimbogo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Bukure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Bwisige	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Byumba	0	127	770	0	0	0	692	72	128	134	0	819	842	128	134
GICUMBI	Cyumba	0	0	188	378	0	0	49	320	40	66	0	49	508	418	66
GICUMBI	Giti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Kageyo	0	0	298	260	134	0	58	139	152	162	0	58	437	412	296
GICUMBI	Kaniga	0	0	0	0	0	0	0	0	0	140	0	0	0	0	140
GICUMBI	Manyagiro	0	0	342	227	0	0	0	0	24	41	0	0	342	251	41
GICUMBI	Miyove	0	20	836	141	0	0	0	390	85	95	0	20	1226	226	95
GICUMBI	Mukarange	0	0	0	0	77	0	0	0	0	213	0	0	0	0	290
GICUMBI	Muko	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Mutete	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Nyamiyaga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Nyankenke	0	413	611	0	215	0	90	36	80	83	0	503	647	80	298
GICUMBI	Rubaya	0	0	133	101	80	0	0	83	16	24	0	0	216	117	104
GICUMBI	Rukomo	0	0	0	0	515	0	0	0	0	82	0	0	0	0	597
GICUMBI	Rushaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Rutare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Ruvune	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Rwamiko	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GICUMBI	Shangasha	0	0	58	0	189	0	0	0	129	14	0	0	58	129	203

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
GISAGARA	Gikonko	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Gishubi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Kansi	0	0	0	0	54	0	0	0	0	0	0	0	0	0	54
GISAGARA	Kibilizi	0	0	0	70	0	0	34	60	64	107	0	34	60	134	107
GISAGARA	Kigembe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Mamba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Muganza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Mugombwa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Mukindo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Musha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Ndora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Nyanza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GISAGARA	Save	0	0	212	0	139	0	135	97	41	42	0	135	309	41	181
HUYE	Gishamvu	0	0	0	0	0	0	0	0	70	90	0	0	0	70	90
HUYE	Huye	0	0	0	68	304	0	64	210	180	142	0	64	210	248	446
HUYE	Karama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUYE	Kigoma	0	0	0	0	132	0	0	0	51	186	0	0	0	51	318
HUYE	Kinazi	0	0	0	0	0	0	0	0	139	287	0	0	0	139	287
HUYE	Maraba	0	0	0	0	36	0	0	62	268	243	0	0	62	268	279
HUYE	Mbazi	0	218	90	0	234	0	769	82	90	90	0	987	172	90	324
HUYE	Mukura	0	0	265	886	141	0	0	0	21	86	0	0	265	907	227
HUYE	Ngoma	168	202	0	0	0	464	207	88	90	95	632	409	88	90	95
HUYE	Ruhashya	0	0	69	581	206	0	0	49	161	59	0	0	118	742	265
HUYE	Rusatira	0	0	77	0	99	0	0	86	541	312	0	0	163	541	411
HUYE	Rwaniro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUYE	Simbi	0	0	0	0	193	0	0	52	355	28	0	0	52	355	221
HUYE	Tumba	261	438	0	0	0	305	123	90	93	99	566	561	90	93	99
KAMONYI	Gacurabwenge	0	82	316	1060	254	0	0	5	26	91	0	82	321	1086	345
KAMONYI	Karama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAMONYI	Kayenzi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAMONYI	Kayumba	0	0	348	53	614	0	0	0	21	27	0	0	348	74	641
KAMONYI	Mugina	0	0	0	0	0	0	0	0	0	178	0	0	0	0	178
KAMONYI	Musambira	0	0	271	616	1212	0	0	0	18	57	0	0	271	634	1269
KAMONYI	Ngamba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAMONYI	Nyamiyaga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAMONYI	Nyarubaka	0	0	0	266	455	0	0	0	0	18	0	0	0	266	473
KAMONYI	Rugalika	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAMONYI	Rukoma	0	44	177	421	516	0	0	3	15	41	0	44	180	436	557
KAMONYI	Runda	0	130	844	382	154	0	39	79	122	106	0	169	923	504	260

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
KARONGI	Bwishyura	0	0	279	309	63	0	385	465	133	121	0	385	744	442	184
KARONGI	Gishari	0	0	0	0	0	0	0	0	29	0	0	0	0	0	29
KARONGI	Gishyita	0	0	0	0	59	0	0	0	336	486	0	0	0	336	545
KARONGI	Gitesi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARONGI	Mubuga	0	0	0	0	88	0	0	0	22	110	0	0	0	22	198
KARONGI	Murambi	0	0	0	0	223	0	0	35	163	386	0	0	35	163	609
KARONGI	Murundi	0	0	0	0	0	0	0	0	54	0	0	0	0	0	54
KARONGI	Mutuntu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARONGI	Rubengeru	0	32	949	676	89	0	76	388	109	159	0	108	1337	785	248
KARONGI	Rugabano	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARONGI	Ruganda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARONGI	Rwankuba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KARONGI	Twumba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Gahini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Kabare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Kabarondo	0	0	0	0	101	0	0	0	677	461	0	0	0	677	562
KAYONZA	Mukarange	0	0	0	0	80	0	0	65	261	542	0	0	65	261	622
KAYONZA	Murama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Murundi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Mwiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Ndego	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Nyamirama	0	0	0	0	0	0	0	0	711	586	0	0	0	711	586
KAYONZA	Rukara	0	0	0	0	0	0	0	0	413	419	0	0	0	413	419
KAYONZA	Ruramira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KAYONZA	Rwinkwavu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KICUKIRO	Gahanga	0	0	0	300	991	0	0	0	0	15	0	0	0	300	1006
KICUKIRO	Gatenga	0	0	0	0	0	574	1194	93	97	100	574	1194	93	97	100
KICUKIRO	Gikondo	0	0	0	0	0	671	38	39	42	43	671	38	39	42	43
KICUKIRO	Kanombe	0	774	1303	0	0	934	52	96	160	166	934	826	1399	160	166
KICUKIRO	Karama	0	0	0	0	0	459	27	28	28	31	459	27	28	28	31
KICUKIRO	Kicukiro	0	0	0	0	0	629	35	38	38	39	629	35	38	38	39
KICUKIRO	Kigarama	0	0	0	0	0	533	462	56	59	61	533	462	56	59	61
KICUKIRO	Masaka	0	0	0	212	0	0	0	633	34	48	0	0	633	246	48
KICUKIRO	Niboye	0	0	0	0	0	800	46	47	48	50	800	46	47	48	50
KICUKIRO	Nyarugunga	0	0	0	0	0	2234	121	126	130	135	2234	121	126	130	135

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
KIREHE	Gahara	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Gatore	0	0	0	265	402	0	0	0	0	17	0	0	0	265	419
KIREHE	Kigarama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Kigina	0	0	0	0	167	0	0	0	0	0	0	0	0	167	167
KIREHE	Kirehe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Mahama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Mpanga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Musaza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Mushikiri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Nasho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Nyamugali	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KIREHE	Nyarubuye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MUHANGA	Cyeza	0	111	984	1319	264	0	0	7	117	153	0	111	991	1436	417
MUHANGA	Kabacuzi	0	0	0	0	145	0	0	0	0	0	0	0	0	145	145
MUHANGA	Kibangu	0	0	0	0	173	0	0	0	0	0	0	0	0	173	173
MUHANGA	Kiyumba	0	0	0	0	306	0	0	0	0	0	0	0	0	306	306
MUHANGA	Muhanga	0	0	0	0	157	0	0	0	285	307	0	0	0	285	464
MUHANGA	Mushishiro	0	0	0	0	163	0	0	0	169	237	0	0	0	169	400
MUHANGA	Nyabinoni	0	0	0	0	66	0	0	0	0	0	0	0	0	66	66
MUHANGA	Nyamabuye	0	600	0	0	0	1028	248	138	141	147	1028	848	138	141	147
MUHANGA	Nyarusange	0	0	0	0	167	0	0	0	0	227	0	0	0	0	394
MUHANGA	Rongi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MUHANGA	Rugendabari	0	0	0	107	121	0	0	0	313	262	0	0	0	420	383
MUHANGA	Shyogwe	387	633	107	0	0	789	457	156	173	177	1176	1090	263	173	177
MUSANZE	Busogo	186	435	0	0	0	523	58	91	95	99	709	493	91	95	99
MUSANZE	Cyuve	0	791	507	0	0	724	56	115	157	161	724	847	622	157	161
MUSANZE	Gacaca	0	76	443	344	261	0	509	106	147	108	0	585	549	491	369
MUSANZE	Gashaki	0	625	242	355	0	0	0	41	58	84	0	625	283	413	84
MUSANZE	Gataraga	43	549	623	0	0	138	191	72	117	124	181	740	695	117	124
MUSANZE	Kimonyi	0	103	161	0	94	0	376	91	55	55	0	479	252	55	149
MUSANZE	Kinigi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MUSANZE	Muhoza	0	0	0	0	0	1621	133	143	147	152	1621	133	143	147	152
MUSANZE	Muko	0	379	0	157	299	0	309	58	58	70	0	688	58	215	369
MUSANZE	Musanze	0	343	767	177	113	0	314	51	106	188	0	657	818	283	301
MUSANZE	Nkotsi	0	0	30	180	0	0	0	170	96	39	0	0	200	276	39
MUSANZE	Nyange	0	0	291	518	189	0	0	330	125	136	0	0	621	643	325
MUSANZE	Remera	0	769	0	0	0	80	737	107	112	115	80	1506	107	112	115
MUSANZE	Rwaza	0	1017	181	0	112	0	296	97	114	122	0	1313	278	114	234
MUSANZE	Shingiro	0	0	56	164	355	0	253	96	233	56	0	253	152	397	411

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
NGOMA	Gashanda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Jarama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Karembo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Kazo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Kibungo	0	0	445	405	184	0	85	9	69	71	0	85	454	474	255
NGOMA	Mugesera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Murama	0	0	0	512	647	0	0	0	0	32	0	0	0	512	679
NGOMA	Mutenderi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Remera	0	0	0	0	0	0	0	0	0	64	0	0	0	0	64
NGOMA	Rukira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Rukumberi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Rurenge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Sake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGOMA	Zaza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Bwira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Gatumba	0	0	141	202	243	0	0	167	157	46	0	0	308	359	289
NGORORERO	Hindiro	0	744	640	140	137	0	0	56	106	121	0	744	696	246	258
NGORORERO	Kabaya	0	442	1153	0	0	0	38	129	137	230	0	480	1282	137	230
NGORORERO	Kageyo	0	0	23	0	175	0	0	0	2	2	0	0	23	2	177
NGORORERO	Kavumu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Matyazo	0	76	612	908	238	0	0	6	51	116	0	76	618	959	354
NGORORERO	Muhororo	0	0	0	364	924	0	0	0	0	27	0	0	0	364	951
NGORORERO	Muhunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Ndaró	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Ngororero	0	246	797	1178	284	0	0	19	82	176	0	246	816	1260	460
NGORORERO	Nyange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NGORORERO	Sovu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYABIHU	Bigogwe	0	506	565	444	115	0	892	151	135	163	0	1398	716	579	278
NYABIHU	Jenda	0	810	750	0	0	801	152	111	164	167	801	962	861	164	167
NYABIHU	Jomba	0	0	446	102	0	0	178	115	56	62	0	178	561	158	62
NYABIHU	Kabatwa	0	0	307	441	0	0	0	345	40	244	0	0	652	481	244
NYABIHU	Karago	0	374	785	0	260	0	878	80	132	138	0	1252	865	132	398
NYABIHU	Kintobo	0	0	50	0	269	0	0	225	20	215	0	0	275	20	484
NYABIHU	Mukamira	0	680	218	0	0	0	1037	119	138	144	0	1717	337	138	144
NYABIHU	Muringa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYABIHU	Rambura	0	0	0	191	76	0	0	384	444	66	0	0	384	635	142
NYABIHU	Rugera	0	56	375	284	344	0	0	4	31	54	0	56	379	315	398
NYABIHU	Rurembo	0	0	530	228	649	0	0	0	34	51	0	0	530	262	700
NYABIHU	Shyira	0	0	0	546	891	0	0	0	0	35	0	0	0	546	926

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
NYAGATARE	Gatunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Karama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Karangazi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Katabagemu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Kiyombe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Matimba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Mimuli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Mukama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Musheli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Nyagatare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Rukomo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Rwempasha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Rwimiyaga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAGATARE	Tabagwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Buruhukiro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Cyanika	0	0	0	0	0	0	0	0	24	0	0	0	0	0	24
NYAMAGABE	Gasaka	0	70	64	0	0	0	412	141	69	71	0	482	205	69	71
NYAMAGABE	Gatare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Kaduha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Kamegeri	0	0	0	0	93	0	0	0	0	54	0	0	0	0	147
NYAMAGABE	Kibirizi	0	0	0	0	0	0	0	0	0	35	0	0	0	0	35
NYAMAGABE	Kibumbwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Kitabi	0	0	0	40	279	0	0	0	305	294	0	0	0	345	573
NYAMAGABE	Mbazi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Mugano	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Musange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Musebeya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Mushubi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Nkomane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMAGABE	Tare	0	0	0	165	417	0	0	181	191	45	0	0	181	356	462
NYAMAGABE	Uwinkingi	0	0	0	195	483	0	0	0	221	30	0	0	0	416	513



Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
NYAMASHEKE	Bushekeri	0	0	0	0	0	0	0	0	0	84	0	0	0	0	84
NYAMASHEKE	Bushenge	0	43	0	297	435	0	598	47	51	71	0	641	47	348	506
NYAMASHEKE	Cyato	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMASHEKE	Gihombo	0	0	0	0	0	0	0	0	47	169	0	0	0	47	169
NYAMASHEKE	Kagano	0	425	468	0	323	0	605	379	133	139	0	1030	847	133	462
NYAMASHEKE	Kanjongo	0	138	627	85	174	0	210	102	80	87	0	348	729	165	261
NYAMASHEKE	Karambi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMASHEKE	Karengera	0	0	0	528	0	0	0	250	17	140	0	0	250	545	140
NYAMASHEKE	Kirimbi	0	0	0	322	54	0	0	0	0	21	0	0	0	322	75
NYAMASHEKE	Macuba	0	0	0	278	318	0	0	0	0	19	0	0	0	278	337
NYAMASHEKE	Mahembe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMASHEKE	Nyabitekeri	0	0	228	674	502	0	0	0	17	63	0	0	228	691	565
NYAMASHEKE	Rangiro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYAMASHEKE	Ruharambuga	0	0	0	0	181	0	0	0	304	750	0	0	0	304	931
NYAMASHEKE	Shangi	0	285	77	466	200	0	0	372	53	87	0	285	449	519	287
NYANZA	Busasamana	0	689	134	509	0	76	1344	152	170	212	76	2033	286	679	212
NYANZA	Busoro	0	0	0	70	117	0	0	0	256	177	0	0	0	326	294
NYANZA	Cyabakamyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYANZA	Kibirizi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYANZA	Kigoma	0	0	0	0	838	0	0	0	59	5	0	0	0	59	843
NYANZA	Mukingo	0	0	0	170	958	0	0	0	1167	143	0	0	0	1337	1101
NYANZA	Muyira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYANZA	Ntyazo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYANZA	Nyagisozi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYANZA	Rwabicuma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGENGE	Gitega	0	0	0	0	0	1577	85	88	91	95	1577	85	88	91	95
NYARUGENGE	Kanyinya	0	0	0	0	0	0	0	674	638	190	0	0	674	638	190
NYARUGENGE	Kigali	0	442	266	838	276	0	560	51	205	117	0	1002	317	1043	393
NYARUGENGE	Kimisagara	0	0	0	0	0	3004	154	159	165	172	3004	154	159	165	172
NYARUGENGE	Mageragere	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGENGE	Muhima	0	0	0	0	0	2058	111	115	119	124	2058	111	115	119	124
NYARUGENGE	Nyakabanda	0	0	0	0	0	691	299	52	53	56	691	299	52	53	56
NYARUGENGE	Nyamirambo	0	0	0	0	0	13	399	296	356	53	13	399	296	356	53
NYARUGENGE	Nyarugenge	0	0	0	0	0	186	14	14	14	14	186	14	14	14	14
NYARUGENGE	Rwezamenyo	0	0	0	0	0	47	114	10	10	10	47	114	10	10	10

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
NYARUGURU	Busanze	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Cyahinda	0	0	0	60	47	0	0	0	0	5	0	0	0	60	52
NYARUGURU	Kibeho	0	0	0	25	0	0	0	0	0	2	0	0	0	25	2
NYARUGURU	Kivu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Mata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Muganza	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Munini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Ngera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Ngoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Nyabimata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Nyagisozi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Ruheru	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Ruramba	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NYARUGURU	Rusenge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUBAVU	Bugeshi	0	0	144	1005	1262	0	0	0	9	69	0	0	144	1014	1331
RUBAVU	Busasamana	0	124	218	2025	186	0	0	8	21	140	0	124	226	2046	326
RUBAVU	Cyanzarwe	0	72	155	67	267	0	0	5	14	19	0	72	160	81	286
RUBAVU	Gisenyi	17	207	0	0	0	1783	149	171	178	184	1800	356	171	178	184
RUBAVU	Kanama	0	0	89	108	0	0	0	194	18	27	0	0	283	126	27
RUBAVU	Kanzenze	0	642	0	0	0	112	766	94	96	103	112	1408	94	96	103
RUBAVU	Mudende	0	124	0	697	0	0	387	448	58	103	0	511	448	755	103
RUBAVU	Nyakiliba	0	392	183	0	0	0	954	86	98	104	0	1346	269	98	104
RUBAVU	Nyamyumba	101	1521	0	0	0	255	262	154	164	171	356	1783	154	164	171
RUBAVU	Nyundo	0	1148	965	106	0	189	144	100	164	174	189	1292	1065	270	174
RUBAVU	Rubavu	150	1095	932	0	0	0	14	90	154	158	150	1109	1022	154	158
RUBAVU	Rugerero	0	724	115	0	0	1100	224	143	154	159	1100	948	258	154	159
RUHANGO	Bweramana	0	0	0	112	380	0	0	0	299	29	0	0	0	411	409
RUHANGO	Byimana	0	0	0	575	180	0	0	352	281	97	0	0	352	856	277
RUHANGO	Kabagari	0	0	0	0	0	0	0	0	0	43	0	0	0	0	43
RUHANGO	Kinazi	0	0	0	0	118	0	77	170	528	54	0	77	170	528	172
RUHANGO	Kinihira	0	0	0	0	104	0	0	0	37	41	0	0	0	37	145
RUHANGO	Mbuye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUHANGO	Mwendo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUHANGO	Ntongwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUHANGO	Ruhango	0	87	691	242	173	0	441	984	227	196	0	528	1675	469	369

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
RULINDO	Base	0	0	0	121	0	0	0	1325	84	94	0	0	1325	205	94
RULINDO	Burega	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RULINDO	Bushoki	0	0	79	79	0	0	0	1411	344	121	0	0	1490	423	121
RULINDO	Buyoga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RULINDO	Cyinzuzi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RULINDO	Cyungo	0	0	759	0	0	0	121	353	79	81	0	121	1112	79	81
RULINDO	Kinihira	0	0	0	162	103	0	0	218	14	393	0	0	218	176	496
RULINDO	Kisaro	0	0	59	0	308	0	0	150	199	112	0	0	209	199	420
RULINDO	Masoro	0	0	0	273	0	0	305	286	40	128	0	305	286	313	128
RULINDO	Mbogo	0	0	0	0	0	0	0	0	0	353	0	0	0	0	353
RULINDO	Murambi	0	0	65	618	99	0	0	209	112	65	0	0	274	730	164
RULINDO	Ngoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RULINDO	Ntarabana	0	0	0	89	94	0	0	70	5	11	0	0	70	94	105
RULINDO	Rukozi	0	161	204	126	96	0	540	135	202	84	0	701	339	328	180
RULINDO	Rusiga	0	0	0	0	0	0	0	0	0	41	0	0	0	0	41
RULINDO	Shyorongi	0	0	0	48	429	0	0	0	108	194	0	0	0	156	623
RULINDO	Tumba	0	0	0	167	0	0	0	504	216	471	0	0	504	383	471
RUSIZI	Bugarama	164	848	0	0	0	1040	77	130	134	141	1204	925	130	134	141
RUSIZI	Butare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUSIZI	Bweyeye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUSIZI	Gashonga	0	0	0	135	635	0	0	167	402	138	0	0	167	537	773
RUSIZI	Giheke	0	0	68	373	0	0	0	414	32	59	0	0	482	405	59
RUSIZI	Gihundwe	273	570	193	0	0	437	59	102	118	124	710	629	295	118	124
RUSIZI	Gikundamvura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUSIZI	Gitambi	0	0	0	90	0	0	81	6	396	39	0	81	6	486	39
RUSIZI	Kamembe	0	0	0	0	0	886	72	76	80	80	886	72	76	80	80
RUSIZI	Muganza	0	0	0	0	0	454	534	68	256	88	454	534	68	256	88
RUSIZI	Mururu	0	0	452	229	0	0	181	256	249	97	0	181	708	478	97
RUSIZI	Nkanka	0	172	168	318	491	0	0	12	23	47	0	172	180	341	538
RUSIZI	Nkombo	0	0	0	379	123	0	0	0	0	25	0	0	0	379	148
RUSIZI	Nkungu	0	0	0	414	0	0	0	0	0	74	0	0	0	414	74
RUSIZI	Nyakabuye	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUSIZI	Nyakarenzo	0	0	0	0	0	0	0	95	263	233	0	0	95	263	233
RUSIZI	Nzahaha	0	0	0	83	235	0	0	0	98	137	0	0	0	181	372
RUSIZI	Rwimbogo	0	293	97	0	0	0	525	225	214	90	0	818	322	214	90

Summary of New Grid Connections by Sector and Type (2009–2013) (continued)

District	Sector	Greenfields					Brownfields					Total				
		2009	2010	2011	2012	2013	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
RUTSIRO	Boneza	0	0	42	243	263	0	0	0	3	19	0	0	42	246	282
RUTSIRO	Gihango	0	0	0	88	103	0	37	48	227	208	0	37	48	315	311
RUTSIRO	Kigeyo	0	951	725	156	237	0	0	67	121	138	0	951	792	277	375
RUTSIRO	Kivumu	1464	392	172	0	0	0	119	154	176	182	1464	511	326	176	182
RUTSIRO	Manihira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUTSIRO	Mukura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUTSIRO	Murunda	0	0	0	0	75	0	0	44	3	25	0	0	44	3	100
RUTSIRO	Musasa	0	0	0	0	496	0	0	0	186	99	0	0	0	186	595
RUTSIRO	Mushonyi	0	1379	317	45	0	0	69	105	132	143	0	1448	422	177	143
RUTSIRO	Mushubati	0	0	0	0	109	0	0	0	45	193	0	0	0	45	302
RUTSIRO	Nyabirasi	0	0	0	27	31	0	0	0	0	2	0	0	0	27	33
RUTSIRO	Ruhango	0	148	124	124	111	0	0	170	73	45	0	148	294	197	156
RUTSIRO	Rusebeya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Fumbwe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Gahengeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Gishari	0	0	0	97	123	0	0	240	492	51	0	0	240	589	174
RWAMAGANA	Karenge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Kigabiro	0	0	0	541	0	0	0	327	172	264	0	0	327	713	264
RWAMAGANA	Muhazi	0	0	638	528	336	0	264	1253	213	163	0	264	1891	741	499
RWAMAGANA	Munyaga	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Munyiginya	0	0	0	0	137	0	0	0	265	162	0	0	0	265	299
RWAMAGANA	Musha	0	0	0	0	59	0	0	0	299	181	0	0	0	299	240
RWAMAGANA	Muyumbu	0	0	0	0	0	0	0	0	0	59	0	0	0	0	59
RWAMAGANA	Mwulire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Nyakariro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Nzige	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RWAMAGANA	Rubona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

### 2.3 Potential Micro-hydro Developments

This section of the Technical Annex highlights the micro-hydro sites identified for potential development under the access programme. The geographic location of these sites is presented in Section 4 of Volume I of the Prospectus.

**Table 2.7: Micro-hydro Sites Identified for Potential Development to 2013**

MCH Zone ID	Potential Capacity	Province	District	Sector	Priority Sequence	Phasing [year]
MCH ID	kW				SEQUENCE	PHASING
SNB-34	500	South	Nyamagabe	Buruhukiro	1	2009
NGA-31	750	North	Gakenke	Rusasa	2	2009
SNR-33	500	South	Nyaruguru	Munini	3	2009
ONS-11	100	West	Nyamasheke	Mahembe	4	2009
SMU-10	25	South	Muhanga	Mushishiro	5	2009
ONS-05	50	West	Nyamasheke	Mahembe	6	2010
SNR-14	25	South	Nyaruguru	Munini	7	2010
NGA-06	25	North	Gakenke	Ruli	8	2010
ONS-10	50	West	Nyamasheke	Mahembe	9	2010
SMU-14	25	South	Muhanga	Kabacuzi	10	2010
ONS-04	50	West	Nyamasheke	Mahembe	11	2011
NGI-06	25	North	Gicumbi	Rushaki	12	2011
ONS-13	25	West	Nyamasheke	Karambi	13	2011
SNB-11	25	South	Nyamagabe	Kaduha	14	2011
SNR-23	100	South	Nyaruguru	Cyahinda	15	2011
OKA-22	100	West	Karongi	Twumba	16	2012
SNB-13	25	South	Nyamagabe	Kaduha	17	2012
ONG-02	50	West	Ngororero	Ndaro	18	2012
SNR-25	250	South	Nyaruguru	Munini	19	2012
OKA-20	100	West	Karongi	Twumba	20	2012
ONG-03	100	West	Ngororero	Ndaro	21	2013
SNR-12	50	South	Nyaruguru	Muganza	22	2013
SNR-40	250	South	Nyaruguru	Nyabimata	23	2013
ORT-08	750	West	Rutsiro	Mushonyi	24	2013
SNR-31	50	South	Nyaruguru	Ruheru	25	2013

Source: Prospectus GIS Database, Ministry of Infrastructure and BTC "Hydropower Atlas" (2007)

**Table 2.8: Connection Decision for Priotised Micro-hydro Sites**

MVmax	Existing grid (2008) within proposed MCH supply zone?	Distance to existing grid	Distance to 2013 grid	Distance to nearest MCH	Grid compatible	Compatible to connect to nearest MCH mini-grid
m		m	m	m		
3644	N	6,580	4182	369	N	Y
5498	N	2,259	312	331	Y	Y
3606	N	20,982	8030	1466	N	Y
740	N	3,674	3674	547	N	Y
186	Y	865	577	876	N	N
390	N	3,731	3731	261	N	Y
189	N	16,347	3001	258	N	N
195	N	4,939	4316	675	N	N
391	N	3,130	3130	547	N	N
196	N	9,243	2761	969	N	N
412	N	3,949	3949	261	N	Y
206	N	7,780	7780	121	N	Y
206	N	7,643	5196	2676	N	N
203	N	12,818	11100	1680	N	N
799	N	16,342	4482	357	N	Y
867	N	2,036	2036	1400	N	N
215	N	9,526	7787	1846	N	N
431	N	5,558	3136	427	N	Y
2122	N	17,621	5690	404	N	Y
861	N	3,435	3435	717	N	Y
916	N	5,783	3356	427	N	Y
450	N	14,814	11329	1096	N	N
2255	N	14,847	11155	978	N	Y
6876	N	6,461	753	964	Y	Y
451	N	25,358	14631	411	N	Y

Source: Prospectus GIS Database, Ministry of Infrastructure and BTC “Hydropower Atlas” (2007)

### 3 Cost Estimates for Programme Components

The following cost estimates have been used in the Prospectus for new MV line, MV/LV Transformers, LV Line and Service Connections. In Table 3.1 the cost components used in this Prospectus are compared to recent experience in Rwanda and the STEG pilot project. All programme components are expected to achieve cost reductions.

**Table 3.1: Targeted Cost Efficiencies to 2012 and 2020 (MV Line, MV/LV Transformers, LV Line and Service Connections)**

	%cost compon	Rwanda (current)		STEG		Access Programme						
		2008	2008	% improvement	2009	new compon cost	% improvement	2012	new compon cost	% improvement	2020	new compon cost
		<b>overall programme improvement</b>			<b>-16%</b>		<b>-38%</b>		<b>-54%</b>			
<b>MV Lines</b>		<b>75000</b>	<b>65279</b>	<b>-16%</b>	<b>55161</b>		<b>40194</b>		<b>29996</b>			
Wires & accessories	35%	26250	22848	15%	19421	35%	30%	13594	34%	33%	9108	30%
Poles	25%	18750	16320	28%	11750	21%	36%	7520	19%	34%	4963	17%
Transport	15%	11250	9792	5%	9302	17%	37%	5860	15%	20%	4688	16%
Labour	25%	18750	16320	10%	14688	27%	10%	13219	33%	15%	11236	37%
		<b>overall programme improvement</b>			<b>-15%</b>		<b>-30%</b>		<b>-41%</b>			
<b>MV/LV Transformer S/S's</b>		<b>20000</b>	<b>15823</b>	<b>-15%</b>	<b>13505</b>		<b>11103</b>		<b>9367</b>			
Trfr's & accessories	65%	13000	10285	15%	8742	65%	20%	6994	63%	15%	5945	63%
Transport	14%	2800	2215	20%	1772	13%	20%	1418	13%	20%	1134	12%
Labour	21%	4200	3323	10%	2991	22%	10%	2691	24%	15%	2288	24%
		<b>overall programme improvement</b>			<b>-16%</b>		<b>-38%</b>		<b>-50%</b>			
<b>LV Lines</b>		<b>40000</b>	<b>32698</b>	<b>-16%</b>	<b>27532</b>		<b>20175</b>		<b>16279</b>			
Wires & accessories	40%	16000	13079	15%	11117	40%	30%	7782	39%	20%	6226	38%
Poles	20%	8000	6540	20%	5232	19%	42%	3034	15%	25%	2276	14%
Transport	18%	7200	5886	20%	4709	17%	25%	3531	18%	20%	2825	17%
Labour	22%	8800	7194	10%	6474	24%	10%	5827	29%	15%	4953	30%
		<b>overall programme improvement</b>			<b>-14%</b>		<b>-23%</b>		<b>-30%</b>			
<b>Service Connections</b>		<b>285</b>	<b>346</b>	<b>-14%</b>	<b>298</b>		<b>266</b>		<b>241</b>			
Service Cable & Meter	74%	211	256	14%	220	74%	12%	194	73%	10%	174	72%
Transport	8%	21	26	15%	22	7%	15%	19	7%	15%	16	7%
Labour	18%	51	62	10%	56	19%	5%	53	20%	5%	51	21%
<b>Overall cost component</b>												
Material		60.8%	60.7%		58.5%			54.5%			51.3%	
Transport		15.7%	15.7%		16.4%			15.1%			15.5%	
Labour		23.5%	23.6%		25.1%			30.4%			33.2%	

## 4 Electricity Sector Operations and Financing Model

This section provides technical detail on the assumptions and results from the Rwanda electricity sector operating and financing model.

### 4.1 Sector Operating and Financing Model Assumptions

Macroeconomic, operating and cost assumptions used in the operations and financing model are presented in the following table. Information on investment cost assumptions for different electrification options is presented in this Technical Annex in Section 1.

**Table 4.1: Macroeconomic Assumptions**

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		Q4	Q4	Q4	Q4								
<b>Macroeconomic Indicators</b>	Units and rates												
Population	No.	10,126,194	10,369,357	10,616,248	10,866,856	11,118,968	11,374,704	11,635,185	11,900,467	12,170,607	12,445,663	12,725,690	13,010,746
Population growth	Percent (annual)	2.4%	2.4%	2.4%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%
Households		2,109,624	2,160,283	2,211,718	2,263,928	2,365,738	2,420,150	2,475,571	2,532,014	2,645,784	2,705,579	2,766,454	2,891,277
Kigali	8.50%	173,529	188,756	205,319	223,336	242,319	262,916	285,264	309,512	335,820	364,365	395,336	428,939
Other Urban	6.80%	201,516	215,572	230,609	246,695	263,470	281,386	300,520	320,956	342,781	366,090	390,984	417,571
Rural		1,734,579	1,755,954	1,775,790	1,793,898	1,859,949	1,875,847	1,889,787	1,901,547	1,967,183	1,975,124	1,980,135	2,044,767
Household Size	No.	4.8	4.8	4.8	4.8	4.7	4.7	4.7	4.7	4.6	4.6	4.6	4.5
GDP	7.00%	974	1044	1119	1200	5136	5495	5880	6291	6732	7203	7707	8247
GDP per capita (US\$)	US\$/person	96	101	105	110	462	483	505	529	553	579	606	634
Currency Exchange Rate	RWF/USD	552	554	555	556	560	565	571	577	583	588	594	600
Forecast Domestic Inflation	Percent	1.50%	1.25%	1.25%	1.25%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Forecast US Inflation	Percent	1.00%	1.00%	1.00%	1.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%	4.00%
Oil Price (US\$/barrel)	US\$/barrel	85.76	100	100	100	100	100	100	100	100	100	100	100

Source: Economic Consulting Associates “Rwanda Energy Strategy and Policy” (2008) and Vernstrom (2008).



**Table 4.2: System Operating Assumptions**

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		Q4	Q4	Q4	Q4								
<b>Collection Efficiency</b>													
	Residential and Institutional	75%	76%	77%	78%	79%	80%	81%	82%	83%	84%	85%	86%
	Commercial	80%	81%	82%	83%	84%	85%	86%	87%	88%	89%	90%	91%
	Industrial	80%	81%	82%	83%	84%	85%	86%	87%	88%	89%	90%	91%
<b>Plant Capacity and Utilization (%)</b>													
	MW												
<b>Hydro (Baseload)</b>													
	Gihira 1.80	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%
	Gisenyi 1.20	41%	41%	41%	41%	41%	41%	41%	41%	41%	41%	41%	41%
	Ntaruka 11.50	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
	Mukungwa 12.75	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%	55%
	Rukarara 9.50	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%	48%
	Mukungwa 2 2.50	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
	Nyaborongo 27.50	-	-	-	-	50%	50%	50%	50%	50%	50%	50%	50%
<b>Imports (Baseload)</b>													
	SNEL 3.50	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%	59%
	SINELAC 12.00	61%	61%	61%	61%	61%	61%	61%	61%	61%	61%	61%	61%
<b>Thermal - Gas (Baseload)</b>													
	KP1 Pilot 4.20	50%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
	RIG Pilot 3.80	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
	Contour Global Methane 100.00	-	0%	22.5%	22.5%	23%	40%	50%	90%	90%	90%	90%	90%
<b>Solar (Baseload)</b>													
	0.25	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
<b>Grid Connected Micro Hydro (Baseload)</b>													
	GtZ-funded plants 1.80	20%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
	BTC-funded plants 4.70	0%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
	UNIDO/Govt plants 6.00	40%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
<b>Thermal - Oil (Marginal)</b>													
<b>Maximum</b>													
	Jabana HFO 20.00	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
	Jabana Diesel 7.80	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
<b>Proportion of time generating</b>													
	Marginal Thermal Plants 20.00	54%	57%	12%	14%	12%	12%	12%	12%	12%	12%	12%	12%

Source: Electrogaz Annual Report (2007) and Vernstrom (2008)

**Table 4.3: Operating Cost Assumptions**

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
		Q4	Q4	Q4	Q4								
<b>Generation cost assumptions</b>													
Existing Hydro	USc/kWh	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Solar	USc/kWh	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Imported Hydro - SNEL	USc/kWh	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
Imported Hydro - SINELAC	USc/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Rukarara	USc/kWh	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
Mukungwa 2	USc/kWh	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
Methane Pilot 1	USc/kWh	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Methane Pilot 2	USc/kWh	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Contour Global Methane	USc/kWh	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Nyaborongo	USc/kWh	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Grid Connected Micro Hydros	USc/kWh	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Jabana HFO	USc/kWh	0.154	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180	0.180
Jabana Diesel	USc/kWh	0.260	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304	0.304
<b>Transmission and Distribution Maintenance Costs</b>													
Transmission Operations and Maintenance	% line km	0.5%	0.5%	0.5%	0.5%	2%	2%	2%	2%	2%	2%	2%	2%
Distribution Operations and Maintenance	% Connection	0.5%	0.5%	0.5%	0.5%	2%	2%	2%	2%	2%	2%	2%	2%
<b>Other Operating Expenses</b>													
Staff	% Revenues	10.0%	10.0%	10.0%	10.0%	10%	10%	10%	10%	10%	10%	10%	10%
Administration	% Revenues	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Assumed Interest Expense	RWF mil	44	44	44	44	175	175	175	175	175	175	175	175
Operating Contingency	% Operating Costs	12.0%	10.0%	8.0%	6.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

Source: Vernstrom (2008) and Electrogaz Annual Report (2007). Operating contingency is an allocation to factor in operating efficiencies achieved over time.

**Table 4.4: Technical Assistance Assumptions**

---

<b>Technical Assistance Cost Assumptions</b>		<b>Cost</b>
<b>Grid Based Technical Assistance</b>		
Programme Manager	USD per annum	400,000
Procurement Specialist	USD per annum	350,000
Safeguards Advisor	USD per annum	350,000
GIS systems and training	USD contract	2,000,000
Predesign of contract packages	USD contract	1,500,000
Pole manufacturers	USD contract	500,000
Local component suppliers	USD contract	400,000
Local contractors	USD contract	500,000
SMEs	USD contract	350,000
Lowering programme costs	USD contract	400,000
Training programme	USD per annum	500,000
Electrogaz Strategic Plan	USD Total	6,900,000

Source: Hampton (2009) for Electrogaz Strategic Plan and consultant estimates for other

---

## 4.2 Results from Sector Operations and Financing Model

The results of the sector operations and financing model are presented in the following tables. Results are presented for demand and generation projections, operating cash flows, investment costs and a summary of programme outcomes. An indicative economic cost benefit analysis is also presented in Table 4.13.

**Table 4.5: Projected Demand (2009-2013)**

	Units	2009	2010	2011	2012	2013
<b>Number of Customers</b>						
Residential and Institutional						
Existing		110,000	110,000	110,000	110,000	110,000
New Connections		36,969	57,428	65,983	67,661	71,645
Urban		14,706	4,482	2,106	1,196	1,284
Peri Urban		12,283	22,383	18,425	13,780	15,797
Rural		9,980	30,563	44,879	47,852	44,881
Deep Rural		-	-	573	4,832	9,683
Commercial						
Existing		1,500	1,500	1,500	1,500	1,500
New Connections		56	56	56	56	225
Industrial						
Existing		20	20	20	20	20
New Connections		1	1	1	1	2
<b>TOTAL</b>		<b>157,958</b>	<b>215,613</b>	<b>281,823</b>	<b>349,711</b>	<b>421,583</b>
<b>Average Demand per Customer</b>						
Residential and Institutional						
Existing	kWh	1,224	1,260	1,296	1,332	1,368
New Connections						
Urban	kWh	993	1,031	1,074	1,125	1,155
Peri Urban	kWh	649	679	720	774	795
Rural	kWh	443	460	481	505	519
Deep Rural	kWh	354	368	385	404	415
Commercial						
Existing	kWh	80,016	82,416	84,888	87,432	87,432

	Units	2009	2010	2011	2012	2013
New Connections	kWh	40,008	41,208	42,444	43,716	43,716
Industrial						
Existing	kWh	80,016	82,416	84,888	87,432	22,514
New Connections	kWh	40,008	41,208	42,444	43,716	11,257
<b>Total Demand</b>						
Residential and Institutional						
Existing	MWh	134,640	138,600	142,560	146,520	150,480
New Connections	MWh					
Urban	MWh	9,129	17,493	20,639	22,328	23,811
Peri Urban	MWh	4,980	17,464	31,449	43,092	55,656
Rural	MWh	2,762	13,211	31,975	55,181	78,475
Deep Rural						
Commercial						
Existing	MWh	120,024	123,624	127,332	131,148	131,148
New Connections	MWh	5,626	14,797	24,242	33,971	43,807
Industrial						
Existing	MWh	1,600	1,648	1,698	1,749	450
New Connections	MWh	50	132	215	302	324
Total Demand Existing		256,264	263,872	271,590	279,417	282,078
Total Demand New Connections		22,547	63,096	108,658	156,315	207,536
<b>TOTAL DEMAND</b>		278,811	326,969	380,247	435,732	489,614

**Table 4.6: Projected Generation (Existing and New Connections) (2009-2012)**

	Units	2009	2010	2011	2012	2013
<u>Generation to Meet Existing Demand</u>						
Existing Hydro (Baseload)						
Gihira	MWh	4,323	4,323	4,323	4,323	4,323
Gisenyi	MWh	4,323	4,323	4,323	4,323	4,323
Ntaruka	MWh	16,571	16,571	16,571	16,571	16,571
Mukungwa	MWh	42,234	42,234	42,234	42,234	42,234
Solar (Baseload)	MWh	1,096	1,096	1,096	1,096	1,096
Imports (Baseload)	MWh					-
SNEL	MWh	18,156	18,156	18,156	18,156	18,156
SINELAC	MWh	64,124	64,124	64,124	64,124	64,124
New Builds	MWh					-
Rukarara	MWh	10,007	40,027	40,027	40,027	40,027
Mukungwa 2	MWh	3,835	7,670	7,670	7,670	7,670
KP1 Pilot	MWh	18,409	33,135	33,135	33,135	33,135
REC Pilot	MWh	22,485	29,980	29,980	29,980	29,980
Contour Global Methane	MWh	-	-	63,136	68,623	67,597
Nyaborongo	MWh	-	-	-	-	-
Grid Connected Micro Hydro (Baseload)						-
GtZ-funded plants	MWh	-	-	-	-	-
BTC-funded plants	MWh	-	-	-	-	-
UNIDO/Govt plants	MWh	-	-	-	-	-
Thermal - Oil (Marginal)						-
Thermal for peak		19,008	19,008	19,008	19,008	19,008
Jabana HFO	MWh	108,240	57,650	-	-	-
Jabana	MWh	-	-	-	-	-
Total Generation to Meet Existing Demand	MWh	332,811	338,298	343,785	349,271	348,245
<u>Access Programme Generation</u>						
Grid Connected Micro Hydro (Baseload)						

	Units	2009	2010	2011	2012	2013
GtZ-funded plants	MWh	1,183	9,467	9,467	9,467	9,467
BTC-funded plants	MWh	-	15,450	24,720	24,720	24,720
UNIDO/Govt plants	MWh	13,149	30,243	31,558	31,558	31,558
Existing Hydro (Baseload)						
Gihira	MWh	-	-	-	-	-
Gisenyi	MWh	-	-	-	-	-
Ntaruka	MWh	-	-	-	-	-
Mukungwa	MWh	14,037	18,797	19,008	19,008	19,008
Solar (Baseload)	MWh	-	-	-	-	-
Imports (Baseload)	MWh					
SNEL	MWh	-	-	-	-	-
SINELAC	MWh	-	-	-	-	-
New Builds	MWh					
Rukarara	MWh	-	-	-	-	-
Mukungwa 2	MWh	-	-	-	-	-
KP1 Pilot	MWh	-	-	-	-	-
REC Pilot	MWh	-	-	-	-	-
Contour Global Methane	MWh	-	-	52,788	109,500	129,638
Nyaborongo	MWh	-	-	-	-	41,825
Thermal - Oil (Marginal)	MWh					
Jabana HFO	MWh	912	6,936	-	1,141	-
Jabana	MWh	-	-	-	-	-
Total Access Programme Generation	MWh	29,282	80,893	137,541	195,394	256,217
<u>Total Generation (MWh)</u>						
Existing Hydro (Baseload)						
Gihira	MWh	4,323	4,323	4,323	4,323	4,323
Gisenyi	MWh	4,323	4,323	4,323	4,323	4,323
Ntaruka	MWh	16,571	16,571	16,571	16,571	16,571
Mukungwa	MWh	56,271	61,030	61,242	61,242	61,242
Total Existing Hydro (Baseload)	MWh	81,488	86,248	86,459	86,459	86,459
Solar (Baseload)	MWh	1,096	1,096	1,096	1,096	1,096
Imports (Baseload)						

	Units	2009	2010	2011	2012	2013
SNEL	MWh	18,156	18,156	18,156	18,156	18,156
SINELAC	MWh	64,124	64,124	64,124	64,124	64,124
Total Imports (Baseload)	MWh	82,280	82,280	82,280	82,280	82,280
New Builds						
Rukarara	MWh	10,007	40,027	40,027	40,027	40,027
Mukungwa 2	MWh	3,835	7,670	7,670	7,670	7,670
KP1 Pilot	MWh	18,409	33,135	33,135	33,135	33,135
REC Pilot	MWh	22,485	29,980	29,980	29,980	29,980
Contour Global Methane	MWh	-	-	115,925	178,122	197,235
Nyaborongo	MWh	-	-	-	-	41,825
New Hydro	MWh	13,842	47,698	47,698	47,698	89,523
Methane Gas	MWh	40,893	63,115	179,040	241,237	260,350
Grid Connected Micro Hydro (Baseload)						
GtZ-funded plants	MWh	1,183	9,467	9,467	9,467	9,467
BTC-funded plants	MWh	-	15,450	24,720	24,720	24,720
UNIDO/Govt plants	MWh	13,149	30,243	31,558	31,558	31,558
Total Grid Connected Micro Hydro (Baseload)	MWh	14,332	55,160	65,745	65,745	65,745
Thermal - Oil (Marginal)						
Thermal generation required for peak	MWh	19,008	19,008	19,008	19,008	19,008
Jabana HFO	MWh	109,152	64,586	-	1,141	-
Jabana	MWh	-	-	-	-	-
Total Thermal - Oil (Marginal)	MWh	128,160	83,594	19,008	20,149	19,008
Exports	MWh	9,249	30,067	61,019	60,472	61,019
Total Generation	MWh	371,341	449,258	542,345	605,136	665,480



**Table 4.7: Electricity Sector Operating Cash Flows (2009-2013)**

	Units	2009	2010	2011	2012	2013
Sector Revenues						
Electricity Sales Collections						
Existing Customers	USD m	40.2	41.8	43.5	45.2	45.9
New Connections	USD m	3.4	9.7	16.9	24.3	31.9
Connection Charges Paid	USD m	2.3	5.0	6.3	6.7	7.2
Other Income	USD m	-	-	-	-	-
Total Sector Revenues	USD m	46.0	56.5	66.6	76.2	85.0
Supply Costs						
For Existing Demand						
Generation costs						
Existing Hydro	USD m	0.7	0.7	0.7	0.7	0.7
Solar	USD m	0.1	0.1	0.1	0.1	0.1
Imported Hydro - SINELAC	USD m	0.7	0.7	0.7	0.7	0.7
Imported Hydro - SNEL	USD m	4.5	4.5	4.5	4.5	4.5
Rukarara	USD m	0.9	3.5	3.5	3.5	3.5
Mukungwa 2	USD m	0.3	0.7	0.7	0.7	0.7
Methane Pilot 1	USD m	1.7	3.0	3.0	3.0	3.0
Methane Pilot 2	USD m	2.0	2.7	2.7	2.7	2.7
Contour Global Methane	USD m	-	-	5.7	6.2	6.1
Nyaborongo	USD m	-	-	-	-	-
Grid Connected Micro Hydros	USD m	-	-	-	-	-
Jabana HFO	USD m	13.9	13.8	3.4	3.4	3.4
Jabana Diesel	USD m	-	-	-	-	-
Off-grid Supply (including T&D)	USD m	-	-	-	-	-
Total Generation costs For Existing Demand	USD m	24.7	29.5	24.8	25.3	25.2

	Units	2009	2010	2011	2012	2013
Transmission and Distribution Costs						
Transmission Operations and Maintenance	USD m	3.6	3.3	3.0	2.6	2.3
Distribution Operations and Maintenance	USD m	0.7	0.7	0.7	0.7	0.7
Total Transmission and Distribution Costs For Existing Demand	USD m	4.3	4.0	3.6	3.3	3.0
Cost of Supply for Existing Demand	USD m	29.0	33.4	28.4	28.6	28.2
Other Operating Expenditures						
For Existing Demand						
Staff	USD m	4.0	4.2	4.3	4.5	4.6
Administration	USD m	0.8	0.8	0.9	0.9	0.9
Interest	USD m	0.3	0.3	0.3	0.3	0.3
Tax	USD m	-	-	-	-	-
Total Other Operating Expenditures For Existing Demand	USD m	5.1	5.3	5.5	5.7	5.8
Total Operating Costs for Existing Demand	USD m	34.1	38.8	34.0	34.3	34.0
For Access Programme						
Generation costs						
Existing Hydro	USD m	0.1	0.2	0.2	0.2	0.2
Solar	USD m	-	-	-	-	-
Imported Hydro - SINELAC	USD m	-	-	-	-	-
Imported Hydro - SNEL	USD m	-	-	-	-	-

	Units	2009	2010	2011	2012	2013
Rukarara	USD m	-	-	-	-	-
Mukungwa 2	USD m	-	-	-	-	-
Methane Pilot 1	USD m	-	-	-	-	-
Methane Pilot 2	USD m	-	-	-	-	-
Contour Global Methane	USD m	-	-	4.7	9.8	11.7
Nyaborongo	USD m	-	-	-	-	4.6
Grid Connected Micro Hydros	USD m	1.7	6.6	7.9	7.9	7.9
Jabana HFO	USD m	0.1	1.2	-	0.2	-
Jabana Diesel	USD m	-	-	-	-	-
Total Generation costs For Access Programme	USD m	2.0	8.0	12.8	18.1	24.3
Transmission and Distribution Costs						
Transmission Operations and Maintenance	USD m	0.1	0.3	0.7	1.0	1.3
Distribution Operations and Maintenance	USD m	0.2	0.6	1.1	1.6	2.3
Total Transmission and Distribution Costs For Access Programme	USD m	0.3	0.9	1.8	2.6	3.7
Off-grid Supply (including T&D)	USD m	0.7	1.5	2.8	4.8	1.4
Cost of Supply to New Connections	USD m	3.0	10.5	17.4	25.5	29.4
For Access Programme						
Staff	USD m	0.6	1.5	2.3	3.1	3.9
Administration	USD m	0.1	0.3	0.5	0.6	0.8
Interest	USD m	-	-	-	-	-
Tax	USD m	-	-	-	-	-

	<b>Units</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Total Other Operating Expenditures For Access Programme	USD m	0.7	1.8	2.8	3.7	4.7
Total Supply and Operations Costs						
Existing Demand	USD m	34.1	38.8	34.0	34.3	34.0
Access Programme	USD m	3.7	12.2	20.1	29.2	34.1
Operating Contingencies	USD m	4.5	5.1	4.3	3.8	3.4
Total Supply and Operations Costs	USD m	42.3	56.1	58.4	67.4	71.5
Net cash flow from operations	USD m	5.3	7.2	21.9	22.4	27.2

---

**Table 4.8: Projected Technical Assistance for Access Programme (2009-2013)**

	Units	2009	2010	2011	2012	2013
<b>Grid-based TA</b>						
Electrogaz Strategic Planning	USD m	1.7	1.7	1.7	1.7	-
Programme implementation						
Programme Manager	USD m	0.4	0.4	0.4	0.4	0.4
Procurement Specialist	USD m	0.3	0.3	0.3	0.3	0.4
Safeguards Advisor	USD m	0.3	0.3	0.3	0.3	0.4
GIS systems and training	USD m	0.5	0.5	-	-	-
Predesign of contract packages	USD m	0.4	0.4	0.4	0.4	-
Total Programme implementation	USD m	2.0	2.0	1.5	1.5	1.1
Strengthening local supply chains						
Pole manufacturers	USD m	0.2	0.2	-	-	-
Local component suppliers	USD m	0.2	0.2	-	-	-
Local contractors	USD m	0.2	0.2	-	-	-
SMEs	USD m	0.2	0.2	-	-	-
Total Strengthening local supply chains	USD m	0.9	0.9	-	-	-
Lowering Programme Costs	USD m	0.2	0.2	-	-	-
Training Programme	USD m	0.5	0.5	0.5	0.5	0.5
Total Grid-based TA	USD m	5.3	5.3	3.7	3.7	1.6
<b>MININFRA / NEDA TA</b>						
SWAP Secretariat						
Manager / Lead Advisor	USD m	0.3	0.3	0.3	0.3	0.3
Economist	USD m	0.1	0.1	0.1	0.1	0.1
Engineers (2 Technical Experts)	USD m	0.4	0.4	0.4	0.4	0.4

	<b>Units</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Total SWAP Secretariat	USD m	0.8	0.8	0.8	0.8	0.8
Monitoring Programme Performance						
Joint sector performance reports	USD m	0.4	0.4	0.4	0.4	0.4
Special programme monitoring reports	USD m	0.3	0.3	0.3	0.3	0.4
Total Monitoring Programme Performance	USD m	0.7	0.7	0.7	0.7	0.8
Micro-hydro sustainability framework	USD m	0.2	0.2	-	-	-
Solar PV installation	USD m	0.1	0.1	0.1	0.1	-
Solar hot water systems	USD m	0.1	0.1	0.1	0.1	-
Total MININFRA / NEDA TA	USD m	2.0	2.0	1.7	1.7	1.6
Total Technical Assistance	USD m	7.2	7.2	5.4	5.4	3.2

---

**Table 4.9: Electricity Access Programme Connections and Costs (2009-2012)**

	Units	2009	2010	2011	2012	2013
Number of new household connections	No.	36,969	57,428	65,983	67,661	71,645
Urban	%	40%	8%	3%	2%	2%
Peri-urban	%	33%	39%	28%	20%	22%
Rural	%	27%	53%	68%	71%	63%
Deep rural	%	0%	0%	1%	7%	14%
Total number of households connected	No.	146,969	204,397	270,380	338,041	409,686
Total number of connections		157,958	215,613	281,823	349,711	421,583
Proportion of population	%	7%	10%	13%	16%	19%
Grid						
MV Investment Costs	USD m	23.5	24.1	20.6	22.7	13.3
Infill connections	USD m	10.4	10.0	9.9	11.1	11.0
Expansion connections	USD m	1.5	16.3	16.6	17.8	18.6
Compact Fluorescent Lightbulbs	USD m	0.2	0.3	0.3	0.4	0.4
Network strengthening	USD m	1.5	4.1	7.1	10.2	11.8
Offgrid						
Microhydro	USD m	4.1	9.2	16.7	16.9	7.3
Solar PV	USD m	6.4	6.4	6.4	6.4	0.7
Solar Hot Water	USD m	1.3	1.3	1.3	1.3	0.0
Total Investment Costs	USD m	48.9	71.6	78.8	86.7	63.2
Technical Assistance	USD m	7.3	7.3	5.4	5.4	3.2
Total	USD m	56.1	78.9	84.2	92.1	66.3
Cumulative Investment	USD m	56.1	135.0	219.2	311.4	377.7
MV/LV Investment	USD m	35.5	50.4	47.1	51.6	43.0
Cost per connection MV/LV	USD m	959.7	877.2	713.5	763.3	599.6

**Table 4.10: Electricity Access Programme Connections and Costs (2009-2020)**

	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of new household connections	No.	36,969	57,428	65,983	67,661	71,645	71,837	71,948	71,326	66,260	65,535	30,495	16,452
Urban	%	40%	8%	3%	2%	2%	2%	2%	1%	1%	1%	2%	4%
Peri-urban	%	33%	39%	28%	20%	22%	21%	16%	16%	13%	9%	11%	21%
Rural	%	27%	53%	68%	71%	63%	61%	53%	47%	36%	36%	33%	52%
Deep rural	%	0%	0%	1%	7%	14%	16%	29%	36%	49%	54%	53%	23%
Total number of households connected	No.	146,969	204,397	270,380	338,041	409,686	481,523	553,471	624,797	691,057	756,592	787,087	803,539
Total number of connections		157,958	215,613	281,823	349,711	421,583	493,647	565,822	637,375	703,862	769,624	800,346	817,025
Proportion of population	%	7%	10%	13%	16%	19%	23%	26%	29%	32%	35%	36%	36%
<b>Grid</b>													
MV Investment Costs	USD m	23.5	24.1	20.6	22.7	13.3	11.8	11.1	10.5	9.1	7.3	7.1	7.2
Infill connections	USD m	10.4	10.0	9.9	11.1	11.0	10.0	11.2	11.0	13.0	13.4	15.1	15.5
Expansion connections	USD m	1.5	16.3	16.6	17.8	18.6	20.1	18.3	19.6	16.5	16.3	15.5	17.4



	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Compact Fluorescent Lightbulbs	USD m	0.2	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4
Network strengthening	USD m	1.5	4.1	7.1	10.2	11.8	12.7	12.7	11.9	10.2	7.7	4.4	0.5
<b>Offgrid</b>													
Microhydro	USD m	4.1	9.2	16.7	16.9	7.3	7.3	7.3	7.4	7.3	7.3	7.4	7.4
Solar PV	USD m	6.4	6.4	6.4	6.4	0.7	1.0	0.9	1.1	1.0	1.1	1.2	1.0
Solar Hot Water	USD m	1.3	1.3	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Investment Costs</b>	USD m	48.9	71.6	78.8	86.7	63.2	63.3	62.0	61.8	57.5	53.6	51.0	49.3
Technical Assistance	USD m	7.3	7.3	5.4	5.4	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
<b>Total</b>	<b>USD m</b>	<b>56.1</b>	<b>78.9</b>	<b>84.2</b>	<b>92.1</b>	<b>66.3</b>	<b>66.4</b>	<b>65.1</b>	<b>65.0</b>	<b>60.7</b>	<b>56.7</b>	<b>54.2</b>	<b>52.5</b>
<b>Cumulative Investment</b>	<b>USD m</b>	<b>56.1</b>	<b>135.0</b>	<b>219.2</b>	<b>311.4</b>	<b>377.7</b>	<b>444.1</b>	<b>509.3</b>	<b>574.2</b>	<b>634.9</b>	<b>691.6</b>	<b>745.8</b>	<b>798.3</b>
<b>MV/LV Investment</b>	<b>USD m</b>	<b>35.5</b>	<b>50.4</b>	<b>47.1</b>	<b>51.6</b>	<b>43.0</b>	<b>41.9</b>	<b>40.7</b>	<b>41.1</b>	<b>38.6</b>	<b>37.1</b>	<b>37.7</b>	<b>40.1</b>
<b>Cost per connection MV/LV</b>	USD	959.7	877.2	713.5	763.3	599.6	583.4	565.6	576.0	582.5	565.5	1236.1	2436.0

**Table 4.11: Summary of Sector Funding Needs and Sources (USD million)**

	2008 - 2013	2014 - 2020	Total
<b>Access Programme Capital Costs</b>			
Grid	266.2	359.2	625.4
Off-grid	82.7	64.8	147.6
Technical Assistance	28.7	23.4	52.1
<b>Total</b>	<b>377.6</b>	<b>447.4</b>	<b>825.0</b>
Non-grid components	111.5	88.2	199.7
<b>Other Investment Capital Costs</b>			
Generation	74.8	30.9	105.6
Transmission	80.7	82.9	163.6
Distribution Rehabilitation	8.7	5.5	14.2
<b>Total</b>	<b>164.1</b>	<b>119.3</b>	<b>283.4</b>
<b>Operating Costs</b>			
Existing Demand	176.9	262.5	439.4
Access Programme	100.6	445.5	546.2
Contingency	21.4	35.4	56.8
<b>Total</b>	<b>298.9</b>	<b>743.5</b>	<b>1,042.3</b>
<b>Funding Sources for Capital Costs</b>			
Operating Cash Flows	383.4	924.5	1,308.0
Government Transfers	203.5	239.1	442.5
Donor Grants	253.8	146.5	400.3
<b>Total</b>	<b>840.7</b>	<b>1,310.1</b>	<b>2,150.8</b>
<b>Financing Gap</b>	<b>457.3</b>	<b>385.6</b>	<b>842.8</b>

**Table 4.12: Summary of Sector Funding Needs and Sources (RWF million)**

	2008 - 2013	2014 - 2020	Total
<b>Access Programme Capital Costs</b>			
Grid	146,402	197,553	343,956
Off-grid	45,510	35,661	81,171
Technical Assistance	15,792	12,849	28,641
<b>Total</b>	207,704	246,064	453,768
Non-grid components	61,302	48,510	109,812
<b>Other Investment Capital Costs</b>			
Generation	41,115	16,974	58,089
Transmission	44,364	45,591	89,955
Distribution Rehabilitation	4,800	3,029	7,829
<b>Total</b>	90,279	65,594	155,873
<b>Operating Costs</b>			
Existing Demand	97,273	144,377	241,650
Access Programme	55,349	245,051	300,399
Contingency	11,761	19,471	31,232
<b>Total</b>	164,382	408,899	573,282
<b>Funding Sources for Capital Costs</b>			
Operating Cash Flows	210,876	508,497	719,373
Government Transfers	111,898	131,482	243,380
Donor Grants	139,592	80,578	220,170
<b>Total</b>	462,366	720,557	1,182,923
<b>Financing Gap</b>	251,490	212,060	463,550

**Table 4.13: Analysis of Economic Costs and Benefits of Access Programme (2009-2020)**

	Units	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>Connections added</b>	#	36,969	57,428	65,983	67,661	71,645	71,837	71,948	71,326	66,260	65,535	30,495	16,452
Cumulative connections	#	36,969	94,397	160,380	228,041	299,686	371,523	443,471	514,797	581,057	646,592	677,087	693,539
<b>Costs</b>													
Programme Capital Costs	USD m	56	79	84	92	66	66	65	65	61	57	54	52
Energy supply	USD m	2	8	13	18	24	29	34	40	45	50	53	56
Operating expenses	USD m	2	4	7	11	10	11	13	15	16	18	18	19
Total costs	USD m	60	91	104	121	100	107	113	120	122	125	126	127
PV of Total costs @10%	USD m	712											
<b>Benefits</b>													
First 20kWh (0.7)	USD m	6	16	27	38	50	62	75	86	98	109	114	117
> 20 kWh (0.5)	USD m	4	13	23	33	43	53	60	67	70	72	74	76
New commercial and industrial (0.7)	USD m	4	10	17	24	31	38	45	52	59	65	72	79
Total benefits	USD m	14	39	67	95	124	153	179	205	226	246	260	272
PV of Total benefits @10%	USD m	880											
<b>Net economic flows</b>	USD m	-46	- 52	- 37	- 26	24	46	67	85	104	122	134	145

**Table 4.14: Parameters from Analysis of Economic Costs and Benefits of Access Programme**

NPV (@ 10%)	USD m	\$168
ERR	%	24%
Total consumption	MWh	3,342,708
Levelised economic cost	US\$/kWh	0.21
Levelised economic benefits	US\$/kWh	0.26
Levelised net economic benefits	US\$/kWh	0.05



T: +1 (202) 466-6790  
F: +1 (202) 466-6797  
1700 K Street NW Suite 450  
WASHINGTON DC 20006  
United States of America

T: +61 (2) 9231 6862  
F: +61 (2) 9231 3847  
Level 10, 1 Castlereagh Street  
SYDNEY NSW 2000  
Australia

T: +64 (4) 913 2800  
F: +64 (4) 913 2808  
Level 2, 88 The Terrace  
PO Box 10-225  
WELLINGTON 6143  
New Zealand

T: +33 (1) 45 27 24 55  
F: +33 (1) 45 20 17 69  
7 Rue Claude Chahu  
PARIS 75116  
France

----- [www.castalia.fr](http://www.castalia.fr)