REPUBLIC OF RWANDA

MINISTRY OF INFRASTRUCTURE

ENERGY SECTOR STRATEGIC PLAN

2013/14 - 2017/18

17th March 2015

ACRONYMS AND ABBREVIATIONS

Table 1 List of Acronyms and Abbreviations

ACRONYM	DESCRIPTION
AfDB	African Development Bank
BEST	Biomass Energy Strategy
BTC	Belgian Technical Cooperation
CBOs	Community-Based Organizations
CDM	Clean Development Mechanism
CFL	Compact Fluorescent Lamp
CO_2e	Carbon Dioxide Equivalent
COMESA	Common Market for East and Southern Africa
DP	Development Partners
DSM	Demand Side Management
EAC	East African Community
EAPP	East African Power Pool
EDCL	Electricity Development Corporation Limited
EDPRS	Economic Development and Poverty Reduction Strategy
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EICV	Enquête Intégrale sur les Conditions de Vie
EU	European Union
EUCL	Electricity Utility Corporation Limited
EWSA	Energy Water and Sanitation Authority
GDP	Gross Domestic Product
GIZ	German Technical Cooperation Agency
GoR	Government Of Rwanda
M/GWh	Mega/Giga-Watt hour
HFO	Heavy Fuel Oil
HLTO	High-Level Target Objectives
HPS	High Pressure Sodium-lamps
HV	High Voltage
ICS	Improved Cook Stoves
IPP	Independent Power Producer
IRST	Institute of Scientific and Technological Research
JICA	Japan International Cooperation Agency
KWh	Kilowatt-hour (Unit of electricity)
LCPDP	Least Cost Power Development Plan
LEDs	Light Emitting Diodes
LV	Low Voltage
LPG	Liquid Petroleum Gas
MDGs	Millennium Development Goals
MEPS	Minimum Energy Performance Standards
MINAFFET	Ministry of Foreign Affairs
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and Economic Planning
MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce

MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MINISANTE	Ministry of Health
MIS	Management Information System
MTEF	Medium Term Expenditure Framework
MV	Medium Voltage
NBI	Nile Basin Initiative
NDBP	National Domestic Biogas Programme
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NGO	Non-Governmental Organization
NICA	National Inspectorate and Competition Authority
NIRDA	National Industrial Research and Development Agency
OGS	Office of The Government Spokesperson
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSF	Private Sector Federation
PV	Photovoltaic
RSB	Rwanda Standards Board
RDB	Rwanda Development Board
RECO	Rwanda Electricity Corporation
REDF	Rwanda Energy Development fund
REFIT	Renewable Energy Feed-in Tariff
REG	Rwanda Energy Group
REMA	Rwanda Environment Management Authority
RHA	Rwanda Housing Authority
RPPA	Rwanda Public Procurement Agency
RURA	Rwanda Utilities Regulation Authority
RWASCO	Rwanda Water and Sanitation Corporation
RWF	Rwandan Franc
SE4ALL	Sustainable Energy For All
SINELAC	Société Internationale d'Electricité des Grands Lacs
SME	Small and Medium Sized Enterprise
e-SWAP	Energy Sector Wide Approach Program
SWG	Sector Working Group
SWH	Solar Water Heater
UNFCCC	United Nations Framework convention on Climate change
VAT	Value Added Tax

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EXECUTIVE SUMMARY

The main objective of the Rwandan Energy Sector Strategic Plan (ESSP) is to ensure effective delivery of the set targets in the energy sector as set out under the EDPRS-II and to guide in the implementation of the National Energy Policy (EP). The ESSP thus functions as a detailed plan that serves to translate the policy directives and principles into concrete measures necessary to reach medium-term targets, reflecting current resource constraints and risk/uncertainties. The ESSP also contains high-level target objectives, and a monitoring framework with key performance indicators and interim milestones.

The ESSP addresses the challenges facing the sector and outlines strategies to meet critical needs. Principal among these needs are:

i. To enhance energy security and to better align demand and supply balances;
ii. To ensure that tariffs and prices for energy services are cost-reflective;
iii. To reduce coordination failures and the cost of financing infrastructure;
iv. To meet energy access targets without raising the average cost of electricity services, increasing subsidies, compromising service quality, or compromising environmental sustainability;
v. To develop the requisite institutional, organizational, and human capacity to increase accountability, transparency, national ownership and decentralized implementation of energy service delivery;
vi. To dramatically scale-up energy investments through more effective private sector engagement.

An earlier version of the ESSP was drafted in 2012 in conjunction with the national EDPRS-II formulation process. This updated ESSP outlines several new high-level target objectives (HLTOs) that have been determined on the basis of political ambitions and rigorous technical analyses. These cut across all key energy sub-sectors. The HLTOs serve to translate the policy goals laid out in the EP and EDPRS-II into tangible outcome indicators achievable by the end of the EDPRS-II period (2013 to 2018).

ESSP high-level target objectives
⊙ Increase the electric power system equivalent installed capacity (domestic generation + imports) to 563 MW.
⊙ Increase household access to grid electricity to 48% and access to off-grid electricity to 22%.
⊙ Achieve savings from energy efficiency measures of 10% through demand-side management measures and grid-loss reductions (from a 2013 baseline).
⊙ Reduce the carbon intensity of the grid by 10% by 2018, and 25% by 2025 (from a 2013 baseline).
⊙ Ensure 80% of all households employ clean cooking energy technologies.
⊙ Realize all EAC Regional Integration Policy priorities for energy sector.
⊙ Ensure the necessary infrastructure is in place to meet current petroleum strategic reserve requirements (currently 3 months' supply)

The government intends to provide 70% of the population with access to electricity both on-grid and off-grid by the end of EDPRS II. The priority is to extend the grid network to allow heavy users of electricity across the country to connect to the grid. For lighter users of electricity, grid connections are unlikely to make economic sense in the short term and as such, off-grid solutions will be preferred.

To keep pace with increased demand for electricity and to facilitate achievement of EDPRS-II targets for economic growth, the government will ensure increased electricity generation capacity to a level of up to 563 MW by the end of 2017/2018. Diversifying power generation sources and reducing diesel generation over time will enable the government to lower the long-term cost of service and gradually phase out indiscriminate subsidies to the tariff.

The total estimated cost of all programs is around $4.1 billion, with around $2 billion selected to come from public funds. The anticipated power generation road map, a large contributor to the future sector budget, is detailed in Table 20, in Annex I.

Table 2 Summary of sector strategies and HLTOs by Sub-Sector (FY 2012 to 2017)

ELECTRICITY	
On-Grid Electricity Supply	▶ *Electric power system installed capacity (domestic generation + imports) to reach **563 MW** by 2018.* • **Demand:** Current projections at roughly 470 MW by 2018. A 15% reserve margin shall be factored into plans to improve power quality and reliability**.** • **Supply:** The generation portfolio will be optimized to reduce long-term costs, increase energy security, and achieve environmental sustainability objectives. Government will increase investment in resource assessments and feasibility studies to reduce perceived investment risks and attract greater private sector participation.
Electricity Access	▶ *Reach 70% electricity access based on differentiated grid and off-grid strategies and targets.* • **Grid access (48%):** Priority to be given to productive end-users and households consuming sufficient electricity to make connections financially sustainable. **Off-grid access (22%):** Implement market transformation initiatives and PPPs to increase household access to off-grid solutions such as solar PV. These will target households where grid connection financially unviable. Regulatory changes to encourage mini-grids and SPDs. ▶ All **schools and hospitals** to have 100% access to electricity by 2018 through on/off-grid mix.
Environmental Sustainability	▶ *Reduce the carbon intensity of the grid by 10% by 2018 (from a 2013 baseline).* • Measures to promote renewable energy and low-carbon power supply, including expanding REFIT scope. • Gradual reduction in petroleum-based power generation over time. • Mainstreaming climate vulnerability into hydropower planning.
Electricity tariff	▶ *Make power increasingly affordable and phase out indiscriminate subsidies to the electricity tariff by **2017/2018**.* • Specific strategic industries and vulnerable population groups will be targeted for **"smart" subsidies** as matter of policy and to achieve cost transparency.

	• The power generation mix will be **diversified** to gradually reduce petroleum-based power generation. • **Revised tariff methodology** to disaggregate tariffs based on end-user categories, and to reduce barriers to new customers by removing fixed meter charges. • **Increased regional imports** from EAPP countries at cheaper tariff levels expected. • **EWSA restructuring** to yield operational efficiencies and reduced non-technical losses that contribute to high cost of power.
Energy Efficiency	▶ *Save up to 10% of 2013 power output by implementing priority energy efficiency programs including demand-side management and grid-loss reduction measures.* • New **Energy Efficiency Strategy** developed to shave peak-demand and avoid unnecessary investment in new power generation. • Consolidation of institutional responsibilities to execute priority demand-side energy conservation and management programs (such as industry audits, lighting retrofits, and solar water heater subsidies). • Implement a **grid-loss reduction program** and improve plant maintenance. • Develop **new regulations** and a regionally appropriate appliance standards and labelling program.
BIOMASS	
Sustainable biomass solutions	▶ *Ensure 80% of all households employ clean cooking energy technologies* • Further **decentralise** and streamline the implementation of programmes, including promotion of improved cook stoves (ICS) and biogas digesters. Reform subsidy program for household biogas digesters. • Implement **market transformation activities that incentivize fuel switching** to cleaner, more sustainable fuels and cooking technologies such as biogas, biomass pyrolysis, LPG, and vetted improved cook-stoves models. Strategies will vary depending on end-user appropriateness and economic viability. • Promote **efficient charcoal production**, including wood-harvesting and carbonisation techniques.
PETROLEUM	
Security of supply	▶ *Ensure adequate storage infrastructure (equivalent to 3 months' supply), and implementation of regional projects.* • **Strategic Stocks:** New storage facilities to be built in Kigali based on strategic reserve levels set by MINICOM. This has been decided upon as 3 months strategic supply split between government and private sector, but may be revised based on future analyses. • **Decrease import costs:** Regional oil pipeline and refining projects will be developed. Bulk purchasing and hedging strategies will be pursued. LPG market assessment to be undertaken.
Upstream Exploration	• Streamlined new **licensing procedures** to be implemented
Affordability	• MINICOM to enact new fuel pricing methodology and regulatory mechanisms.
Quality	• Streamline and consolidate approach to regulation of sector. • Strengthen enforcement of quality standards through increased tests and checks.

1 OVERVIEW OF THE ENERGY SECTOR

Chapter outline

This chapter gives an overview of the energy sector, discussing the current status of energy consumption and the baseline situation in each of the sub-sectors (Electricity, Electricity Access, Energy Efficiency and Demand-Side Management, Biomass and Petroleum).

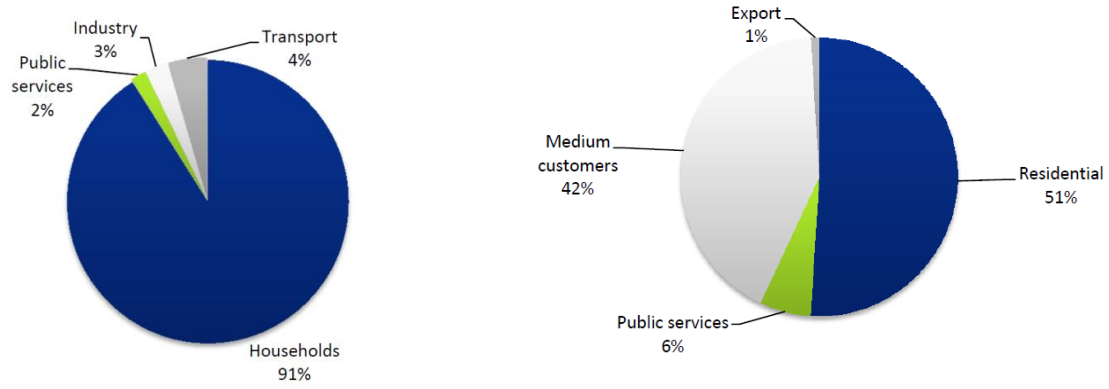
1.1 Context

The energy sector is pivotal to the Rwandan economy, given its systemic link to almost all other sectors of the economy such as transportation, housing and urbanization, manufacturing, agro-processing, mining and IT services. A core focus continues to be on electric power supply and transmission. Electricity can be generated from a variety of technologies and natural resources in Rwanda, such as petroleum-based fuels, hydro, solar, methane gas, peat, geothermal, biomass, waste, and wind. An increasing focus is also given to energy efficiency and conservation measures, which includes both demand-side and supply-side elements. The ESSP scope goes beyond electricity, however, to include the bioenergy sub-sector, including bio-products[1], such as wood fuel, charcoal, and biogas, as well as petroleum products, such as diesel, kerosene, LPG and natural gas.

Considering energy use broadly, the main consumers are households (91%), which mainly use energy in the form of traditional fuels such as wood, followed by the transport sector (4%), industry (3%), and public services (2%)[2]. Households are also the dominant consumers of electricity (51%), the bulk of which demand is primarily used for lighting. The industrial sector (42%) is the second largest consumer of energy, which mainly comes from motor-drivers and lighting. Major industrial consumers include companies in the cement, mining, textile, and agricultural sector (including tea estates). Public sector consumption of electricity (6%) is mainly for powering public buildings, street lighting and water pumping[3].

[1] Bio-products cover fuels developed from biological materials, including charcoal, biogas from waste matter, and biofuels from agricultural crops and resources.
[2] Low-Carbon Africa Report, November 2011
[3] Draft National Energy Efficiency Strategy, January 2014

Figure 1. Total Energy (2009) & Electricity Consumption (2012) by Sector



Biomass energy resources represent 85% of the energy balance. In fact, the primary source of energy in Rwanda continues to be biomass, principally used in cooking. The most basic forms of biomass are firewood, which represents 57% of all energy use, and charcoal, which represents 23%. Crop waste and other fuels (6%) are used to a limited extent, but new technologies are increasing their commercial appeal[4]. In urban areas, electric stoves and microwaves are used only to a limited extent. Commercial establishments and wealthier households in urban areas are also increasingly using Liquefied Petroleum Gas (LPG).

Table 3 below illustrates projected usage trends by energy carrier and across the main different demand end-uses. It summarises the anticipated demand shifts and transitions across the main energy carriers as a result of current policies and strategies.

Table 3 Illustrative view of energy use patterns and transitions from different sources by 2018

	Transport	Heating and Cooking	Lighting	Modern Domestic and commercial Technologies	Industrial processing
Bio-products	Small fraction of transport expected to use Biofuels	Bio-products dominate; transition away from wood to charcoal and Biogas.		none	Small use of Bio-products e.g. wood burning for tea processing
Petroleum	Vast Majority of transport will continue to use petroleum products	LPG will be used but will remain a luxury for the urban wealthy	Kerosene may be used but Electricity will dominate	none	Petroleum to be used for heavy machinery or where grid connections are unavailable
Electricity	Electric Vehicles not envisaged in the next 5-years	Electricity will not make economic sense for heating and cooking	We expect a significant increase in both on and off-grid electricity for lighting	Electricity will be the only possible option	We expect a significant increase in Electricity use for industrial processing

Note: A red arrow indicates where a significant rise in use of a particular energy source for a given activity is anticipated

[4] MININFRA, Presentation on 'Initiatives to promote renewable energy in Rwanda', RE Energy Program of Activities Workshop, January 2013

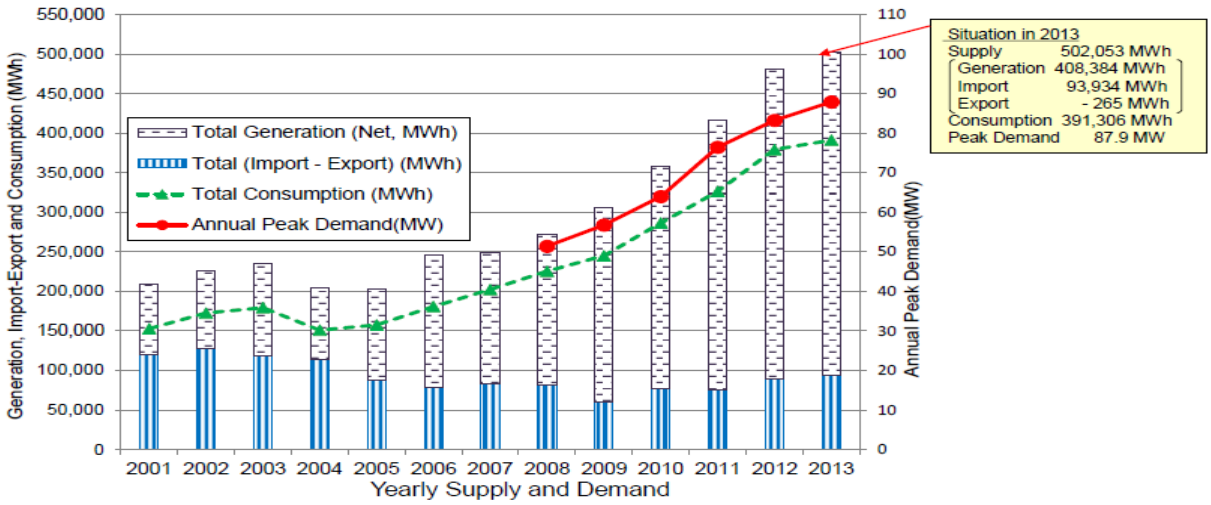
The following sections summarize expected trends and transitions across the sub-sectors.

1.2 Electricity Sub-sector

Electricity is an essential driver of modern technology and socio-economic development. Its use is required at low levels for devices such as lights and mobile phones, as well as at high levels for industrial processing activities that contribute to economic value-added products and job creation.

At the end of 2012, electricity represented only about 4% of primary energy consumed in Rwanda.[5] Total installed electricity generation capacity is currently 160 MW of which roughly 60% comes from hydrological resources and 40% from diesel-powered generators.[6] Since 2008, power supply has increased by 10% to a total of 502,053 MWh. In July 2014, the utility had about 450,775 household customers and 170 customers in the industrial category. Total consumption has been growing on an annual basis, following a logarithmic trajectory. Rwanda has a very pronounced peak demand load, which was registered at 87.9 MW on average annually in 2013. Supply is occasionally unable to match demand in these peak hours. Future demand for electricity by 2017/2018 is projected to reach 470 MW. Power demand does not fluctuate seasonally.

Figure 2 Energy Demand and Supply Situation (2001-2013)



The electricity tariff is currently not cost reflective and heavily subsidized. A reliance on costly petroleum-based power generation, which was brought in temporarily to respond to an extended drought over a decade ago, has led to high costs; the cost of supplying electricity is around 50% higher than the average tariff in East Africa, and over 20% higher than the regional average in sub-Saharan Africa. Approximately US$ 56,000 is spent per day

[5] Biomass use survey in urban and rural areas in Rwanda, 2012.
[6] EWSA, Grid Audit Report, 2013.

as operational expenditure on diesel imports. A combination of high-cost generation from diesel and Heavy Fuel Oils and low demand for electricity has also impeded the financial sustainability of the Utility.

1.2.1 On-grid Electricity

Currently, Rwanda has one of the lowest per capita electricity consumption rates in the world, at 42kWh per annum compared to an average of 478 kWh for sub-Saharan Africa and 1,200 kWh for developing countries as a whole.[7] Presently around 20% of Rwanda's households are connected to the grid. This partially reflects a situation of "supressed demand," which can be partly attributed to the fact that the tariff of $0.24/kWh is relatively high for the region, and the geo-spatial realities and dispersed settlement patterns in Rwanda render the infrastructure costs of grid extension projects expensive.

While network connections require significant capital costs, they provide stable, high-voltage electricity required to power large domestic and industrial equipment for commercial and large residential users. Thus, expanding on-grid access will facilitate a shift from the current agriculture based economy towards industrialisation. In recent years, there has been an aggressive program to increase access to the electricity services by all sectors of the economy, especially industry and small and medium enterprises (SMEs). Grid connections do however require significant capital investment which needs to be financed and repaid. Calculations indicate that consumption would have to reach around 130 kWh/month to recover these financing costs.

Several challenges and complexities are associated with power generation and supply, more general, and in Rwanda, in particular: First, it cannot be stored on a large scale,[8] unlike other energy sources. Careful planning and network operations are required to allow power to travel instantaneously from the source of generation to the end user. During this journey, a significant amount of energy is lost as heat. **Proper network planning and operation** is essential to minimise these losses. The current average estimate of losses in the power system (both technical and non-technical) is around 23%. Secondly, generation output must continuously flex with end user demand, which is not constant throughout the day. As a result, different generation technologies can fulfil different roles. Third, **electricity is capital intensive.** Unlike petroleum, where the majority of costs are variable and associated with the commodity cost, electricity production costs are mainly associated with infrastructure investment costs. These are typically paid off over multiple years over the useful (depreciated) life of the asset. Therefore, a decision to invest or enter into an agreement with the private sector must make sense not just for the next few years but for the entire

[7] EDPRS II, p.49

[8] In a number of countries electricity is stored through pumped storage (i.e. pumping water up a hill) this is extremely inefficient and only appropriate where a country has a very cheap base-load energy resource such as nuclear or geothermal. We are investigating the potential for pumped storage as part of the Nyabarongo II scheme.

life of the asset. A small change in the financing costs will result in a large change in the total cost and long-term return, which brings with it inherent risks. As a result, careful consideration must be given to ways to mitigate investor risk.

1.2.2 Off-grid Electricity

Lighting in rural areas is in most cases provided by kerosene. Use of other energy sources such as solar, biogas and LPG is limited. At current tariff levels, on-grid electricity access is unaffordable to most rural customers and their consumption is insufficient to recover up-front costs. These users would mainly use electricity to charge their phones, radios and for a few hours of lighting per day.

Government has already had some degree of success with various initiatives. For instance: donor supported programs have connected over 150 remote rural schools with 1.7kW solar energy solutions and 300 schools, and 46 health centres are now being connected. Solar lantern kits of 5W have been distributed to 15 rural settlements (approximately 1500 households) and lastly, 400 solar kits of 300W have been installed in 4 rural settlements. This is in addition to private sector initiatives with several, now well established, companies operating in Rwanda.

1.2.3 Generation Resources

Rwanda has a range of indigenous resources that complement each other in the energy mix. Table 9 illustrates how this can be split across the different generation technologies:

Table 4 Overview of Rwanda's indigenous energy resources

Resource potential	Characteristics and Considerations
Hydropower 313-400 MW[9]	Hydropower has generated the bulk of electricity in Rwanda since 1960s. Its overall potential is estimated at about 400 MW but the current installed hydro capacity is 98.5 MW. As a result of extremely low operational costs however, hydro is still one of the cheapest forms of generation in the long run.
Methane 350 MW[10]	Pilot projects have demonstrated the commercial and technical viability of extracting methane from Lake Kivu. Following completion of KivuWatt 1, this will be further proven, and increased interest from private investors can be expected.
Peat 700 MW[11]	A Peat master plan was first developed in 1993. It indicated the potential to develop around 700MW of peat generation based on estimated reserves of 155 million tons of dry peat spread over 50,000 hectares. About 77% of peat reserves are near Akanyaru and Nyabarongo rivers and the Rwabusoro Plains. The cost of electricity produced from peat will be slightly higher than from methane gas, due to the cost of

[9] Consisting of 250 MW of Domestic potential and 150MW of regional potential
[10] Total resource is estimated at 55bcm of Methane or approximately 700MW; this is to be shared equally with DRC
[11] Peat resources include 40,000 ha of peat bogs of various quality – 1992 Peat Master plan. A more detailed study to provide the fuller picture of peat reserves in Rwanda is underway and expected to be finalized by the end of October 2014.

	peat mining. Peat is considered less risky for power generation compared to methane or geothermal, and can therefore deliver increased capacity sooner.
Geothermal (TBD)	Rwanda's geothermal resource is yet to be proven. Geo-scientific studies are on-going which will lead to the development of the necessary drilling strategy to confirm the resource. A quantitative estimation of Rwanda's geothermal potential would thus be premature at this point in time.
Solar Energy	There is a high interest from private sector in on-grid solar power development. However the penetration level of solar power to the grid is limited by technical capacity of the grid. Solar Power will be added according to the increase of generation capacity from non-intermittent sources and reinforcement of the grid.
Biomass (TBD)	Small-scale power generation using agricultural residues (either directly, in the case of bagasse or rice husks) or biomass briquettes from compacted waste residues or charcoal dust is feasible at low levels of capacity. In addition, there is a small potential for generating power from landfill gas, waste water effluent, and municipal solid waste. A more detailed resource assessment for the purpose of power generation needs to be conducted.
Wind Energy	Commercialy wind power resources are not expected to be significant based on past resource assessments and modeling work. However, MININFRA is proceeding with more detailed assessments of national wind energy potential to verify niche contributions to the country's energy needs.

Hydro Power generation

Studies suggest that Rwanda's topography is most suitable for medium- to high-head pico- and micro-hydro run-of-river schemes. Rwanda's overall technical hydropower potential has been estimated at 400 MW, although this varies according to different studies made at different times. The most significant resource assessment conducted to date—the Rwandan Hydropower Atlas conducted roughly five years ago—found that the majority of potentially feasible sites would be rated between 50 kW and 1 MW in capacity. This study estimated a potential of 96 MW for the category of micro-hydro projects. Although fairly comprehensive, with some 333 potential sites identified across a large number of locations, additional viable sites have already been, and are likely to continue to be identified.[12] An assessment of the energy sector undertaken by the African Development Bank in 2013 estimated Rwanda's domestic hydropower potential at 313 MW, broken down into 130 MW of domestic and 183 MW of regional hydro resources. Feasibility studies have been completed or are under way for a number of sites, representing at least 32 MW of technically viable new capacity. In addition, over 192 sites have been identified for pico-hydro with a capacity below 50 kW.

Evidently, a more detailed resource mapping for the hydropower sector would be valuable, particularly taking a spatial river basin approach before prioritizing specific sites for

[12] Roughly 20% of proposed sites to be developed to date were not already included in the Hydropower Atlas. Informal communication with Rwanda Development Board, 30 May 2014

development. An on-going comprehensive assessment of hydro resources on the Akanyaru River basin, located on the border between Rwanda and Burundi, adopts this approach. These resources can be developed in cascade form, with 11 domestic sites and 3 shared sites recommended for further feasibility analysis. Based on preliminary estimates, these projects could potentially augment Rwanda's total installed capacity by over 25 MW.[13]

Peat to power

Currently peat is used as an input in cottage industries, cement production, and as a cooking fuel in a small number of decentralized institutions. Rwanda has estimated reserves of 155 million tons of dry peat[14] spread over about 50,000 hectares in Akanyaru, Nyabarongo, Rwabusoro and other areas. Approximately one-third of this resource is currently commercially extractable for industrial heat or electric power production. These estimates are largely based upon a 'high level' master plan undertaken in 1993, with only a small number of samples having been taken and the majority of work being carried out as desk research. In late 2013 and early 2014, REG undertook more detailed resource assessments in order to complement and refine the existing peat master plan. Parallel to this, several projects have independently developed feasibility studies based on resource potentials identified in specific locations. However, it is important that at the national level Rwanda has an accurate assessment of its resources in order to determine how to use them most efficiently and sustainably, as peat energy is not generally considered to be renewable. In addition, some peat resources are located in environmentally sensitive habitats.

Geothermal energy resources

Rwanda may have geothermal potential which is manifest in the form of hot springs. Three main prospect areas have been demarcated for further exploration: Kinigi, Gisenyi and Bugarama. The potential of geothermal energy is still uncertain. Given the complexity involved in determining the commercial viability of geothermal power, however, much more detailed exploration studies and sub-surface drilling are required.

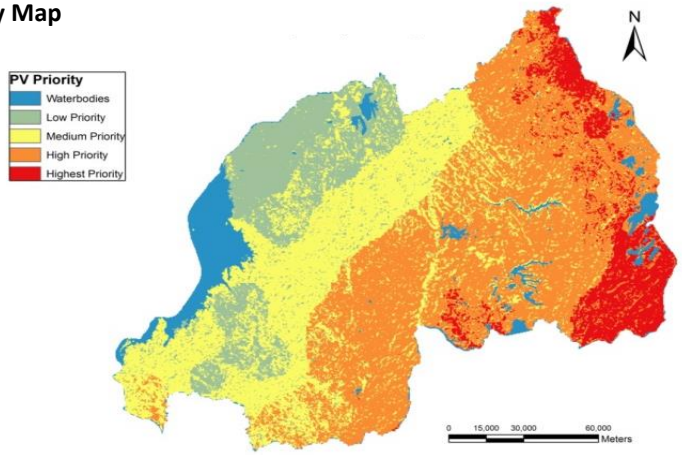
Solar energy

Rwanda's solar radiation and solar resources were assessed by the U.S. National Air and Space Agency (NASA) as well as the University of Rwanda. Rwanda's Eastern Province has the greatest potential for generating energy from solar resources, as shown in solar energy resource map that was created from this study. Another academic assessment, undertaken in partnership with the MININFRA Department of Meteorology in 2007, used a

[13] The unshared (Rwandan territory) part of the river has a total potential installed capacity of 12 MW or annual generation of about 64 GWh. See "Study on the Identification of Hydropower Potentials Along the Akanyaru River," MWH Consortium for European Commission, 2014.
[14] Peat Master Plan prepared by EKONO.

meteorological data set to estimate monthly averaged global solar radiation. This was found to vary between 4.3 and 5.2 kWh per m2 per day over all regions of Rwanda.[15]

Figure 3 Rwanda PV Suitability Map



Source: NASA 'Rwanda Agriculture & Energy' (2013)

Wind

Being located close to the equator, Rwanda's inherent resource potential for wind energy is low. A rapid wind energy resource assessment was carried out in Rwanda in five locations over the course of 2011. Preliminary indications from the analysis of recorded field measurements of wind speeds and climate data were that most of Rwanda is not highly suitable for wind energy. The Eastern province was identified as the location with the most promising potential, and a simple analysis comparing wind and solar energy feasibility suggested that wind energy could be competitive in this region. Another academic study using modelling analyses based on recorded wind measurements at selected Rwandan meteorological stations noted that electricity production in the area of the Gisenyi station could be possible with a good mean value of both wind speed and power density, whereas in areas such as Kigali, Butare and Kamembe, wind energy potential is only sufficient for windmills or water pumping for agricultural and intuitional needs.[16] More detailed resource assessments and feasibility studies are required to determine commercially viable wind energy potential in Rwanda.

Methane Gas

The majority of the country's methane gas resources stem from the globally unique geology of Lake Kivu and the naturally regenerating methane gas that is found there. Some 1000 studies have been carried out, the consensus of which is that Lake Kivu is estimated to

[15] C. Museruka and A. Mutabazi. *Assessment of Global Solar Radiation over Rwanda* Proceedings of the International Conference on Clean Electrical Power, (ICCEP), 21-23 May, 2007.
[16] Bonfils Safari. "Modelling wind speed and wind power distributions in Rwanda." Renewable and Sustainable Energy Reviews 15 (2011) 925–935.

contain around 55 billion cubic metres of methane gas, with a further 150 to 250 million cubic metres of methane being generated annually. In recent years, Government has put great efforts on proving the technical and commercial viability of safely extracting methane from Lake Kivu to produce power. Indeed, the more methane gas that is extracted, the safer are riparian communities, as there will be less methane gas that could potentially explode in case of a sub-surface volcanic eruption. According to feasibility studies undertaken [by EWSA], it is possible to sustainably extract sufficient gas to generate around 700MW of power. This would put the national potential at 350MW, as the resources are shared equally by Rwanda and DRC through an international agreement. A small pilot plant, owned and operated by Kibuye Power (KP I), and having an installed capacity of 3.6MW, has been operational for some time. The expected commissioning of the 25MW KivuWatt power plant in late 2014 will go a long way, however, toward corroborating the commercial feasibility of Lake Kivu methane gas as resource for large-scale power generation. In addition to Lake Kivu, Rwanda also possesses inherent methane resources that can be extracted from underground mining seams.

Methane gas has a variety of commercial and industrial uses, beyond the production of electricity, although it is currently anticipated that the primary end-use of the resource will be for electricity. Feasibility studies for direct use of methane gas in heating applications, fertilizer, and petrochemical production have already been conducted and more are to be expected with a lower risk of extraction of the resource.

Biogas

Biogas can be generated from a variety of biomass resources, including agricultural, human, and municipal waste. The national resource potential for these alternative sources of methane or biogas has never been systematically estimated through surveys or extensive resource assessments. Pre-feasibility studies have been conducted for a landfill gas-to-electricity project in Kigali, however, which suggested that commercial plant could be feasible in the near-term future given higher population growth and volumes of waste collected and more systematic separation of waste streams.

1.3 Energy Efficiency and Demand-Side Management

Government is undertaking various *ad hoc* energy efficiency programs, although these are not streamlined in an energy efficiency and demand-side management strategy. Current programs include:

Compact Fluorescent Lights (CFL): Lighting is the main use of electricity in Rwanda. A CFL distribution program took place in 2007, and targeted residential customers: 400,000 CFLs were sold to the existing 95,000 beneficiaries over several phases, and 400,000 CFLs were provided to 80,000 new customers as part of a 'welcome pack'. It was estimated that 54 GWh per year were saved, along with 260,000 tCO2e.

'SolaRwanda' Solar Water Heaters (SWH): Initiated in 2012, the project aims to establish a SWH market through promotion and financial incentives to suppliers. The target is to distribute 12,000 units by 2015 with an estimated saving of 23,000MWh per year. However, currently only 800 units have been distributed, mainly due to supply and incentives issues.

Street Lighting: A pilot project was implemented by the City of Kigali to replace high-pressure sodium (HPS) lamps with LEDs in street lights. This led to a 60% reduction of power consumption from the baseline level. The financial savings or payback of the program requires further analysis in order to justify scale-up and replication.

1.4 Biomass energy subsector

In Rwanda, the biomass energy subsector covers mainly cooking energy and boiler fuels, but it also concerns power generation and transport fuels to a lesser extent. Biomass resources are exploited in form of firewood, charcoal or agricultural residues mainly for cooking purposes by households and also in some industries.[17] Country-wide, biomass meets up to 85% of energy needs; the balance being met by other options such as kerosene, diesel, dry cells, grid and non-grid electricity, biogas, solar, wind and other renewable energies.

Rwandans have traditionally used biomass as their main source of energy, currently meeting 84% of the primary energy needs. It is estimated that Rwanda's sustainable supply potential of wood fuel was 3.2 million tonnes in 2009, and this can be increased further with forestry programs. Currently over 80% of the country's firewood and charcoal comes from privately operated plantations of eucalyptus trees and other small-scale agro forestry programs. Many farmers dedicate a small portion of their plots to eucalyptus for self-consumption; however, much of this wood is either used for construction, rather than energy.

Charcoal is the preferred cooking fuel for urban households. Experience across Africa suggests that demand for charcoal will increase rapidly with urbanization trends. Households will first use it as a complementary fuel to firewood but gradually shift entirely as it is more convenient, and alternatives such as LPG and electricity are currently expensive.

Biomass consumption is putting pressure on existing resources, with an estimated 870,000[18] tonne woody biomass deficit in 2009. Along with this the use of biomass for fuel is having harmful effects through health impacts and emissions. To rectify this, the Government is further developing the public sector forestry programs, has licensing for tree harvesting and is diversifying away from traditional wood fuel to look at other forms of biomass such as papyrus and rice and coffee husks, as well as biogas which benefits from the 'One cow per

[17] MININFRA, 2008
[18] BEST,FAO High Resolution aerial photos (GIS NUR 2012)

poor family' scheme. The Government has put in place strict tree harvesting regulations; only licensed persons with permits are allowed to cut trees, including those from private lands. These measures have helped to reduce deforestation and Rwanda is one of only a handful of countries in Africa where the relationship between charcoal consumption and deforestation no longer exists. Government is to focus on increased wood production

1.4.1 Improved cooking technologies

According to a recent study, traditional wood fuel is the energy used by the vast majority of rural households (i.e. over 90%) for cooking.[19] The average household uses around 1.8 tonnes of firewood each year to satisfy its cooking needs with a traditional stove. The average monthly consumption per household on fuel wood is RWF 1,930.

The government program has been running since the 1980s with 60% household penetration. Private sector led efforts are also distributing cook stoves that are up to three times more efficient than the traditional 3-stone stove, and can reduce biomass consumption by anywhere between 68-94%[20] This will free up the time spent by women and children in collecting firewood, giving them more time to study and undertake more productive commercial activities

Whilst it must be noted that there are significant health and social benefits of transitioning to charcoal, it is likely to increase the pressure on the limited wood supplies. This issue is likely to be accelerated as more and more people move from rural to urban and peri-urban settlements where charcoal is more common and convenient.

1.4.2 Biogas

The potential biogas market in Rwanda is estimated at 150,000 households, among predominantly rural customers. Government has put in place an elaborate program for disseminating bio digesters in households, schools and prisons to reduce demand for wood and charcoal and improve people's health since 2007—the National Domestic Biogas Programme (NDBP). The NDBP's initial focus was on capacity development, training technicians and entrepreneurs, and social marketing. The institutional Biogas Program began at KIST as a pilot in 1999. In 2008, Government announced a policy to introduce biogas digesters in all schools (estimated at around 600), large health centers and institutions with canteens. Through this Institutional biogas program, 11 out of the 14 prisons in Rwanda are currently using biogas for cooking. Since the beginning of the program, **3,687** domestic biogas digesters have been installed in households and **68** institutional digesters have been installed mainly in schools and prisons. Government continues to subsidize biogas technologies, with a 50% government subsidy and the use of local microfinance institutions, even after the termination of financial support by DPs to the

[19] EWSA. Baseline Impact Evaluation Survey for the EARP Sub-Components in Rwanda August 2014.
[20] Inyenyeri Promotion Material, 2014

program. The biogas systems installed in the schools and prisons have reduced firewood consumption by close to 60% and 40% respectively, along with significantly improved hygienic conditions and cost savings.

1.4.3 Bio-fuels

Bio-fuels could significantly reduce Rwanda's dependency on imported petroleum products by replacing fuels (especially transport fuels), with fuel produced from domestically harvested crops. Bio-crops generally require significant areas of land in order to produce any significant level of output. Given the current challenges of land shortages, the trade-off between bio-crops for fuel and food production is likely to be too great to be attractive.

The Institute of Scientific and Technological Research (IRST) drafted a policy in 2008 to promote bio-diesel exploration, production and use in Rwanda. This came following a country-wide study conducted by IRST on bio-diesel production that revealed its viability in Rwanda. NIRDA currently carries out research and piloting activities on biofuels, including running a small dedicated fleet on biodiesel.

1.5 Petroleum subsector

Currently, Rwanda depends entirely on imported fuel products, because its petroleum resources are yet to be commercially proven and developed. Petroleum consumption increased in absolute terms by over 16% between 2000 and 2012, yet the oil import bill grew by more than 700% in the same period. As a share of GDP, oil imports increased from about 2.5% in 2000 to above 5.5% by 2012. The cost of procurement has an important macro-economic impact. At present, oil products account for 25% of import costs and the proportion of export revenues spent on oil products is even higher at around 55%[21]. Still, this level of growth has been relatively more modest compared to Rwanda's neighbours.

The reduction of imported diesel for electricity production will be more than off-set by the increased need for petroleum products in transportation, particularly aviation and heavy industry. For example, more transport vehicles on the road and expansion of air traffic at Kigali International airport will contribute to rising demand for petroleum products.

As illustrated in the table below, diesel and petrol are the dominant petroleum product imports, where diesel is being mainly used in the generation of Electricity whilst petroleum products are used in transport.

[21] MINICOM Downstream Petroleum Policy, 2012

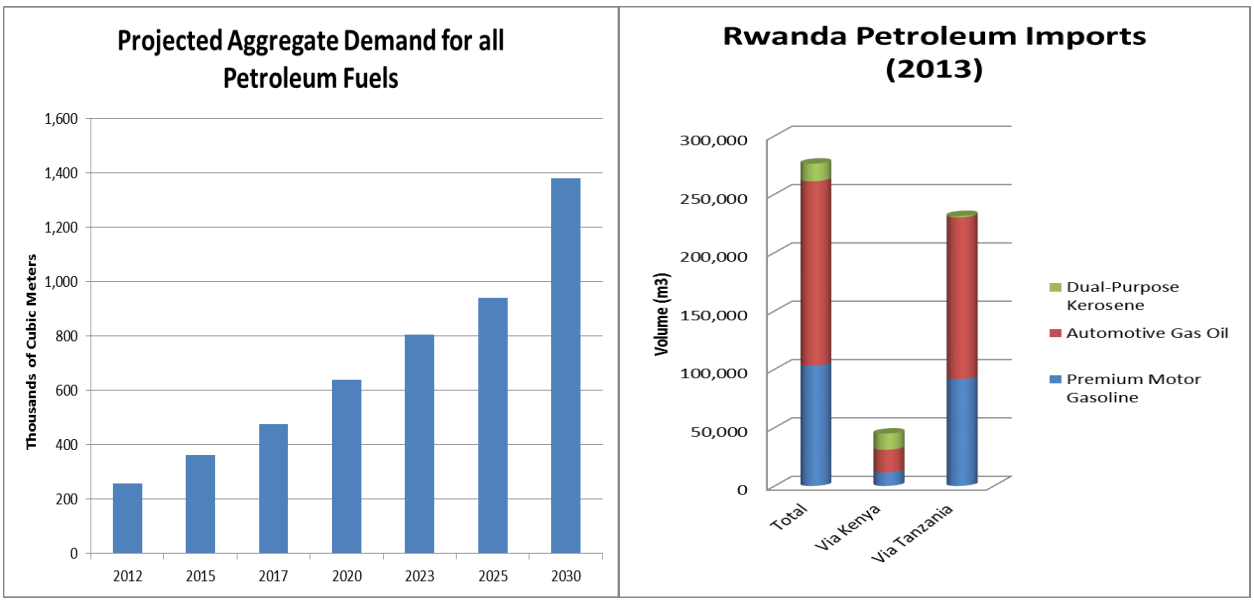
Table 5 Petroleum products importation (Litres) – 2011/12

Product	Annual consumptions (litres)
Petrol	82,263,817
Diesel	121,937,405
ILLUMINATING KEROSENE	15,222,724
HEAVY FUEL OILS	33,666,910
JET A-1	12,454,649
TOTAL	**265,545,505**

Source: MINICOM (Downstream Petroleum Policy, 2012)

The petroleum subsector is vital if government is to achieve required levels of growth over the coming 5-years. Due to Rwanda's geographical location, and lack of commercially developed resources, the economy depends entirely on imports to satisfy the country's need for petroleum products such as diesel, petrol, oil, kerosene and natural gas. Currently around 84% of all petroleum imports come to Rwanda from Tanzania, and 16% of all petroleum imports come to Rwanda from Kenya. Automotive gas oil (i.e., diesel fuel used in road vehicles) represents the largest share of these imports, followed by premium gasoline, and kerosene products, which represent less than 5.5% of all total petroleum imports. The figure below illustrates the current demand[22], and expectation of demand growth for all petroleum products over the coming years:

Figure 4 Projected Aggregate Demand for all Petroleum Fuels & Petroleum Imports for 2013



Source: MINICOM, 2013

The demand for petroleum products is forecast to grow at rates commensurate with GDP growth each year[23] between now and 2020, but will not be evenly distributed:

[22] Kurrent Technologies, Final Report on Developing a Rwandan Downstream Petroleum Strategy, 2014
[23] Kurrent Technologies, Final Report on Developing a Rwandan Downstream Petroleum Strategy, 2014

1) **Diesel imports** will gradually decline, following plans to transition away from diesel to other lower cost, indigenous forms of power generation.
2) **Aviation fuel** demand is expected to grow at a significantly higher rate, as Rwanda is positioned to be a preferred hub for air transportation in the region.[24]

1.5.1 Upstream petroleum sub-sector

- **Preliminary Exploration work**: The Government of Rwanda signed a Technical Evaluation Agreement to conduct preliminary exploration on Lake Kivu and a management prescription developed outlining best practice for sustainable extraction of Rwanda's petroleum resources if found.
- **Development of the Legal and Regulatory Framework:** A draft policy and strategy have been developed for the upstream petroleum sector with the intention to *"Promote and accelerate petroleum exploration in Rwanda to achieve commercial discovery of petroleum resources"*. Details for the developments under the upstream side of petroleum subsector are highlighted in detail in the Environment and natural resources (ENRA) Sector strategic plan. An upstream petroleum strategy, policy and gas law were approved by cabinet in 2013. A draft Gas Law should be adopted at the end of 2014, outlining the main requirements and regulatory structures for developing methane gas projects.
- **Petroleum sharing agreement on Lake Kivu:** The sharing of methane gas resources in Lake Kivu has been spelled out in a MOU between the governments of Rwanda and the DRC; however, this could be upgraded and extended into the form of an International Agreement or Treaty subject to Cabinet approval.
- **Upstream petroleum policy issues and recommendations:** To mitigate energy insecurity that emanates from excessive energy import dependence in the oil and gas sub-sector, it is clear that Rwanda would have to accelerate exploration of domestic oil and gas resources. The degree to which exploration and potential discovery can be accelerated depends on upstream exploration and development policies, their inherent investor incentives and the expediency of the licensing and regulatory process.

1.5.2 Downstream petroleum subsector

Regulations: In line with their role to regulate infrastructure within the Petroleum sector, RURA has recently approved regulations relating to the storage and transit of LPG and petrol station facilities.

Downstream petroleum policy developed: In July 2012, a downstream petroleum policy was presented to Cabinet. The purpose of the policy was to lay the policy framework through which Rwanda can *"achieve cost-effective, affordable and high-quality petroleum*

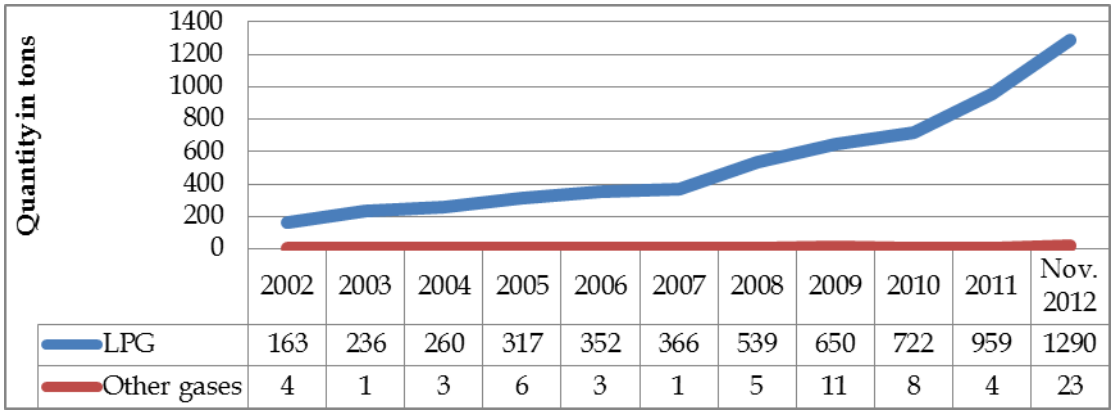
[24] Achieving this is heavily dependent upon our ability to secure cost effective reliable imports of aviation fuel; see section XX00

products". The policy was approved and currently a draft strategy is in the process of adoption.

Rwanda has no domestic production of natural gas. The country relies on imported gas especially LPG from other countries. The LPG market in Rwanda is dominated by six importers and marketers including Société Pétrolière-SP (37%), Kobil (34%), Sulfo (15%), Rwanda Oxygène (6%), Merez (5%) and Hashi energy that takes about 3% of the LPG market. All LPG is imported by road tankers of 10-20 metric tons through either Kenya or Tanzania. Retail distribution is done through service stations, independent distributors, and supermarkets in an assortment of cylinder sizes ranging from 3 kg to 35 kg. The country has a storage facility of 186 tons corresponding to a reserve equivalent to 1.7 month's consumption.

LPG consumption has increased exponentially since 2002, as inferred by importation records, rising by 25% annually between 2009 and 2012. All LPG sold on the Rwandan market is imported from Kenya and Tanzania, independently stored in tanks by each importer, and either filled in cylinders for distribution or imported in filled cylinders directly distributed to retailers. Import cargos vary from 1 to 3 times a month per importer. In November 2012, LPG imports amounted to 1,300 metric tons (equivalent to 2,756 m3) and an annual per capita consumption of 0.12 kg per year.[25] The evolution of LPG imports over time is highlighted in the chart below.

Figure 5 Progress of LPG imports and other gases between 2001 and 2012



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Nov. 2012
LPG	163	236	260	317	352	366	539	650	722	959	1290
Other gases	4	1	3	6	3	1	5	11	8	4	23

Source: MINICOM (Downstream Petroleum Policy, 2012)

Strategic Reserves: Transported oil and gas imports require domestic storage capacity. Rwanda maintains a 30 million litres storage capacity, with an upgrade plan to 150 million litres by 2017. Oil companies are required to keep 10,000 cubic meters of stock as well. These are important steps in strengthening domestic petroleum supply stability..

[25] Based on a population of 10.5 million according to the provisional 2012 census result

Table 6 Location and storage capacity of existing fuel depots[26]

Location	Petrol (M^3)	Diesel (M^3)	Kerosene (M^3)	Fuel oil (M^3)	Jet fuel (M^3)	Total (M^3)
Gatsata	7200	5100	1500	1900	0	15700
Kabuye	3000	2100	0	600	0	5700
Bigogwe	3000	2000	0	0	0	5000
Rwabuye	1900	1900	0	0	0	3800
Kanombe	0	0	0	0	1500	1500
Total	**15100**	**11100**	**1500**	**2500**	**1500**	**31700**

Source: RURA

Product quality standardization: One key element of energy security in the region is the degree of petroleum products adulteration and deterioration of quality. RURA is entrusted with such regulatory oversight and inspection. Proper regulation and maintaining statistics on incidence of product adulteration are useful in managing product quality challenges.

Implement energy diversification and domestication strategies to mitigate oil dependence including viable regional bio-fuels. It is therefore recommended that the case of Ethiopia is reviewed: the only mandated bio-fuels program in Eastern Africa. From there it will be possible to consider the long term viability of integrated fuel mix standards and mandates that will open market for bio-fuels in Rwanda.

26 OILCOM is among potential investors who have shown an interest in building oil storage depots. It is planning to put up 19,000 M^3 while Société Pétrolière (SP) is planning to set up an oil storage depot of 16,000M3 in phase one that can be upgraded to 40,000M3 in the second phase.

2 STRATEGIC FRAMEWORK

Chapter outline

The chapter provides an overview of the key measures and instruments that will be deployed to implement the National Energy Policy. Each sub-sector is structured as follows: (i) The policy objective and HLTOs; (ii) Analysis of the main challenges; (iii) corresponding actions to address those challenges; and (iv) a summary action plan. In order to more effectively mainstream them, cross-cutting themes discussed in the EP and EDPRS-II are integrated into these strategic implementation frameworks.

2.1 Electricity

2.1.1 Policy Objectives

The main policy objectives for the electricity sub-sector are to ensure sufficient, reliable, sustainable and more affordable power supply through the following measures:

- Revise and upgrade existing policy, legal, regulatory, institutional, and financial frameworks to support the rapid development of the electricity industry;
- Meet projected demand expected to exceed 400 MW by the end of 2018 with generation of 563 MW, to account for a reserve margin and system losses, by diversifying resources and increasing the share of clean power generation in the total generation mix over time;
- Align investment planning and funding mobilization more closely to a power sector master plan informed by the ESSP, a least-cost power development plan, and electricity sub-sector action plans;
- Enhance regional cooperation and trade in electricity, including investment in transmission network development, to further improve security of supply;
- Streamline IPP processes and fast track project delivery by securing long-term funding for planned electricity projects through a medium-term budget expenditure framework, revising and expanding the existing Renewable Energy Feed-In Tariff regime, developing new information management systems to streamline project development steps and procedures, and building greater capacity in planning, procurement, and negotiating power transactions.

2.1.2 Challenges within the Electricity Sub-sector

Challenge 1: Ensuring financial sustainability of network investments: Rwanda has a relatively high cost of electricity compared to other countries in the region, and at the same time, extremely low average volumes of consumption. The average annual cost of each connected customer is around $50. Currently this would require a consumer to use approximately 130KWh per month to fund her new connection, whilst in reality roughly half of consumers are using less than 20KWh per month. This challenge and the corresponding solutions are discussed further in chapter 2.2 Electricity Access.

Challenge 2: Ensuring financial sustainability of the generation investment: Approximately 80% of the tariff amount goes toward recovering the cost of generating electricity. Of this, the majority of the costs are fixed. If generation capacity and demand are kept aligned, an efficient tariff can be maintained. If demand fails to keep pace with increased generation capacity, then the tariff will increase. Investment decisions taken today, particularly in generation, will have an impact on future prices and competitiveness. Every MW of generation capacity installed must be paid for whether consumed or not. This should inform decision-makers to ensure that investment in generation is in line with demand.

Challenge 3: Insufficient reserve margin to meet power quality standards: Generation cannot run all of the time. At any moment, it is likely that some of our generation capacity will be unavailable, either through a planned outage for maintenance or for other reasons (shortage of fuel, technical error). Thus, there must always be a reserve margin (i.e., a surplus of generation capacity above maximum demand). The reserve margin mitigates or counteracts against any reduction in generation capacity experienced through planned or unplanned outages of generation plants or the loss of network connectivity. Current reserve margins are not adequate to maintain quality of supply standards according to the Grid Code. The exact reserve margin will depend on the level of uncertainty over demand and the nature of generation plan (more reliable plants would require a lower reserve margin).

Challenge 3: Capacity to deliver the electricity infrastructure: Project development, monitoring, and implementation require skilled and experienced managers and efficient coordination. There is strong need to hire and retain enough qualified staff to monitor energy projects and engage in strategic investment negotiations.

Challenge 4: Minimising system losses: A loss in energy between generation and consumption is an inherent feature of electricity networks. Current network distribution losses stand at 23%, which is above average for the region and is a serious issue that requires more attention.[27] Whilst these losses cannot be eradicated completely, they can be materially reduced cost-effectively. This challenge is discussed further in chapter 2.3.

Challenge 5: Lack of timely maintenance and servicing of electric power infrastructure: Power plants require regular maintenance to ensure optimum productivity; otherwise, capacity is threatened by regular breakdowns that can impact electricity generation and contribute to technical losses. High losses in electricity distribution (≈23%)

The proposed solutions to the above challenges are described in the following sections.

[27] MANITOBA, Grid Loss Reduction Audit Report, 2013

2.1.3 EWSA Restructuring and corporatization

The electricity sector has undergone significant changes in the last 12 years. ELECTROGAZ, which had a monopoly over the production and distribution of water and electricity until late 1990s, lost its monopoly power by a law enacted in 1999. After extensive deliberations, ELECROGAZ was placed under a management contract with Lahmayer International in 2003. This ended in 2006, when the company management reverted to the Government. In 2008, ELECTROGAZ was split into the Rwanda Energy Corporation (RECO) and the Rwanda Water and Sewerage Corporation (RWASCO). These were integrated in 2011 within the Energy and Water and Sanitation Authority (EWSA).

EWSA institutional reforms address historical and chronic problems such as lack of focus on planning and investment, low operational performance and transparency, and lack of autonomy over delivery. The strategic thrust of the reform measures is to restructure the company organization by 'corporatizing' its governance structures to inject more autonomy and accountability in management decision-making and to streamline its processes with the support of state-of-the-art modern management information systems. Law n°97/2013 of 30th/12/2014 prescribed the split of the Energy and Water Sanitation Authority (EWSA) in two corporations Rwanda Energy Group Ltd (REG Ltd) and Water and Sanitation Corporation Ltd (WASAC Ltd), focused on service delivery of energy and power and water and sanitation, respectively. Two companies have subsequently been created. The resulting Power and Energy Holding Company is organized in two subsidiaries:

Energy Utility Corporation Limited (EUCL): The EUCL is in charge of day-to-day operations of power generation, transmission, distribution and sales to final customers. Refocusing EUCL on customer service and improving service delivery in line with quality of service parameters lies at the heart of EWSA reform. The EUCL will take charge of planning the transmission and distribution grid in areas already reached by electrification and promoting energy efficiency and demand side management programmes. New management contracts will strengthen incentives for the company to achieve aims such as cost reductions, technical and non-technical loss reductions, and improving customer satisfaction.

Energy Development Corporation Limited (EDCL): The EDCL is responsible for developing both generation and transmission projects, exploiting new energy resources, and executing a least cost power development plant. Its core objective is to facilitate the development and exploitation of domestic energy resources and investments. In pursuing this objective, it will have autonomy in managing its affairs, but will regularly report to MININFRA on progress towards set targets. Specifically, the EDCL will:

- Collaborate with MININFRA in conducting all activities necessary to explore and assess the country's indigenous resource base;
- Collaborate with MININFRA and RDB to reduce the risk profile of energy projects to a level acceptable to the private sector;

- Execute generation and transmission and distribution projects necessary to expand on-grid assets to new areas. These will be handed over to EUCL once commissioned;
- Define and update the overall power system master plan, and a least cost power development plan;
- Negotiate along with MININFRA long-term electricity import agreements with neighbouring countries.

2.1.4 Transition to a Cost Reflective Tariff

The EP aims for realizing a cost-reflective, yet still affordable electricity tariff to be reached through a transition period by 2018/19. The strategy to achieve this involves reducing the cost of generation, reducing losses and promoting more demand-side management[28], increasing operational efficiencies through the restructuring of EWSA, and adjusting the tariff structure or methodology.

To ensure the financial sustainability of the EUCL, and to make it an attractive partner for international investors, RURA shall define a clear pathway to a cost reflective tariff structure following the tariff reform conducted in 2013/14. As part of these annual reviews, RURA will assesses the cost structure of the EUCL and set new tariff levels to enable the company to be financially sustainable. The methodology adopts a commonly used "required revenue" approach and takes into account regional benchmarks for utility regulation. Throughout this transitional process, MININFRA and RURA will collaborate with MINECOFIN to agree on incrementally eliminating indiscriminate subsidies to all consumer categories and defining a new "smart subsidies" approach. Under this approach, specific social groups will be protected from any necessary unit price increases, including through systems that target strategic industries and particularly vulnerable social groups.

Some other key features that will be implemented through tariff restructuring are:

- Tariffs will reflect a potential combination of **four different categories of charges**, but not all of these would be borne by all end-user groups. These are: standing charges, demand charges, energy charges, reactive power charges, and transmission charges. While published, transmission charges are not likely in the short-term to be used by other parties besides REG. With policy and regulatory changes adopted to encourage wheeling through international imports and autonomous generation investment activities, however, this will become more relevant.
- Instead of differentiated tariff structures between households and industry, **tariffs will be primarily based on an end-users' voltage requirements** (i.e. medium voltage vs. low voltage customers). This is more efficient, as voltage is the main underlying determinant of the economic cost of service provision. While the tariff structure

[28] These programs will shave peak load and reduce required generation capacity reducing the tariff. See Chapter 2.3

presents only one category of low voltage customers, covering all residential and small business users, within fiscal year 2014/15 RURA will review this approach and differentiate residential from non-residential users and provide support to low income customers, following an "ability to pay" impact assessment.

- **"Metering" charges** previously collected monthly to recoup capital investment costs for installing pre-paid meters **shall be permanently removed**. Instead, "standing fees" will be applied to all medium-voltage customers in the short-term, and eventually to multiple meters installed in commercially oriented low-voltage customers.
- Replacing the current "time of use" tariff regime, characterized by having set time parameters for differentiated tariffs, with **"demand" charges applied on a continuous, non-time bound basis as a function per kW** consumed. In this way, the charge reflects total peak load demand (i.e. the level largely depends on the capacity needed to accommodate peak demand and to build and maintain assets to meet this) and has proven in other countries to be more effective. Demand charges would also apply only to medium voltage customers (an almost complete overlap to industries formerly able to benefit from the time-of use regime). RURA shall ensure that customers have the required information to adjust their consumption patterns and that demand charges are clearly and separately indicated in their bills through its regulation of EUCL. This will encourage end-users to implement demand-side management programs to shave peak load. This will have a positive effect on the tariff as it will reduce the generation capacity necessary to cover the peak demand and reduce overall service delivery costs.

Under the proposed new tariff methodology, unit tariffs for industry are lower relative to that for households. To ensure the transition to a cost-reflective tariff does not negatively impact on industry and large-users, strategic industries will be considered for further targeted subsidies, as required and as mutually agreed by MININFRA and MINECOFIN. Reductions in non-technical losses will also contribute to lowering required tariff levels.

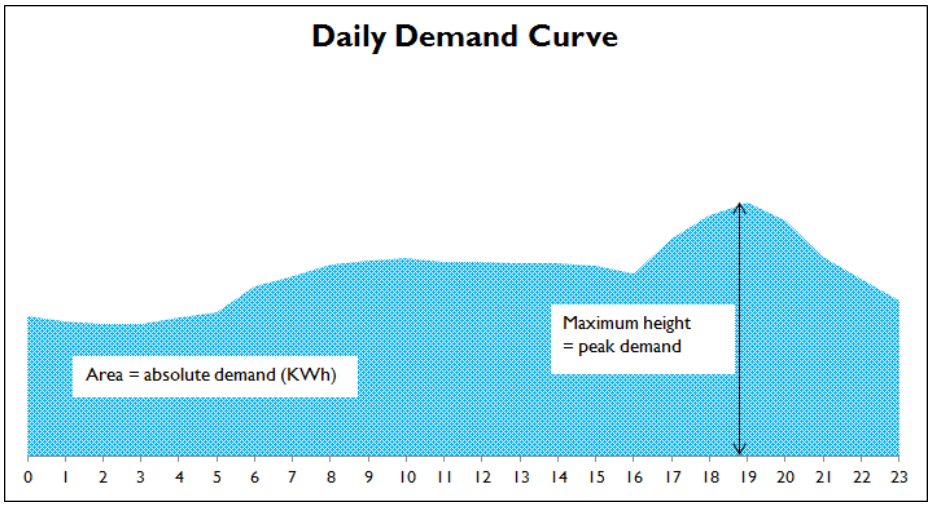
2.1.5 Balancing Demand/Supply and Achieving Security of Supply

In order to strike the right balance between increasing access to grid connectivity, ensuring the long term financial sustainability of the utility, maintaining a reliable supply of electricity, and making electricity more affordable, investments in new power generation and transmission infrastructure need to be tightly aligned to projected power demand. Ensuring an efficient balance between demand and supply in the power system is one of the core functions of the REG. Its Planning Units shall be responsible for projecting electricity demand over a 20-year horizon, and updating this figure annually. REG will also focus on managing key risks and uncertainties, including future demand, availability of financial resources, fuel commodity prices, and project development timelines, etc.

Demand can be measured in absolute terms (i.e. the total volume of energy consumed in a given year) as well as on a "peak demand" basis (i.e. the maximum consumption at any

point in time during a given period). Peak demand will dictate how much generation capacity needs to be developed. The shape of the demand curve (as illustrated in the figure) dictates what type of generation should be installed and how much of it will be used.

Figure 6 Peak vs Absolute Demand



In deriving peak demand, the Planning Unit shall consider four main components:

- **Residential remand**: This is a function of the number of households connected to the grid and their typical level of consumption. As households tend to consume most of their energy at peak times (18:00 – 19:00), residential demand is a key driver of peak demand.
- **Industrial and commercial demand:** This covers all non-residential demand. Significant contributors will be in the mining, manufacturing and agricultural sectors, along with commercial premises. The coincidence with peak is less than with residential demand.
- **Export demand**: Rwanda's attractiveness to export power in any significant volume is unlikely in the short-term. On the contrary, Rwanda will most likely increase imports.
- **Losses** - Reducing power losses from current levels of at around 23% will be prioritized.

In addition to meeting peak demand, there is need for a sufficient reserve margin of power to be available in the system. Following international best practice, the plan is to gradually reach around a 15% reserve margin by 2018. The EUCL as custodians of the Grid Code shall reflect this new guideline into subsequent Grid Code updates. In addition to this policy, the EUCL shall strive for better communication of power outages with an internal tracking system developed to monitor timely responses to outages.

(1) Baseline Demand and Supply Forecast

Summing up demand from each of the above four categories, and factoring in the reserve margin, four generation requirement scenarios have been derived and presented in Table 7.

These scenarios include conservative assumptions[29] that may tend to overestimate demand.

Table 7 Demand and supply projections under different scenarios

Demand scenarios	On-Grid Electricity Access Target
	48% Target
Likely Demand	**Supply: 444 MW** Total Demand: 377 MW
Optimistic Demand	**Supply: 563 MW** Total Demand: 473 MW

Source: REG (2014)

Table 8 Assumptions common to both scenarios to 2018

Demand End-User Category	Scenario Dependant Assumptions to 2018	
	Likely Scenario	Optimistic Scenario
Residential and SMEs	Demand by customers increases 5-fold in 6 years.	Demand by customers increases 5-fold in 6 years.
Commercial and Industrial	50 % of large user projects will materialize	100 % of large user projects will materialize

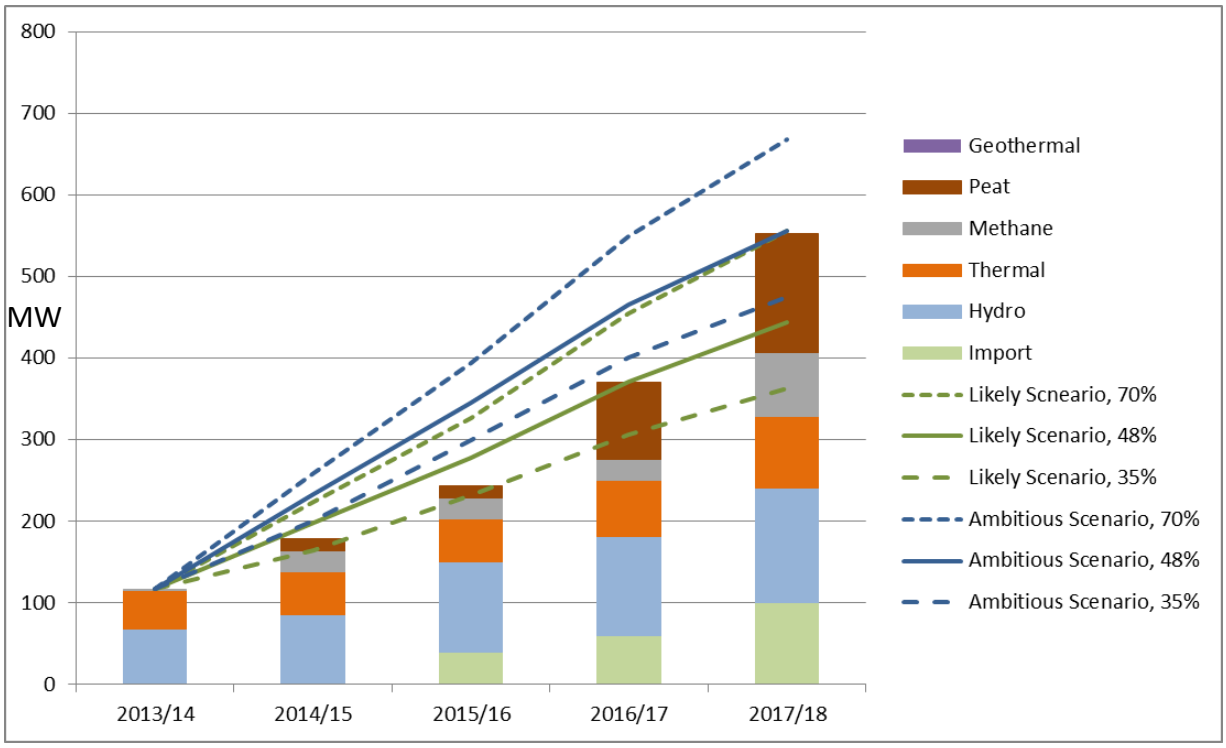
Source: REG (2014)

The current sub-sector HLTO aims for power capacity to increase from a current level of 160 MW installed to up to **563 MW of electric power installed capacity equivalent** by the end of the ESSP period, taking into account an increased reserve margin and imports. It is important to stress that these figures are preliminary, and will be updated once a Power Master Plan and Least Cost Power Development Plan (LCPDP) are finalized (see below). The LCPDP is a key planning tool and input to the Master Plan, wherein a rigorous demand forecast, a "bottom-up" inventory of potential generation and import projects, and planning of future transmission infrastructures are combined. As connecting new generation projects to users will require the expansion of the existing transmission network, the contribution of grid expansion plans to the overall system costs has to be factored in to identify the most cost effective solutions. The output of the LCPDP would be a recommended sequence of supply investments to ensure long term balance at least cost. The LCPDP will be developed for the first time in 2014, and updated every year thereafter. Existing project development plans and the LCPDP will be effectively integrated into a single National Power Master Plan, which will contribute to an East African Power Pool (EAPP) Master Plan.

[29] For example, commercial demand may be less high than stated, as a portion of the increase in "residential" demand will also come from SMEs as the split between existing low-voltage customers is not crystal clear. "Large user projects" refer to those identified by MINICOM.

The chart below illustrates how the proposed generation investment plan aligns to differing peak demand forecasts. The dotted lines indicate generation requirements under various scenarios, inclusive of reserve margin requirements.

Figure 7 Generation and Load Forecast



(2) Optimizing the power mix

According to the EP, the National Power Master Plan and generation road map shall reflect a strategic balancing act to ensure an **optimized power mix** which reduces the long-run cost of service while simultaneously achieving other policy objectives. Among these include:

- **Ensuring security of supply**: Adequate supply will be provided to meet expected domestic demand by developing sufficient generation projects and energy import supply agreements. An appropriate reserve margin shall be maintained (dependent upon the make-up of the generation mix, in terms of technology and unit size, and as determined by REG). In line with security of supply considerations, Rwanda will also diversify its energy mix wherever possible, and limit excessive dependency on any one source of power generation (e.g., hydropower). Net imports will be limited to up to a maximum of 20-30% of expected demand.[30]

- **Maximizing exploitation of indigenous energy resources:** This will be carried out

[30] This figure will be periodically reviewed, but is well in line with average import-export ratios of other countries in the region.

where rationale and cost effective, and taking into account the alternative of imports. In the short-term, priority is given to domestic resources such as methane gas resources, geothermal, and peat for base load applications over hydro-based imports and petroleum-based generation sources. The development of other indigenous energy resources such as biomass and solar power will be pursued as long as it will lead to energy sources that are sustainable, affordable, and reliable compared to imports.

- **Refocusing and reducing reliance on petroleum-based generation**: Utility owned plants based on petroleum-based fuels could be maintained to either cover peak demand or used as reserve to hedge against short term unavailability of generation capacity or imports. This would result in phasing out expensive rental capacity and achieve the policy aim to refocus petroleum-based generation to serve peak load and back-up power demands only by 2020.

- **Accelerating regionally-integration:** Economically advantageous trading agreements will be concluded with regional power houses (net exporters), in line with technical constraints and energy security guidelines. Regional integration readiness extends far beyond merely building interconnection lines. Among the necessary steps include: negotiating equitable commercial arrangements, establishing guidelines to synchronize systems and harmonize national grid codes, creating new institutional and regulatory arrangements, and developing the capacity necessary to manage the system or power pool. An action plan is under preparation to define all the activities necessary to operationalize energy import opportunities. To ensure Rwanda's interests are advanced internationally, representatives of the Government and the Utility participate regularly in EAC/EAPP technical meetings as active promoters of regional integration.

- **Achieving environmental and social considerations, including reductions to the current level of carbon intensity**. Only projects that are environmentally and socially sustainable will be implemented. The Master Plan will, as far as possible, integrate the results of a Strategic Environmental Assessment for the Energy Sector and other guidelines. These include macro-level climate risk and sustainability studies, including an assessment of hydropower vulnerability, and future guidelines on power generation ESIAs elaborated by REMA. To advance Rwanda's GHG global contribution to mitigate climate change, the Government targets a 10% reduction in carbon intensity (i. e. the average amount of carbon dioxide produced per unit of electricity generated in the system) by 2018, and a 25% reduction in carbon intensity by 2025.[31] A strategy to access

[31] Draft Rwanda Grid Emission Factor Standardized Baseline proposal (REMA, 2014).

climate finance and incorporate this into planning and budgeting processes will be undertaken[32] to further incentivise realization of this HLTO.

Table 9 Carbon intensity targets[33]

Year	Carbon intensity Reduction Target	Value (tons of CO2/MWh)
Baseline	-	0.504
2018	10%	0.454
2025	25%	0.378

2.1.6 Electricity Generation and Transmission roadmap

The EDCL will play a key role in pursuing investments in new generation capacity as well as transmission and distribution systems in areas still un-electrified, while at the same time conducting rehabilitation programmes for existing assets and extending transmission and distribution networks. Loss-reduction activities are discussed in chapter 2.3.

The level of investment required in electricity infrastructure is significant. Roughly $3.2 Billion will be required if we are to achieve our target of providing access to electricity (on-grid or off-grid) to 70% of households. Table 10 outlines the full list of projects through which 593 MW can be generated by 2017/18, along with when they could be delivered and at what projected investment cost. Delivery of 563 MW by 2017/18 will cost around $1.6 Billion. If all projects in the current pipeline are successfully implemented at projected scale, then total installed capacity would be closer to 590 MW by 2017/18, a bit higher than required (563 MW). The justification for this margin is to cushion against supply shortfalls due to projects being delayed as a result of technological or financing barriers.

Since the demand profile is uneven, different sources of energy will have a different role in matching demand. Geothermal, hydro and methane based power plants have very low operating costs and can run almost constantly, and thus could provide base-load power. Peat can be operated slightly more flexibly and adjust to meet evening peak demand, whilst solar can only operate during the day. To cover evening peak demand only, it will be more economical to utilize power plants running on HFO or diesel. As these will operate a few hours a day, they are characterized by low investment and high operating costs.

[32] The Climate Finance Strategy will be made in harmony with the Green Growth and Climate Resilience Strategy (2012).
[33] Rwanda's current carbon intensity is 0.504 tons of CO_2/MWh. This will be calculated and monitored using the standard UNFCCC Toolkit for emission estimations, or standardized baseline for Rwanda, as per REMA's submissions to UNFCCC.

Table 10 Generation roadmap to achieve required supply

	Project	Capacity	Total Capacity
2013/14	Installed capacity		119.6
2014/15		70.5	190.1
Hydro	Mushishito HPP (Rukarara V) (Phase I)	2	
Hydro	Nyabarongo I EHP	28	
Thermal	Rental (Thermal Power Plant)	4	
Solar	Rwamagana Solar Power Plant	8.5	
Methane	KivuWatt Methane PP (Phase I)	25	
Peat	Gishoma Peat Power Plant	15	
Hydro	Mukungwa I HPP	-12	
2015/16		65	255.1
Hydro	Mushishito HPP (Rukarara V) (Phase II)	3	
Hydro	Mukungwa I HPP	12	
Hydro	Micro Hydro (IPPs)	10	
Solar	Rwinkwavu Solar Power Plant	10	
Import	Interconnection (Ethiopia-Kenya-Uganda-Rwanda)	30	
2016/17		58	313.1
Hydro	Micro Hydro (IPPs & REFIT)	12	
Thermal	Kigali Special Economic Zone (KSEZ) HFO	40	
Solar	Nyagatare Solar Power Plant	10	
Thermal	Rental (Thermal Power Plant)	-24	
Import	Interconnection (Ethiopia-Kenya-Uganda-Rwanda)	20	
2017/18		251	564.1
Hydro	Ntaruka B HPP	5	
Hydro	Micro Hydro ((IPPs & REFIT)	14	
Solar + Bioenergy	Solar + Bioenergy (REFIT)	12	
Methane	Symbion Methane PP	50	
Peat	Hakan Peat PP (Phase I net Output)	70	
Import	Interconnection (Ethiopia-Kenya-Uganda-Rwanda)	100	
Total Generation/Import Capacity End EDPR II			**564.1**

Table 11 Projected capital costs

Generation	$289.4	$318.6	$524.2	$510.5	$1,642.8
Project Preparation (all Public/DP)	***$56.3***	***$28.4***	***$56.0***	***$0.6***	***$141.3***
Peat	$1.0	$0.5	$0.0	$0.0	$1.5
Hydro	$7.0	$0.0	$0.0	$0.0	$7.0
Geothermal	$38.6	$22.7	$55.2	$0.0	$116.5
Methane	$0.6	$0.0	$0.0	$0.0	$0.6
Solar	$0.5	$0.0	$0.0	$0.0	$0.5
Other sector studies	$8.7	$5.2	$0.8	$0.6	$15.2
Generation	***$233.1***	***$290.2***	***$468.3***	***$509.9***	***$1,501.5***
Public/Dev Partner	$96.4	$114.0	$78.7	$143.9	$433.0
Private	$136.6	$176.2	$389.6	$366.0	$1,068.4
Peat	$71.5	$116.4	$152.9	$103.1	$443.8
Hydro (Domestic)	$69.9	$26.6	$46.3	$24.8	$167.6
Hydro (Regional)	$19.5	$39.1	$62.4	$85.7	$206.8
Geothermal	$0.0	$0.0	$0.0	$0.0	$0.0
Methane	$0.0	$54.0	$176.0	$255.0	$485.0
Thermal	$24.2	$54.0	$5.7	$11.3	$95.2
Solar	$48.0	$0.1	$25.0	$30.0	$103.1

The following are key points to note from the above analysis:

- Even if in the worst-case scenario geothermal power cannot be generated by 2017/18 on commercial terms, **Rwanda will be able to meet its most optimistic power demand requirements.**
- The large amount of power generation coming online in 2017/18, principally from peat, will allow Rwanda to meet its generation requirements. Of more concern is the short term: 2015/16. For this reason, **more emphasis on developing flexible generation** such as small hydro, and HFO peaking plants is warranted.
- Based on the existing project pipeline, load-shedding would be the norm if a 70% on-gird connection target was pursued as shown in Figure 7.

(i) Feasibility of energy resources

Most proposed generation projects rely on indigenous resources that, in most cases, are yet to be fully proven. Proving these resources will require time and finance (roughly $120m), and attempts to shortcut this step are likely to bear negative economic consequences. Government intends to use its limited resources wisely to demonstrate Rwanda's energy resource potential by undertaking feasibility activities that the private sector is unlikely to bear to reduce perceived investment risks.

Table 12 Status on feasibility and exploration activities of various energy resources

Hydro	A large number of local and regional hydro projects have already been identified; however, further funding is required to: i. complete feasibility work on large regional projects ; ii. refine the feasibility of domestic hydro resources and undertake a hydropower master plan to be completed in 2015/2016.
Peat	REG is procuring a detailed resource assessment of all bogs and creating a national resource database. It will prove the feasibility and drain peat bogs in preparation for private investment. This will allow REG to either develop its own plant or to attract a private investment once the risk associated with bog development is removed. A peat energy strategy and action plan will be developed by MININFRA, including economic and social-environmental impacts, to ascertain the optimal use of different peat applications. For example it will ascertain the optimal use of peat across a range of applications: power generation, direct industrial heat, steam applications and domestic charcoal substitute. Environmental and social impacts will be studied and appropriate risk mitigation and private sector participation guidelines developed. RSB and REMA to develop technology guidelines. Government proposes to fund the following: -Peat development capability -Detailed feasibility studies for 4 bogs: -Site drainage in advance of peat harvesting

Geothermal	Government will continue to carry out exploration to de-risk the resource, continue developing the necessary institutional arrangements to operationalize a Geothermal Development Program to coordinate activities, and upgrade the existing legal and regulatory framework as required. Geo-scientific surface studies in Gisenyi and Bugarama will continue. Further uses of geothermal energy may be considered to support economic growth actions (ex: industrial heating, drying).
Methane	A wide ranging pre-feasibility study will be conducted to identify the range of opportunities available for investors, assessing projects of differing sizes and based on different technology types. Action plan will analyse investor options including different sizes, technologies and possibly splitting the extraction and power generation components for IPP purposes. Lastly, prioritization will be given to technologies which maximise extraction sustainably, subject to value for money.

RSB will support the process by developing relevant technology standards. REMA shall also play a role in developing and/or revising relevant environmental guidelines. REMA, RURA, and NICA, will be responsible to enforce compliance as required by their respective mandates. Investment procedures relevant to the energy sector will be reviewed. This includes the investment code and modalities of engagement.

(ii) REFIT

The existing REFIT tariff schedule, with regard to the hydropower, will be adjusted subject to fixed price per output, to ensure only economically viable projects are procured.[34] The revised REFIT will be reviewed after a period of three years to see the impact on the utility. Furthermore the review will determine whether the REFIT tariff schedule should remain the same or be revised downwards. In order to reduce risks in projects covered by REFIT mechanism, a standardized PPA approved by MININFRA, RURA, and the Utility shall be included in the overall regulation. Standardized PPAs provide a stable environment for private sector participants intending to invest in those technologies, so that the rules and the price for the off-take of electricity are known in advance and committed to. Competitive processes such as REFIT shall be followed exclusively to identify private sector partners for hydropower projects.

In addition to hydropower, bio-energy and potentially grid-connected solar shall also be considered under REFIT as they are more sustainable and less technologically complex than large-scale methane-to-power projects and geothermal projects. Wind power and peat-to-power projects shall not be included, as they are not fit for purpose to the objectives of the policy instrument.[35] Inclusion under REFIT will create a clear incentive for private investors to conduct feasibility studies where preliminary analysis show potential viability.

[34] Although a fair number of viable micro- and PICO-hydro sites in Rwanda are less than 250 kW in capacity, such projects are a poor fit for a REFIT policy tool and should rather be developed though energy access support frameworks and off-grid renewable technology financing mechanisms that can be supported by DPs.
[35] See Annex 1 for further details on prior wind resource assessments and feasibility analyses.

A “catch-all” bio-energy category shall be included in the REFIT under an “avoided cost approach” rather than a fixed tariff linked to output. Inclusion under REFIT will create a clear incentive for private investors to conduct feasibility studies where preliminary analysis show potential viability. The tariff for these projects would be set equivalent to the long-run marginal cost of REG’s current power output as determined before the beginning of each fiscal year in conjunction with annual tariff reviews conducted by RURA. This would effectively place a price cap on new capacity additions.[36]

(iii) Autonomous Generation

Mining and mineral processing is an example of an industry rapidly expanding in Rwanda[37] and requires increased energy. However, connecting operations to the grid can be very expensive as mining locations are often relatively remote. As well as this, given the challenges in developing generation projects to keep up with the demand growth, the government will encourage the development of dedicated power plants through simplified regulations and approaches for autonomous generation and wheeling through the grid system. Ambiguity in the law for this type of type of installations will be removed, and the scope of simplified licensing regulations targeting rural electrification activities will be made clear and extended to autonomous generation. In parallel to improving the legal environment, research will be undertaken to investigate the optimal systems integration of solar energy and solar-diesel hybrid energy. The impact of a major scale-up in autonomous generation activities and their integration into the grid will need to be studied further. As building-integrated photovoltaic power may become an important contribution to the energy portfolio in the next years, it will be necessary before undertaking any action to promote this type of solution to run some pilot projects to test the costs, benefits, and systems impact of introducing net metering arrangements.

2.1.7 Transmission investment

Significant reinforcements will be needed to the existing transmission system in order to accommodate the increased generation and demand over the coming years. These extension, rehabilitation and reinforcement projects are outlined in Table 13.

[36] The “avoided cost” tariff can also be set for the lifetime of the PPA as is the practice in Kenya, rather than annually adjusted.
[37] Among these include cassiterite, wolframite, colombo-tantalite, tunsgsten, and gold.

Table 13 Transmission projects

	Project	Category	Length [km] for Line	Commis-sioning
1	110kV line Gishoma-Bugarama*	Line	11 km	2014
2	Kilinda - Nyaborongo1 110kV line*	Line	25 km	2014
3	Rukarara - Kilinda 110kV*	Line	29.5 km	2015
4	220kV line Shango-Rilima	Line	53 km	2015
5	Construction of 220/110/30kV Rilima substation	Substation		2015
6	Construction of Nyabihu Substation	Substation		2015
7	Extension of Bugarama Substation	Substation		2015
8	Construction of 110/30kV Ntendezi substation	Substation		2015
9	Construction of 30 kV transmission line Rulindo-Byumba-Gatuna and Byumba-Ngarama	Line	41km + 22km	2015
10	110kV line Mukungwa - Nyabihu	Line	23.5 km	2015
11	Rehabilitation of 110/30kV Gifurwe substation	Substation		2015
12	Nyabugogo Substation (Kigali Reinforcement)	Substation		2015
13	Jabana - Mont Kigali 110kV line (Kigali Ring)	Line	14 km	2015
14	110kV line Mont Kigali - Gahanga (Kigali Ring)	Line	8 km	2015
15	Mirama(Uganda) - Shango*	Line	92 km	2015
16	Shango - Rubavu - 220kV line*	Line	106.5 km	2015
17	Shango 220/110kV Substation*	Substation		2015
18	Shango - Birembo 110kV double circuit*	Line	9 km	2015
19	Kigoma-Butare-Burundi 220kV*	Line	64 km	2016
20	Construction of 220kV Transmission line Butare – Mamba	Line	23 km	2016
21	Construction of 110/30kV Rulindo substation	Substation		2016
22	Construction of 220/30kV Gabiro substation	Substation		2016
23	Construction of 220/110/30kV Ruhengeri substation	Substation		2016
24	Rilima 220/110/30kV Substation	Substation		2016
25	Kabarondo - Kirehe 110kV line	Line	32 km	2016
26	Kirehe substation	Substation		2016
27	Gahanga Substation (Kigali Ring)	Substation		2016
28	220kV Transmission line Bwishyura-Kilinda-Kigoma-Rwabusoro-Rilima	Line	100 km	2016
29	Construction of 110kV Transmission line Musha – Ngarama – Rulindo	Line	92 km	2016
30	Construction of 110/30kV Ngarama substation	Substation		2016
31	Rubavu - Bwishyura 220kV line*	Line	54 km	2016
32	Rubavu 220/30kV Substation*	Substation		2016
33	Bwishyura 220/110/30kV Substation*	Substation		2016
34	110kV Line Rukarara - Huye - Butare	Line	42 km	2016
35	Huye Substation	Substation		2016
36	Ndera Substation (Kigali Ring)	Substation		2017
37	110kV line Gahanga - Ndera (Kigali Ring)	Line	15.5 km	2017
38	110kV line Ndera - Gasogi (Kigali Ring)	Line	6.52km	2017
39	Nyaborongo I - Nyabihu 110kV line	Line	43 km	2017
40	Nyaborongo I 110/30kV 10MVA substation	Substation		2017
41	110kV transmission line NyabarongoII HPP – Rulindo substation	Line	13 km	2017
42	220kV line Rilima-Rusumo falls	Line	70 km	2017
43	Kirehe - Nyamugari 110kV line	Line	17 km	2018
44	Nyamugari substation	Substation		2018
45	Upgrade Jabana - Kabarondo line	Line	57 km	2018

Note: Projects with * are ongoing projects

2.1.8 Developments in regional trade

The long-term vision is for Rwanda to become an active electricity trading partner and potential exporter of electricity to the regional grid network. In the short term, a push for greater regional economic integration and access to cheaper supplies of power will involve increased imports. These will be secured from sources like large hydro plants in the Lower Kafue Gorge of Zambia (to be imported via Tanzania), and hydro plants in Ethiopia (to be imported via Kenya and Uganda). The cost of power generation in Ethiopia for current and projected projects is below $0.09/KWh, for example, offering a possibility of Rwanda's importing relatively inexpensive power. However, at the same time this must be balanced with security of supply, and so initially **a limit of 20% of the energy mix coming from imports has been set**, based on consultations and technical considerations.

The Eastern Africa Power Pool (EAPP) was formally established in February 2005. There are currently 9 members including Rwanda, Kenya, Uganda, Tanzania, Burundi and the DRC. EAPP fosters coordinated power development by promoting synergies among the region's electricity utilities and therefore optimizing investments and resource allocation. Presently, EAPP is in the process of building its technical and regulatory capacity. A number of development partners are providing support in the design of the power system and control centre, harmonization of standards, preparation of grid codes and market rules.

Rwanda is a member of the Nile Basin Initiative (NBI) and the EAPP. However, apart from using its share of regional hydro plants – SNEL and SINELAC (Rusizi I and Rusizi II), Rwanda is not connected to any regional transmission network; however, it is pursuing cross-border interconnections with Uganda and Kenya to enable imports from Uganda and Kenya (by 2016) and from Ethiopia (beginning of 2018) in the context of the Nile Equatorial Lakes Subsidiary Action Plan (NELSAP).

International experience has shown that the establishment of wholesale trading arrangements to facilitate full cross-border trade can take a considerable amount of time. The countries also need to develop the necessary technical standards, operational procedures, commercial agreements (both PPA and wheeling agreements), tariffs, regulatory environment and human capacity to manage the interconnected systems. It is estimated that the wheeling and PPA agreements for imports from Kenya and Uganda will be ready by the end of 2015. An action plan is also currently being developed, detailing all the necessary activities to enable a successful power connection to Ethiopia in time when the transmission infrastructure is completed. Rwanda is monitoring the progress of regional activities to capture the synergies with other on-going market integration activities. A revised Rwanda power tariff is expected to contain a unique transmission-related component to help facilitate regional trade. Furthermore, the role and economic impact of various import sources will be assessed in the context of the LCPDP.

In the short to medium term, trade is likely to take place utility-to-utility. Rwanda, Kenya and Uganda signed a MoU to foster coordination in infrastructure development and trade arrangements. Rwanda and Ethiopia also signed another MoU for the supply of power from Ethiopia to Rwanda. Other bilateral arrangements with DRC, Burundi and Tanzania in expanding existing shared power supplies and pursuing bilateral energy development opportunities and joint investments are also under discussion. For the time being net imports will be restricted to 30% of expected demand for security of supply reasons.

The capacity available for import will increase dramatically, from 30 MW at the end of 2015, to about 100 MW at the end of 2017/18. Limitations on import growth are however driven by grid bottlenecks on the Rwandan and Ugandan side and technical power quality and security of supply considerations (i.e., to avoid black-outs in case of faults in other countries). A large number of ongoing projects are underway to strengthen grid interconnectivities and to connect Rwanda to its East African partners so as to facilitate energy trade are underway. There are also a number of other power interconnection projects between EAPP countries at different stages of implementation. Key transmission projects being developed are:

Table 14 Key regional transmission line projects

Transmission Line Project	Voltage Type	Construction Status	Expected Completion Date
Gilgel Gibe III (Ethiopia) - Suswa (Kenya)	High Voltage Direct Current	Financing completed	December 2017
Lessos (Kenya) – Tororo (Uganda)	400 kV	Under construction	December 2016
Masaka – Mbarara (Uganda)	designed for 400 kV but to be initially operated at 220 kV	Under discussion	December 2016
Mbarara – Mirama	220 kV double circuit	Under construction	April 2015
Mirama – Shango	220 kV double circuit	Under construction	June 2015

2.1.9 Electricity Sub-sector Implementation Plan

Table 15 Electricity Sub-sector Implementation Plan

Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution
Demand/ Supply Balance	Annual review.	Dedicated planning unit established; demand survey and forecast undertaken	-Integrate all studies and plans into a National Power Master Plan. -Annual reviews undertaken. -Align with EAPP Master Plan			REG, MININFRA
Feasibility Studies	Further geothermal studies	Develop Peat strategy action plan	Additional studies as and when required e.g. regional hydro, wide ranging Methane study			REG
LCPDP	Review Interim Report	Prepare and implement LCPDP	Annual update of LCPDP as part of overall planning exercise			REG
Reduce carbon intensity	Annual Grid Emission Calculation exercise and update and extend forecasts					REMA with MININFRA
Timely maintenance and servicing		Full plan of power plant maintenance and grid network developed				EUCL
Cost-reflective tariff	-'Ability to pay' assessment New methodology calculated		Annual reviews as with previous years. Targeted industries approved			RURA, MININFRA, EUCL, MINECOFIN
Key Generation Activities	-Develop peat strategy and action plan and implement -Detailed peat resource assessment complete -Methane Action Plan to be undertaken in 2015/16					MININFRA, REG
Regional Integration	Development of Action Plan to operationalize import opportunities		Implementation of Action Plan			MININFRA
REFIT	Finalize REFIT revision	Draft standardized PPAs for REFIT	Expand REFIT coverage of clean energy resources			RURA with MININFRA
Autonomous Generation		Research on optimal system integration and simplified regulation developed. Conduct study on systems impact.		Pilot projects to test impact of net metering		MININFRA

2.2 Electricity Access

2.2.1 Objectives

The EP commits the sector to: prioritize of end-users for electricity connections; achieve universal access to electricity in all schools and health clinics by 2018; increase rural energy access through piloting innovative partnerships; introduce greater competition and flexibility in off-grid service provision;; and improve service delivery through institutional reforms.

Over the EDPRS II period, the strategy targets at least 70% of households to have access to electricity. This would be reached from a combination of both on-grid and off-grid solutions:

On-grid access to 48% of households &
Off-grid access to 22% of households by 2018

This represents a big incremental leap from the baseline. As of June 2014, only 20% of Rwandan households were estimated to have access to electricity. Rwanda is also participating in a regional program sponsored by the Global Sustainable Electricity Partnership (GSEP), Eskom, and Duke Energy to develop an electrification roadmap to ensure 500 million people at global level have access to energy by 2025.

Given limited government resources, the targeting of end-users, or consumer groups, for electricity access has also been reprioritized under the EP: large and productive end-users shall be the top priority, followed by schools and hospitals, small and medium enterprises (SMEs) and lastly households. Large and productive energy end-users, and in particular, industries, are key drivers of economic growth in providing employment, marketable goods and services. Many industries require reliable and consistent grid electricity in order to produce efficiently so as to be profitable and regionally competitive. For example, flour millers on average loose three days of production a month due to unreliable electricity.[38] Such losses in productivity can be addressed through reliable grid electricity. Therefore:

Up to 230MW of power supply to be provided for productive end-users

This is a current estimate of what is needed by 2018 for productive end-users in industry, manufacturing, mining, industry, coffee and tea producers, and for special economic zones and irrigation programs.[39] To meet this, direct access to electricity will be provided to these end-users through dedicated connections and by supplying reliable power to the grid.[40]

In addition to large and productive users:

100% of schools and hospitals will be provided with access to electricity by 2018 through a mixture of off-grid and on-grid solutions

In total roughly $1.1 billion of financing is estimated to be required to the end of the EDPRS-II period to meet the targets set. There is an urgent need to build both institutional and individual capacities to effectively deliver on access targets.[41] This will be addressed in both the SE4ALL Country Action Plan and the Energy Sector Capacity Building strategy.

[38] MINICOM Private Sector Development Strategy, 2012
[39] Based on data provided by MINICOM, including MINAGRI and MINIRENA data
[40] Such activities fall outside of the original scope of EARP.
[41] SOFRECO, March 2013

2.2.2 Challenges in Rural/Electricity Access Sub-Sector

Challenge 1: Ensuring the financial sustainability of network investments

The average annual cost of each connected consumer is around $50 (around $45 in financing the loan required for the connection and $5 for operations and maintenance). Under the current tariff structure, a consumer would need to use approximately 130KWh per month in order to fund the cost of their own connection, and despite annual customer growth of 30-40% in recent years, peak electricity demand and sales grew by only 5% in 2012/13. The table below illustrates the current consumption patterns across all of REG's consumers. Currently around half of consumers are using less than 20KWh per month. Thus, even if average household consumption per connection remained at current levels, this would pose a significant challenge to the financial sustainability of network investments, as more and more households who are unable to afford access get connected.

Table 16 Current Electricity consumption patterns

Consumption per month (KWh)	
0 to 5	18.4%
6 to 20	31.2%
21 to 50	26.1%
51 to 150	17.3%
151 and greater	7.0%

Source: EWSA (2013)

Challenge 2: Poor coordination between power distribution and generation plans.

Due to the different determining factors underlying the two plans, there has been poor coordination in the past. Though difficult to integrate, in order to efficiently meet the sub-sector access targets, there is an urgent need to harmonize the distribution planning with changing generation plans.

Challenge 3: Sustainability of off-grid solutions

Preventive maintenance and proper technical support is fundamental to the sustainability of off-grid electrification projects, such as those involving solar PV. In the past, this has not been adequate, even though minimal maintenance is required for off-grid solar systems to maintain on-going functionality. As a result, many projects have had to be rehabilitated at a high cost. There is a need to establish suitable maintenance and support procedures for all projects, incorporating sustainability into the design of programs and strategy.

Challenge 4: Terrain and Settlement Patterns

A significant driver of the cost of any electrification programme is the density of the properties that are to be connected: the more scattered the settlements, the higher the cost of extending the network. Rwanda also has an extremely unique terrain to manoeuvre in terms of extending the power grid. Challenges associated with engineering and

construction show an increasing marginal cost, as rates of existing electrification access rise. As a result, energy access targets may become progressively harder to achieve within a certain budget.

Challenge 5: Access to finance

Achieving a large scale-up in electricity access hinges upon greater household access to finance. Due to their low purchasing power, consumer finance and credit mechanisms are pivotal to assist rural households to switch to solar lighting over kerosene, or to pay off new electricity connections over time. For example, even under the EARP, which is largely financed by international donors, households are still required to put up 10% of the cost of getting electricity. While microfinance and mobile money operators are growing significantly, government and SACCOs may also need to play a strong role to ensure that appropriate financing mechanisms are in place in tandem with new access programs and strategies. Moreover, the private market for off-grid electricity services and technological solutions is still in its infancy. In order to grow, financial inclusion programs targeting these products and services need to be expanded to cover financial organs in rural areas.

2.2.3 Solutions

The ESSP adopts a several strategies to address the above mentioned challenges, including:

- Realizing better coordination and integrated planning over investments and implementation strategies for energy access and electrification, and informing planning through an LCPDP;
- Reprioritizing target groups for on-grid electrification through a clear policy and planning mechanisms, with productive end-users being of first priority to offset the short-term negative financial impacts to EUCL from new connections;
- Developing and mandating the publishing of a transparent (on-grid) National Electrification Plan by REG valid for 3-years to incentivise industrial and private investment in off-grid solutions;
- Developing an off-grid strategy and action plan in conjunction with an SE4ALL Country Action Plan;
- Placing the private sector and PPPs at the core of implementation and procurement approaches for off-grid access strategies;
- Promoting and monitoring urban densification as a matter of national policy. This falls under MININFRA's direct control but can also be promoted by local communities themselves in its outreach and communication strategies;
- Developing new partnerships between MININFRA, the REG, and local financial institutions to establish new lending products that give customers greater access to credit for grid connections whilst reducing financial risk to the utility.

2.2.4 Electrification Strategy & the Electricity Access Rollout Program (EARP)

The first phase of the EARP (2009-2012) aimed at increasing grid connections from a baseline of 6% to 16% of households. It exceeded this target by 1%. The second phase of EARP began in 2012/13 and will finish by the end of 2017/18, with the aim of reaching the consumer groups prioritized above. Government is determined to build on the success of the first phase and where appropriate apply lessons that can help deliver on the 70% electricity access target over the coming 4-years.

The cost per on-grid new connection is high, at roughly $1000; however, donor support has been leveraged and to an extent the socio-economic aspects justify the cost. At the same time it is currently not economical to connect all of these households to the grid irrespective of the location and level of income. For households located far away from the grid network and/or without capacity to afford the grid connection fee, it is more economical to access electricity through off-grid energy solutions or isolated mini-grids. Therefore, the EARP on-grid electrification plan will focus on connecting households, administration offices, schools and hospitals, taking into consideration resettlement plans and other factors.

Currently, customers wishing to be connected pay an amount towards the capital cost of the connection that is dependent on their income. Those well off pay 100%, or 56,000 RWF, while middle income earners pay 50%, and the poor pay a 20% deposit which is paid over 12 months and amounts to 10% of the total costs. The remaining cost is publicly funded through a combination of grants by development partners (80%) and government contributions and loans (10%), ultimately repaid by REG from its operational revenues.

Public Services: As of June 2014, roughly 63% of health facilities, 41% of primary schools, 66% of secondary schools and 64% of administration centres had access to electricity. This was met through a mixture of on-grid connections and off-grid distributions based on basic analysis. EARP will examine the feasibility of reaching the remaining institutions through on or off-grid solutions, whichever is more economical. EARP will also explore the costs and benefits of extending to other public services; ensuring value-for-money.

On-grid Households: Through photographic imaging, EARP has developed a detailed view of household locations, and a strategic perspective on where the network could be extended. Based on the latest household survey data, it will be necessary to connect 669,000 additional households between July 2014 and the end of 2017/18 to reach a target of 48% household on-grid connections. This presents a considerable technical and financial challenge. EARP will continue to continue to bulk buy equipment, encourage local and regional companies to participate, and use Engineering, Procurement and Construction (EPC) contractors for a large share of delivery responsibilities. The EARP program consists of two categories of electricity connection:

- **Direct connections:** Roughly 362,000 *direct connections* would be needed to reach the 48% target over the entire EARP II program.
- **Relocation and Fill-ins:** Based on an assessment of relocation plans, around 396,000 *additional fill-in connections are anticipated*. Once the network has been extended to an area, and 75% of households are assumed to be within immediate reach of the network, a significant number of additional network connection requests are anticipated to come from this category.[42] Given that the network will already exist, the cost of these connections will likely be less than for the direct connections.[43] Achieving this target, however, will depend to a significant degree on the timely availability of all necessary funds to cover the investments, and on the success of urbanisation policies.

Prioritization of end-user connections: The on-grid electrification plan was revised in April 2014 to prioritize productive users, among other changes. This means that areas with higher concentrations of productive users will be connected first. Furthermore, productive user fill-in connections have been prioritized according to their distance from the grid. . The revision included revised industrial demand estimations from MININCOM, which is mandated to work with MININFRA to provide information. The development of industrial parks, SEZs, and development of secondary cities have all been included in plans. The plan will also take into account resettlement policies which MININFRA is monitoring.[44] EARP will develop guidelines for the allocation of resources to different end-users to make prioritization clearer. These will balance the need for industrial connections that provide economic growth and increase sustainability of the utility, and household connections that have strong social and energy poverty alleviation considerations. Chapter 3.3 Risk Analysis contains detailed discussion on how the monitoring and promotion of urban resettlement is being dealt with by MININFRA. A summary of the EARP household and industrial connection policy is given in Annex 3.

Off-grid Households: Government intends to dramatically scale up rural electricity access to households through off-grid solutions. Households not expected to be covered under the National Electrification Plan in the medium term and with low ability to afford connection fees will be facilitated with access to off-grid solutions. These include stand-alone solar PV systems, solar lamp kits, biogas digesters and micro-grids powered by small hydro, efficient diesel or solar-wind, and solar-diesel hybrid systems. These solutions will significantly reduce capital costs and the need for government subsidisation. This will also increase the financial sustainability of the EUCL. To facilitate these systems, a sound enabling environment for off-grid energy services is required such as solar home systems and lamps or solar mini-grids. Financial mechanisms will also be developed for use in the short-term to

[42] It represents either the 25% of households who did not connect when the network was initially built or people relocating to be closer to the electricity network and other infrastructure, driven by urbanisation and resettlement policies.
[43] The average unit cost is expected to be around $470.
[44] Urbanization trends and growth targets around the development of secondary cities will play a strong role in increasing end-user electricity demand, mainly for lighting and to a very small degree for cooking, particularly among middle-class households.

help the off-grid market develop and become sustainable. These will fall under the Renewable Energy Development Fund (REDF), discussed in more detail in Chapter 2.6. To reach the off-grid household access target of 22%, MININFRA will develop a detailed off-grid strategy. Given that this area has not been measured before, clear monitoring frameworks will need to be developed as part of the strategy.

2.2.5 Solutions beyond current EARP activities

Off-grid strategy: A Rural Electrification Strategy is currently being developed in collaboration with MININFRA, including separate on-grid and off-grid action plans, as per the EARP Mid-Term Review recommendations. In parallel, several *ad hoc* activities are underway, and will continue to be rolled out to pilot areas that are clearly off-grid. In tandem, innovative PPPs will be developed to test and scale-up off-grid pilots.

The strategy shall prioritize private sector engagement to deliver off-grid solutions, and the most suitable role of Government. The strategy will include market assessments and sharing of information on energy use patterns and market demand with investors, issuing new technology standards to build market confidence, and testing innovative solutions and business models on a pilot basis that can be scaled-up if successful.

Increase competition and flexibility in off-grid provision through measures to simplify licensing: Since the private sector will be expected to deliver the majority of off-grid energy services to end-consumers, in parallel to the development of an off-grid strategy, a conducive and legal and regulatory environment must be developed to support the private sector and avoid direct subsidisation as much as possible. MININFRA will collaborate with RURA to sensibly simplify the existing licensing framework to facilitate off-grid electricity provision through a clearer, more enabling regulatory environment. These efforts are thrust at stimulating more nimble, small-scale power distributors (SPDs). Lessons shall be drawn from pilot projects already under way in Rwanda, and in other similar countries. The advantages and disadvantages of eventual inclusion of SPDs under REFIT frameworks as the grid expands shall be further and more carefully examined.

Beyond simplified licensing, EARP will publish electrification plans in the public domain which will be valid for a period of 3 years. This will make it clearer to both consumers and private developers where potential for off-grid activities exists and incentivise investment in these areas. Two results-based-finance programs are starting in September 2014 and are targeting to reach 18,750 people with the mini-grid program, and the distribution of 330,000 solar lighting systems with the second program.

Pilot innovative partnerships to increase rural access: MININFRA shall develop innovative PPPs to better understand the costs and benefits of grid electricity connections and the most cost effective means to scale up rural access.[45] Rigorous evaluation will be a vital part of determining what works. PPPs shall offer rural end-users turnkey solutions that can be delivered by the private sector and generate employment and skills development opportunity for youth in rural areas. Operations and maintenance costs shall be factored into anticipated or permitted investment returns through PPPs, while being the primary responsibility of the operators. Government shall support such programs through in-kind assistance among other means. Capitalising support from FONERWA and other climate and renewable energy financing will be a key contributor to success. Such pilots will be accompanied by awareness campaigns in collaboration with CSOs and Energy Associations, led by MINALOC, to support off-grid market development.

Fiscal reform for peri-urban and urban households to reduce consumption of kerosene and increase alternative solar technology: MININFRA will carry out a study in collaboration with MINECOFIN to assess the impacts of potentially phasing out the exemption from excise duty of kerosene. Tax reform and other demand-pull strategies to increase the relative attractiveness of renewable off-grid technologies compared to traditional biomass or petroleum-based fuels could have a strong complementary impact to other measures. They could strongly incentivize fuel switching or leap frogging directly from traditional biomass energy to solar lighting solutions.

Improve and develop institutions to increase coordination, effectiveness and accountability: In the short-term, all major off-grid programs implemented by the REG shall be consolidated under the EARP. Off-grid electrification strategies will be harmonised with existing EARP Phase II plans. This will clearly identify and earmark which areas are most suitable to be developed for off-grid

Cross-border electrification: Rural villages shall be identified that are located close to Rwanda's borders where services could potentially be provided more cost effectively from other distributors, such as the Uganda Electricity Distribution Company. Following the results of a study carried out by RURA, the regulatory framework for allowing low-voltage cross-border electrification among neighbouring utilities could be developed for this kind of arrangement, subject to there being adequate scope and clear economic benefits.

Various technology solutions will be examined in the Action Plan. Their deployment will be context-specific but could include:

[45] These innovative PPPs shall build on guidance set-out in the Draft National PPP Policy and Law (2014)

Solar Installations: Small solar PV kits are available for an initial cost of between $50-200, depending on their capacity factors and the typical end-uses they are required to power, with no need to pay further energy costs.

Off-grid hydro projects: Past experience has shown that off-grid hydro projects could represent a cost-effective solution, and represent good value for money when used to provide power to mini-grids at $5200/kW. However, other experiences have shown that irregular plant maintenance incentives and raising capital can be a strong challenge. Micro hydro projects will be encouraged through micro-grids where economically feasible and representing the least-cost option. This will be done through:

- Establishing enabling regulatory frameworks and licensing
- Education of people on off-grid energy solutions
- Provide training and financial incentives to rural communities to operate micro hydro, which is already underway.

Hybrid systems: Solar-diesel hybrid systems may be appropriate in areas that have inconsistent solar radiation or where an anchor end-user such as a mobile phone operating tower needs reliable power. Similarly, solar-wind hybrid systems could be viable in areas with high commercial viability for wind power in order to optimize availability factors. The feasibility of such systems will be analyzed and piloted to access their commercial viability in comparison to mini-grids operating on 100% thermal or renewable energy sources. Beyond hybrid systems efficient diesel generators for independent generation are common in African countries, and therefore their affordability will need to be tested.

Biogas: Micro-scale biogas power plants are possible on a stand-alone and mini-grid basis. Small-scale biogas digester can be used for lighting as well as for cooking or heating. Biogas is further elaborated in chapter 2.4.

2.2.6 Electricity Access Sub-sector Implementation Plan

Table 17 Electricity Access Sub-sector Implementation Plan

Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution
On and off-grid harmonization		-Update of on-grid electrification plan -Publish 3 year grid development plan	Harmonization of off-grid plans with EARP Phase II		Publish 3-year plan	REG, eSWAP Secretariat
Off-grid strategy	Concept proposed	Development and approval of strategy	Implementation and develop national off-grid database			MININFRA
Regulatory Environment		Develop legal and regulatory environment alongside and informed by the off-grid strategy				RURA, MININFRA
Productive User prioritization	Propose concept	Electrification Plan developed to reflect	Close monitoring and annual reviews of productive user prioritization			EARP, MINICOM
Public services connections	Implementation of school and hospital electricity access projects		Analysis of EARP expansion	Development of rigorous feasibility studies for schools and hospitals		REG with MININFRA
Innovative PPPs for off-grid		Develop PPP pilot concept	Undertake pilot PPP projects. Apply for climate finance, carry out awareness campaigns and evaluate projects			MININFRA
Small-scale off-grid distributors	Revision of simplified licensing framework		-Analyse eventual inclusion under REFIT with grid expansion -Hybrid system comparative analysis			RURA with MININFRA
Financial partnerships	Collaboration with local financial institutions to set-up support		Implementation on support via local financial institutions			MININFRA, REG

2.3 Energy Efficiency and Demand-Side Management

Energy efficiency (EE), energy conservation, and demand-side management (DSM) activities[46] are of strong importance in the Rwanda context because the country's natural resources are limited; the population is growing rapidly, a Green Economy vision is in place, and there is a pronounced peak demand load that requires extra power reserve margin and is a key driver for additional generation capacity. It is cheaper to use energy intelligently and efficiently than to unnecessarily expand energy production. Effective DSM measures will have an immediately positive impact on reducing supply requirements and contribute to reducing the long-run cost of power. Therefore, the EP adopts the following objectives:

[46] EE is about using less energy as an input to maintain the same level of output (for example, when energy efficient bulbs are used, they emit the same or a higher number of lumens for an equivalent number of kWhs). DSM employs tactics and incentives to reduce or shift the timing of demand in a way that reduces the required installed capacity of the system needed to allow an amount of power to be available at a given time.

- Adopt new laws, regulations and codes that mandate energy efficiency measures in public institutions, households, and commercial businesses;
- Restructure the electricity tariff methodology to incentivize efficiency;
- Establish a demand-side management program within REG;
- Encourage and incentivize energy audits among commercial and industrial end-users;
- Promote and remove barriers to implementing priority efficient lighting initiatives;
- Develop and adopt an EAC-wide energy standards and labelling scheme for common household appliances;
- Institutionalize "green" public procurement guidelines and strategies focused on equipment with a high energy footprint.

To meet the policy objectives, an overarching energy efficiency HLTO[47] has been set under the ESSP, by which various programs and actions can be commonly measured.

Increase energy efficiency by 10% through Demand-Side measures & an additional 8% through grid-loss reduction (from a 2013 baseline) by 2018

2.3.1 Challenges to Energy Efficiency and Demand-Side Management

Challenge 1: Limited institutional experience

While of growing importance, EE/DSM is a newer policy priority area. As such, no specific strategy yet exists to guide the development and implementation of national-level activities in the sub-sector. Apart from a large-scale CFL replacement program implemented by the utility, only a few *ad hoc* initiatives that squarely address energy efficiency have ever been undertaken in Rwanda. Thus, there is a strong need to build more institutional capacity and technical skills in a sustainable manner in this area. Ambiguous institutional mandates and the lack of a strong leadership role in implementing EE/DSM activities has also led to poor information sharing, slow progress on regulatory development, and ineffective or inadequately enforced codes and standards.

Challenge 2: High degree of system losses

Energy losses that occur between generation and consumption cannot be totally eradicated and are an inherent feature of any electricity networks. Through better network planning and maintenance, however, they can be reduced. The majority of Rwanda's system losses occurs through heat losses in the distribution network.

Challenge 3: Barriers to uptake including high up-front cost

[47] Energy savings from these measures will be calculated as the ratio of MWh saved over the sum of the total MWh generated in electricity output on the grid plus those MWh that wouldn't have been otherwise saved (i.e. avoided energy consumption) The expected target rate to be achieved is 50,000 MWh of power output equivalent.

Whilst the high cost of electricity can make returns on EE measures appealing, and good financial savings for customers can be generated, inability to cover up-front investment costs to implement them is a major barrier. Even if the potential pay-back period is not especially long, disposable income in Rwanda is very low. High up-front costs similarly pose a major barrier to clean technology diffusion, even though for many households, despite the fact that satisfaction among early adopters is high. Currently there are few dedicated financial mechanisms to support end-users with the up-front cost of implementing efficiency measures. Another key barrier is often lack of consumer awareness or education to make energy-wise choices. Finally, EE/DSM initiatives are often stymied by split incentives. Examples of this include: difficulties getting household tenants to switch to solar water heaters, because they rent, and the systems are not very portable.

2.3.2 Solutions to Energy Efficiency and Demand-Side Management

New Laws, Regulations and Codes

MININFRA will develop an Energy Efficiency Strategy[48] and Law to serve as underlying implementation framework to support a series of new regulations by RURA, RHA, and other agencies that can mandate energy efficiency measures in public institutions, households, and commercial businesses. MININFRA will be responsible for integrating the promotion of energy smart building technologies into monitoring and implementation of new government asset management policy. Together with RHA, it is also responsible for introducing energy-smart and energy-efficient technologies and practices into Rwandan building codes. RURA is already developing a solar water heater regulation. Considering building codes specifically: EE measures will be implemented in the form of improved building design and use of building materials that increase EE over the entire lifetime of facilities help to reduce lighting, mechanical ventilation and air conditioning energy consumption. Mandatory installation of solar water heaters for all large water consumers (e.g., hotels, integrated developments) will take effect, in parallel to extending subsidy to end-users to incentivize switching. In addition, a training program on how to comply with the new EE building code should be established for architects, engineers and builders. Fostering green building through climate oriented urban planning principles and green architecture will have a strong long-term impact on reducing the need for electricity, and to reach this orientation of house and settlement should follow urban planning. Pilot efforts to promote energy smart building codes, particularly for green field construction projects, are being promoted in the six secondary cities of Huye, Nyagatare, Rusizi, Musanze, Rubavu and Muhanga, in conjunction with the National Urbanization and Rural Settlement Sector Strategy.

[48] A draft Energy Efficiency strategy (Econoler 2014) already exists and will be revised accordingly.

Grid Loss Reduction

A grid system loss reduction plan was developed in 2013, encompassing priority proposals and measures identified through an earlier study.[49] An investment of $60m over 3 years will result in over $180m of potential energy savings. This will reduce losses from 23% to 15%, capacity savings equivalent to constructing a 15MW power plant. The proposed measures will need to be carefully analysed and prioritized in order to generate the greatest savings in operational cost for a given level of capital expenditure. The plan will be implemented as soon as feasibly possible to reduce forecasted generation capacity requirements.

Dedicated Demand-Side Management Unit in the Utility

REG will establish a dedicated EE/DSM unit to oversee the design and implementation of relevant efficiency programs to clip electrical peak demand. REG shall develop a staffing and business plan as soon as possible as part of its restructuring/institutional reforms. The unit shall collaborate with MININFRA on improving electricity end-use data collection, so as to better understand trends and patterns and to design appropriate strategies for structuring and target energy efficiency programs. Key metrics include: per capita and total consumption by service and consumer group; breakdown of daily peak demand; and electricity end-use by region. Regular surveys shall be taken to obtain this information, targeting households, industries (e.g., motor drives, boilers, and furnaces), and public utilities (e.g., water and wastewater pumping).

The new unit shall prioritize quick-win energy savings opportunities that reduce demand load and operational costs within public utilities, with priority being given to water and sanitation service provision. Almost half of the required expenditures associated with electricity for water service provision come from pumping stations formerly operated by EWSA. A more detailed audit will examine the payback period for undertaking infrastructure upgrades, including installing variable speed drives and remote sensors, to various plants.

The new unit shall also collaborate with MININFRA and RURA on regulatory development to facilitate related priority measures and actions on the part of electricity end-users. An assessment of the viability of other incentives for LV customers on pre-paid-meters (e.g., rebates) shall be performed to further incentivize shifting demand patterns and smooth demand load during the day. Finally, the unit will be responsible for the promotion and removal of barriers to implementing household and commercial efficient lighting initiatives. It is envisioned, for example, that the unit outsources the implementation of a comprehensive behavioural change marketing campaign focused on priority end-users and actions identified in the strategy. The unit would also support translating existing guidelines into educational curricula and public awareness programs to encourage youth participation.

[49] Manitoba (2013)

Energy Audits

Major users of energy, such as industrial and commercial consumers, shall be encouraged and incentivized to carry out regular energy audits. MININFRA will develop a strategy and business model for an energy efficiency finance facility to bankroll audits (50/50 cost split) and retrofits for industry, which would be initially capitalized by MINECOFIN through a reallocation of the subsidy of the power tariff and DP contributions. The facility would be replenished on the basis of savings achieved. It would also undertake establishing energy performance benchmarks whereby Industries shall be encouraged and required to meet or exceed these benchmarks. This will provide a financial incentive to implement EE/DSM programs. RSB and MININFRA are responsible for developing and adopting minimum energy performance standards (MEPS) for motors and promoting the use of high efficiency motor-drives such as variable speed drives (VSDs) in the industries.

EAC-Wide Energy Standards and Labelling Scheme

RSB is responsible for the development and adoption of an EAC-wide energy standards and labelling scheme for common household appliances and to establish a working group to align regional standards with EAC under existing regional integration processes. A baseline for Rwanda will be established through a market assessment of current conditions.

Solar Water Heaters

MININFRA is responsible for the promotion and rollout of Solar Water Heater (SWH) programme. This involves carrying out awareness campaigns by engaging with all stakeholders. In addition, MININFRA will work closely with RHA to revise the buildings codes so that SWH are included in new builds. The specific modalities and financing of SWH inclusion in the building code will be determined by a study to be carried out by MININFRA.

Efficient Lighting

For household lighting, EE/DSM Unit will investigate expanding and managing bulk procurement and distribution of CFLs for residential customers (based on current consumption and end-user affordability) with targeted subsidies for retrofits. The existing CFL program has already distributed 800,000 heavily subsidised units, resulting in an estimated annual saving of 36GWh. Therefore the CFL program will continue under the EP. As well as this an EE code for street lighting shall be developed. Payments and maintenance for street lighting shall be shifted to local authorities to incentivise them to use them efficiently. An assessment study is also underway to replace the sodium HPS street lamps with LEDs. The EE/DSM unit will provide technical support to conduct economically viable energy-efficient street lighting retrofits and in public institutions.

Green Procurement Guidelines (Public Sector)

MININFRA is responsible for promoting efficient use of energy in the public sector. The main electricity consuming facilities in the public sector are government buildings, water and waste water pumping stations and street lighting. RPPA and REMA shall be responsible to

institutionalize “green” public procurement guidelines and strategies focused on equipment with a high energy footprint and to develop clear criteria, guidelines for integrating energy and resource efficiency into existing procurement policy and processes. Policies must be adhered to under certain conditions, as determined by RPPA.

2.3.3 Energy Efficiency & Demand-Side Management Sub-sector Implementation Plan

Table 18 Energy Efficiency & Demand-Side Management Sub-sector Implementation Plan

Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution
Grid Loss Reduction Plan	Final report	Raising funds for implementation	Implement Phase I	Implement Phase II		REG
Establish Dedicated EE/DSM Unit		Develop staffing and business plan and establish EE/ DSM Unit Conduct detailed energy end-use surveys	-Undertake demand surveys -Behavioural change campaigns, investigate bulk procurement and distribution of CFLs, assess viability of incentives (retrofit subsidies)		Project Expansion subject to savings made. Provide TA.	REG & MININFRA
Industry Energy Audits		Develop strategy, business model for EE facility	Develop performance benchmarks	Develop and adopt minimum energy performance standards		MININFRA with RSB
Green procurement		Develop new guidelines	Approval by RPPA and legislation		Pilot and mainstream	RPPA & REMA
EAC–Wide Standards and Labelling	EAC Scheme	Standards Development; Raise Funds for Implementation		Pilot implementation of new standards		RSB
EE Strategy and Law		Develop Strategy. Develop and submit Energy Efficiency Law for approval			Streamline	MININFRA
Buildings	Adopt new SWH regulations with two-year phased compliance timeline			Close monitoring, evaluate as needed		RHA, RURA and MININFRA

2.4 Biomass

2.4.1 Objectives

The overarching sub-sector policy objective is to promote environmentally sustainable use of biomass fuels, thereby mitigating negative environmental, social and health impacts. Rwandan households will not eliminate the use of traditional biomass fuels in the short run. Indeed, it is the most affordable option to most households, and measures to increase the efficiency of harvesting and consumption through cleaner cooking technologies can render biomass energy a truly sustainable solution. However, as the economy develops, the

strategy aims for alternative clean cooking carriers and technologies, such as biogas, LPG, and peat briquettes, to displace unsustainable, traditional biomass fuels over time. These strategies will be implemented as and where it makes sense. The main HLTO for this sub-sector is the following:

80% of all households to employ cleaner cooking technologies by 2018

In addition to the HLTO, there are several subordinate targets, including: increasing the penetration of ICS to up to 50% of all rural households, distributing 3,500 domestic biogas digesters and 15 institutional biogas digesters annually, and increasing average charcoal yields by 30% from a 2009 baseline.[50] These measures will contribute dramatically to reducing traditional biomass energy consumption by the end of EDPRS II period.[51]

It should be recalled that the EP also calls for:

- Consolidating institutional mandates and strengthening decentralized implementation;
- Improving regulatory oversight over the charcoal sector and mainstreaming more efficient charcoal harvesting and carbonization techniques;
- Increasing access to cleaner cooking technologies by promoting new technology standards, piloting new market transformation activities, and introducing possible fiscal reforms, and;
- Developing a harmonized, regionally-integrated policy and market for sustainable liquid bio-fuels.

2.4.2 Challenges within the Biomass Sub-sector

Challenge 1: Wood fuel deficit

The current trend towards increased urbanization and the declining state of forest resources points to the need to design effective policies to address some of the pressing challenges in the biomass subsector and the entire energy sector. In 2009, demand for conventional fuel wood and charcoal was 4.2 million tonnes, resulting in a deficit of 870,000 tonnes per year. While less than expected due to government plantation programs, it still represents a 21% deficit in relation to current demand.[52]

Challenge 2: Lack of a clear ownership

Effective national management of biomass resources and related consumption is a cross cutting-issue that touches upon energy, health, agricultural growth, natural resources management, and local government. Effecting a transition toward clean cooking and modern biomass will bring a number of economic benefits to the country and prevent many

[50] According to the BEST Report, average charcoal production efficiency was 12% in 2009.
[51] The Seven Year Government Program Assessment (2012) defined a national target to reduce biomass consumption from 85% to 50% by 2018.
[52] WISDOM Report.

deaths from household pollutants: some 5,680 Rwandan deaths a year are related to household air pollutants, 94% of which are children[53]. Lack of clearly consolidated institutional accountability, has led to coordination failures, overlaps, and a duplication of effort. For example, ambiguous intuitional mandates and the lack of a more decentralized institutional framework to manage investments under the NDBP has rendered its impact less than optimally effective. In addition, the Energy Balance survey of 2008 is out of date and it is unknown what the share of biomass is in the energy mix today.

Challenge 3: Limited economically competitive, culturally acceptable alternatives: Alternatives to traditional biomass energy for cooking such as LPG are expensive and rare. Many rural households have a low incentive to switch away from traditional biomass fuels as they pay little to nothing for them or simply cannot afford cleaner alternatives. In addition, changing predominant cooking fuel use is a behaviour adjustment that is deeply culturally conditioned. As a result, programs focusing solely on disseminating new technologies without accompanying behavioural change or social marketing campaigns are likely to fall short of being fully successful.

2.4.3 Solutions for the Biomass Sub-Sector

To achieve the targets set out for the biomass sub-sector, a new strategy will identify appropriate technologies for households at different income levels while considering resource and market realities in relative geographies. More market-based PPP approaches to scaling up clean cooking programs will be developed and evaluated through various pilots. These could potentially be combined with off-grid electricity access initiatives, where economically and technically feasible. Further solutions are elaborated below.

Consolidating Institutional Mandates

The implementation of sustainable biomass energy programs focused on cleaner cooking technologies shall be decentralized in order to accelerate delivery and improve impact. MININFRA will develop the necessary strategies, action plans, be responsible for technology development, and will continue to provide technical assistance through REG to the districts. With support and guidance of MINALOC, district authorities will be required to incorporate delivery of sustainable biomass energy technologies into their annual performance contracts and budget programmes into their plans. Districts will play a pivotal role in education and awareness-raising, and the extension of government subsidy mechanisms and micro-finance schemes. MINALOC shall monitor district development plans more closely for meeting clean cooking and biogas targets. RSB shall elaborate updated national ICS standards with the support of REMA, MININFRA, and the private sector and other stakeholders. MINIRENA is responsible for developing biomass supply i.e. forestry.

[53]Global Burden of Disease Report, 2010. This number is high, even despite the fact that many households cook in areas outside of the main living area of their home. According to the EARP baseline study, roughly 73% of households cook in a covered area outside of the main dwelling, while some 13% of households use a separate room in their dwelling as a kitchen.

Formalize charcoal production and supply

Charcoal regulations: To maintain the right balance of trees harvested for charcoal, RNRA shall closely enforce current regulations, including the licensing regime, to stop illegal wood harvesting. RNRA shall ensure that existing regulations for tree harvesting and replacement are published in the public domain at local levels to improve awareness and compliance.

Better supply chain management and more formalized sector: MININFRA shall undertake efforts to formalize the charcoal sector, including conducting a supply chain analysis, reorganizing charcoal supply centres of Rwanda, and promoting better-organized and trained charcoal producer cooperatives and associations. This will help to streamline efforts to put in place improved carbonization techniques. Local authorities will be used to identify local cooperatives involved in charcoaling who will also train other charcoalers through a 'train-the-trainers' approach. MINALOC will promote the use of improved charcoaling techniques that ensure high yield (Kgs wood/Kgs of charcoal) through training programs and sensitization workshops at the local level.

Government will promote energy conservation measures such as more carbonised charcoal, hydraulic charcoal and other improved technologies among large, non-domestic users of wood and charcoal, such as brick manufacturers.

Access to Cleaner Cooking Energy Carriers

Promotion of improved charcoal and wood stoves: Government will place a much stronger emphasis on social marketing/behavioral change communication strategies to promote clean cooking technology alternatives. This can be done through 'Umuganda' meetings as well as training and sensitization workshops on the economic benefits of ICS. These include: a reduction in biomass required, household budget savings, time savings for productive use, and a reduction in deaths and disease from reduced air pollutants. Government aims to ensure that up to 50% of households in rural areas can access an ICS. Ultimately, the target is to reach 63% of rural households having access to improved cook stoves by 2020.

Biogas: The National Domestic Biogas Program (NDBP) targets to disseminate at least 3,500 bio-digesters to households per year, leading to at least 18,000 additional bio-digesters in households by 2018, and 15 bio-gas digesters in institutions such as prisons and schools per year[54]. To fast-track the program, a national taskforce has been instituted. Through the Institutional Biogas Program (IBP), government is promoting the use of biogas for cooking and heating in schools, hospitals and prisons.

The NDBP will be restructured pending a business evaluation to accelerate dissemination.[55]

[54]EWSA, 2014.
[55]Currently 25% of companies have been responsible for installing 60% of the bio-digesters.

Little success has been had under the current program. Therefore, subsidies will be reformed, pending a more detailed economic analysis, to become more means-tested and in-line with system capacity and market demand. Based on a preliminary analysis, a tentative proposal for altering the subsidy mechanism is provided in Annex 4. Additionally, MININFRA will develop strategies and action plans on end-user financing, fund mobilization, capacity building, and enhancing market transformation.

A feasibility study evaluating the relative merits of new and improved biogas technologies will be undertaken as part of the biomass strategy and action plan.[56] At the same time, the Bio-energy Energy Standards Committee under the RSB shall define and publish new standards for biogas digester technologies, including those suitable for institutional plants, which currently do not yet exist. This will examine fiberglass and flexi-biogas versus existing technologies on the basis of reliability, affordability, environmental impact, and job creation. Development of new standards shall take into account new and emerging technologies[57] that can make biogas more affordable and reliable.

For the Institutional Biogas Program, MINEDUC, MINISANTE and MININTER (RCS) shall take the lead on implementation and provide budget for routine maintenance and operations of biogas digesters in schools, health centres, and prisons. REG will continue to give technical assistance where necessary.

Liquefied Petroleum Gas (LPG): Measures to promote LPG fuel-switching among urban and peri-urban customers will be implemented. Rwanda is expected to join the Global LPG Partnership as a member. An LPG market assessment and action plan shall be under taken to identify measures to increase the uptake of LPG that increase affordability and distribution efficiency. The action plan shall consider the merits of eliminating non-economic LPG cylinders (20Kgs) by regulation. It shall also evaluate the benefits of extending incentives to retailers to invest in LPG infrastructure and measured by MINICOM and MININFRA to facilitate bulk purchase and storage facilities. A temporary VAT exemption for LPG is already in place to promote its use as a biomass cooking alternative. Further detail is given in the chapter on petroleum sub-sector.

Regionally Integrated Market for liquid bio-fuels

Liquid bio-fuels such as biodiesel and bio-ethanol provide alternative sources of fuel for vehicles reducing diesel imports.[58] A variety of crops are suitable to produce bio-fuels in East Africa, including Jatropha, maize, and various varieties of sorghum. Since some bio-crops require extensive land, thus competing with policies to scale-up agricultural development, it

[56]This will evaluate the relative merits of new and improved technologies versus existing technologies on the basis of reliability, affordability, environmental impact, and job creation.

[57]i) DRIMEX (Canvas biogas digesters), ii) Biogas International (Flexi biogas), iii) Fiberglass technology, iv) Q-Energy Consultants &v) Sim-Gas

[58] These fuels can be safely blended in small quantities with the existing petrol and diesel.

is important to take stock of existing marginal lands that can be used to grow bio-crops, and to run test trials on crops to see whether this is a viable solution: one private developer in Rwanda is already doing so. Additionally, given the fact that Rwanda's arable land area is highly constrained in comparison to its neighbours, its policy toward bio-fuels shall be to promote regional approaches, whereby feed stocks are imported duty free from other EAC countries. MINICOM and MININFRA shall promote and harmonize policies and market opportunities for regional biofuel industry development.

Finally, small-scale commercial biogas projects, including those involving the gasification of crop residues or effluents linked to human or agricultural wastes will be promoted through inclusion in the REFIT regime.

2.4.4 Biomass Sub-sector Implementation Plan

Table 19 Biomass Sub-sector Implementation Plan

Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution
Biomass Strategy			Update strategy	Implement strategy		MININFRA
Charcoal Efficiency	Sensitization workshops and training seminars including the latest technology					REG, Local Gov.
Technical Support for cook stoves	ICS program	Large awareness campaign	On-going ICS program		Review of appropriate ICS technology	Local Gov. with MININFRA
Biogas	NDBP on-going	Detailed analysis on subsidies for reform	Subsequent strategy and action-plan development on end-user finance/market. Develop new technology standards.			MININFRA; RSB
Train charcoal professionals		Design training program	Local level training programs and sensitization workshops			Local Gov. with MININFRA
Database/ Survey		-Develop National clean cooking database -Carry out Energy Balance survey for Rwanda		Gather data	Monitor	MININFRA with REG

2.5 Petroleum

2.5.1 Objectives

The EP and ESSP aim to ensure the safe, sufficient, reliable, sustainable and affordable supply of petroleum and LPG. This will entail expanding domestic exploration and production, boosting investments in supply and storage infrastructure, and promoting sound management of downstream petroleum resources. The EP outlines the following policy objectives for the sub-sector:

- Accelerate regional cooperation and strategic infrastructure development including new refining, pipeline transportation, and railway infrastructure
- Institute a more effective public-private hybrid model for maintaining strategic petroleum product reserves.
- Enhance the attractiveness of Rwanda as investment destination for upstream oil and gas exploration and development.
- Enhance the effectiveness of price stabilization mechanisms.
- Improve data collection and enforce fuel quality standards through greater checks
- Define clear institutional mandates.
- Implement market transformation activities for LPG

As a high level target, the ESSP commits government to the following:

Ensure the necessary infrastructure is in place to meet current strategic reserve requirements (currently 3 months' supply).[59]

2.5.2 Challenges with the Petroleum Sub-sector

Challenge 1: Price Volatility. Rwanda has very low security over petroleum-based energy products and the global market for petroleum products can be volatile. Although world prices have been remarkably stable in recent years compared to other periods of time, price volatility and shocks are a cause of concern due to Rwanda's extremely high vulnerability.

Challenge 2: High cost of petroleum products and uncertain product quality. Uneven product quality results from a lack of clear standards, quality control mechanisms, and capacities to carry out adequate quality control.

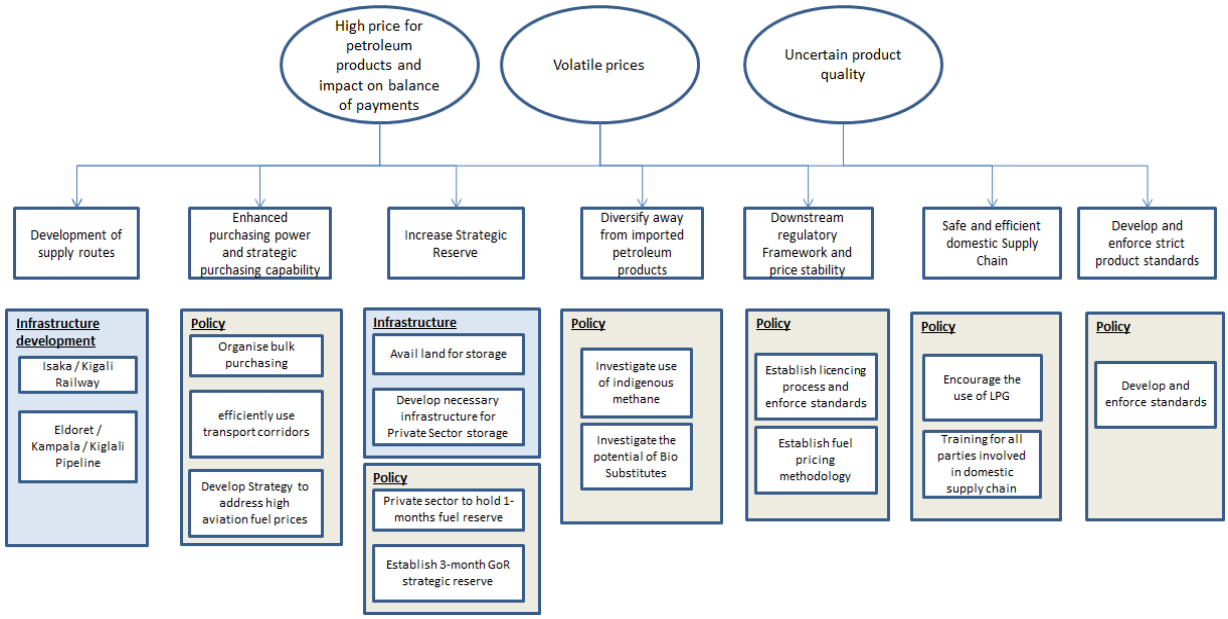
Challenge 3: Insufficient infrastructure. Currently, MINICOM develops and implements regulations for downstream petroleum activities, while MININFRA is responsible for the management of petroleum infrastructure. In order to meet national policy objectives, additional investment in infrastructure development, which has been lagging over recent years, is required. The storage capacity for petroleum imports is insufficient to cope with rising demand and existing infrastructure does not comply with international EHS risk management standards. Large sums of money are required to upgrade existing infrastructure. Infrastructure development strategies must be closely aligned to anticipated market demand and appropriate reserve levels.

2.5.3 Solutions for the Petroleum Sub-sector

The government approach to address each of the main challenges are summarised on the following page, and then discussed in more detail.

[59] The petroleum storage requirements may change over time as a result of a revised level of strategic stocks as mandated by MINICOM.

Figure 8Government approach to address Petroleum sub-sector challenges



Upstream petroleum

Upstream relates to the exploration and production of petroleum, along with the supporting infrastructure to undertake these activities, and is the responsibility of MINIRENA. The National Petroleum Exploration and Production Policy, which was developed and adopted by Cabinet in 2013, will be fully implemented. It addresses key issues of exploration and development, licensing, institutional and regulatory frameworks. According to MINIRENA, the upstream policy is expected to provide Rwanda long-term policy clarity and proper regulatory and institutional set-up, along with proper incentives for investors.

Additionally, it is proposed that the issuance of exploration licenses be liberalized. To mitigate energy insecurity that emanates from excessive energy import dependence in the oil and gas sub-sector, Rwanda would have to accelerate exploration of domestic oil and gas resources. The degree to which exploration and potential discovery can be accelerated depends on upstream exploration and development policies, their inherent investor incentives and the expediency of the licensing and regulatory process. Therefore, based on past experience, a license shall be valid for 2 years and extended for another 5 years subject to satisfactory progress on upstream prospecting. Once a resource is discovered one of three contractual arrangements with the government can be arranged: a profit-sharing agreement, a concession agreement, or an equity participation stake.

Midstream petroleum

Midstream refers to the transportation, storage and wholesale marketing of petroleum. MININFRA is responsible for infrastructure, technology and energy efficiency development of petroleum products. However, MINICOM is responsible for the wholesale marketing and setting strategic reserve requirements. Key interventions here include:

- Develop transportation infrastructure inter-connections for faster, more reliable supplies of petroleum and LPG. Introduce incentives to incentivize retailers and wholesale fuel distributers to increase investments in gas (LPG) storage facilities. Strategic joint investment in Hoima regional refinery project and target participation in other multi-national investments, including bio-diesel blending facilities;
- Encourage and incentivize private investors to undertake bulk purchasing arrangements;
- Assist local importers with storage and distribution infrastructure investments and to undertake bulk purchasing arrangements in order to reduce the price of LPG.

Downstream petroleum subsector

Downstream petroleum refers to the refining, processing, marketing and distribution of petroleum products, including LPG, which is the responsibility of MINICOM. Key interventions here include:

- MINICOM to update the National Downstream Petroleum Policy to reflect current market situation;
- MINICOM to conclude bulk purchasing agreements for petroleum products with Uganda and Tanzania;
- Regulator to adopt an appropriate domestic fuel pricing methodology;
- Regulator to set and enforce standards for all downstream petroleum products and large fuel consumers to enter into fuel hedging arrangements;
- Regulator to adopt regulation for mandatory submission of data related to petroleum products' trade, sales, and strategic stores;
- MINICOM to closely track market growth and penetration rates for LPG through market surveys, etc;
- MININFRA to carry out promotion campaign to increase uptake of LPG targeting urban, upper and middle-class households;
- MININFRA to promote TVETs to provide training in the production/assembly of LPG low cost stoves to march increasing demand.
- Commence full feasibility studies for a petroleum products pipeline between Hoima, Uganda and Kigali, Rwanda. This will establish a supply route to Rwanda from a new oil refinery expected to be operational in Uganda by 2018.

In view of the ongoing harmonisation of best regulatory practices within the EAC region, all energy components including downstream petroleum should be regulated under one umbrella as common practice in the region.

2.5.4 Petroleum Sub-sector Implementation Plan

Table 20 petroleum subsector implementation plan

Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution
Upstream Policy	Finalize and adopt	Implement policy				MINIRENA
Exploration Licenses	Analysis	Develop liberalized licensing scheme		Adopt and enforce		RURA
Regional Investments	Oil pipeline study	Extend pipeline study	Identify other opportunities	Engage in projects and perform feasibility studies		MININFRA
Fuel pricing	Develop appropriate domestic fuel methodology		Adopt and implement			MINICOM, RURA
LPG	Market assessment		Develop awareness and uptake campaign. Develop TVET capacity for LPG stove assembly			MINICOM, MININFRA

2.6 Private Sector Engagement

An unprecedented degree of investment will be needed from the private sector in order to better align energy supply with demand growth. The private sector will play a pivotal role in delivering many of the areas described in the ESSP, particularly in the electricity supply and off-grid energy access sub-sectors. The private sector has the potential for generating inclusive and sustainable growth in Rwanda, by responding to the challenges both through the provision of capital and through human and managerial capacity. This major shift requires strategies to leverage private capital and facilitate private sector engagement and partnership in a manner that best exploits the advantages of each actor.

One lesson from EDPRS-I reflected in the principles of the EP is that clear policies and strategies are needed to attract private investors and streamline investment processes. By creating an enabling environment and enacting conducive policies, the public sector can facilitate the private sector to invest in energy-relevant activities. The private sector is adroit at identifying and exploiting market opportunities, managing risks, and scaling-up clean technologies that have already been demonstrated or piloted.

Challenges with Private Sector Engagement

Past challenges in this area include: passive reactions to expressions of interest, conducting unplanned negotiations without having prior technical or financial feasibility studies including resource assessments, and carefully evaluating the impact of a particular investment against optimization of the energy portfolio.

2.6.1 Solutions for Private Sector Engagement

In order to create a more favourable environment for private investors in the sector, Government will develop a coordinated plan to streamline investment procedures, guarantee stable and positive returns, and reduce perceived and real risks to energy infrastructure investment. Among these measures include updating the investment code and clarifying the rules and modalities of engagement for PPPs.

De-risk investments through financing risky upstream resource assessments and pre-feasibility studies: A pipeline of projects will be developed that are investor ready. To facilitate this, preparatory project development work is essential. An Investment Unit already exists to streamline investment, and the government undertakes almost all pre-feasibility and resource assessment work.

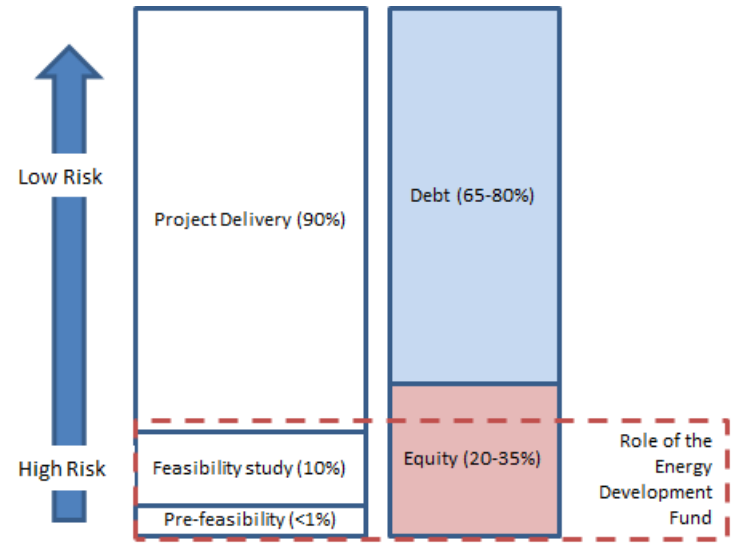
The Establishment of a Rwandan Energy Development Fund (REDF): While a number of development partners fund elements of feasibility work, the timescales and governance required often results in funds not being released quickly enough. A Rwandan Energy Development Fund (REDF) could channel this funding through a single, dedicated strategic funding mechanism.

REF would act to streamline access to funding that would focus on early-stage project finance in renewable generation and off-grid solutions. This would be in the form of early-stage seed capital, equity and concessional loans. Other more complex and innovative instruments would be developed over time. The purpose of REDF would be to bring projects to commercial viability thereby leveraging in more private capital into the sector, and help meet government targets. The REDF concept shall be elaborated and established under the auspices of MINECOFIN as the primary means to co-finance strategic domestic energy projects with public resources. Some related initiatives already exist funded by development partners, however these are scattered, and the governance required often results in under-disbursement or funds being released too slowly to meet commercial deadlines. In general, REDF funds would help to bridge any perceived feasibility gap for projects that are not quite commercially viable unless a small or risky up-front part of the project is funded. The REDF could de-risk investment by funding feasibility studies, technology studies, legal due diligence, or additional service infrastructure to that already pledged by Government.

The illustration below indicates: 1) the relative costs and risk of the feasibility and delivery stages of the project; 2) the usual balance of debt to equity funding; and 3) the target role of REDF participation.

Initial capitalization by the GoR of the REDF is proposed at $30m, with development partners expected to provide additional finance. Climate funds have already been approached to provide seed co-financing. Through this application, funding guidelines and a concept note for the REDF are to be developed by MININFRA in collaboration with MINECOFIN and RDB that will outline the rationale, feasibility and optimal governance and institutional arrangements. The aim would be for the REDF to be operational by the end of 2015/16.

Figure 9REDF Proposal



Streamline investment promotion processes for IPPs. In partnership with RDB, REG, RURA, and other stakeholders, MININFRA shall work to develop clear, simple and harmonised Investment processes for IPP energy projects. In 2014, a new investment process for unsolicited hydropower projects below 5 MW will be finalized that is expected to shorten the timeframes from project concept to financial closure. On the basis of this experience, streamlined processes will be developed for other categories of projects. A dedicated IPP Technical Working Group or Task Force for this area may also be set up, as part of restructuring of sector governance frameworks.

Empower local enterprises to engage in energy sector deals and introduce more competitive, transparent approaches to service provision where appropriate: Under the 2014 National Energy Policy, competitive bidding and procurement of all energy-related projects, including IPP generation activities, shall be the default option to ensure market transparency as well as value-for-money.[60] On the basis of past lessons learned by the EWSA Investment Unit and MININFRA, new procurement guidelines for energy projects solicited by MININFRA, will be developed and aligned with RPPA. These will be developed with a view to ensure that tenders and other competitive bidding processes are fair and unbiased. Wherever feasible, standardized legal documentation will also be used to reduce delays in negotiations. New guidelines shall include templates and manuals for:

[60] In exceptional cases, competitive procurement procedures may prove impractical or not in the public interest.

1) Pre-bid technical specification documents to ensure that project designs align to strategic priorities and local content guidelines or requirements;
2) Determining bid evaluation committees to ensure highly relevant technical evaluation competencies are included. Award evaluation reports to be used when confirming the selection of winning bidders;
3) Any final negotiated agreements with selected bidder.

Extend and expand investment incentives to private investors: A process shall be instituted with agreement from all parties for which transmission connections could be forward paid by energy developers or operators and recouped through agreed fees or tariffs incorporated in Power Purchase Agreements (PPAs). Government shall facilitate the development of IPP projects through the provision of various incentives, including funding access roads and other facilitating infrastructure for projects that meet certain criteria and for which have a concession from MININFRA has already been awarded. The revised Investment Code treats energy as a strategic sector and extends other fiscal and non-fiscal investment incentives to various projects.

Additionally, MININFRA shall elaborate specific operational guidelines for the provision of access roads, including mechanisms for private sector procurement and reimbursement of access road costs as a way to streamline IPP investments in the energy sector. Lastly, a review of the EAC customs exemption schedule shall also be undertaken to ensure the current list fully encompasses all aspects of electric power facilities and that the formulation can be easily understood by customs inspection officers.

3 IMPLEMENTATION OF THE ESSP

3.1 Background and implementation plan

Implementation of this energy sector plan will be done prudently to a void significant disruption to the entire economy. Further, this will be a joint effort of all key players from policy makers, investors and financiers. Some of the challenges to the implementation of the energy sector strategy include issues of coordination given the complexity of the sector (from petroleum to biomass), financing requirements, exogenous forces (resettlement rates) and others. The basis for this strategy though is to create an elaborate approach of remedying these current and future anticipated challenges. An energy Sector Wide Approach Secretariat (SWAP) was created to that respect to ensure coherence and synergy, ensure cross-sectorial collaboration, bridge all key sector players in consultations on strategic actions required for the sector to grow.

The process of developing the ESSP was highly consultative from its initial conception in 2012 to the updated form here alongside the EP consultation process. All key stakeholders from both government and the private sector were exhaustively consulted, and their ideas form the basis of the strategy. Key stakeholders will be kept in the loop through the implementation process with the SWAP secretariat in the lead and the SWG playing an oversight role. Participatory approaches to ESSP implementation will be maintained through a strengthened SWG and technical working groups.

Sequencing of interventions

For a full description of the sequencing of interventions from each of the sub-sectors over the EDPRS II period please refer to Annex 5.

Governance

A full list of the roles and responsibilities of sector stakeholders, and co-ordination and information sharing mechanisms can be found in the EP. For matters of clarity, some of the institutional members of the SWG are: The Lead Ministry (MININFRA), The Lead Donor, Prime Minister's Office, MINECOFIN, Provincial and Kigali City representatives, Development Partners (DPs), Civil Society Organizations, and private sector institutions.

3.2 Communication plan

So as to improve the implementation of the ESSP issues arising from the evaluation process which requires redress will immediately be dealt with inside MININFRA and/or communicated to relevant parties outside the Ministry through the Sector Working Group. REG, given its leading role in projects and programs implementation follow-up will be particularly resourceful in this respect. MININFRA will be responsible for regular

communication of progress and reporting on the status of implementation of energy projects, to the sector stakeholders. Specifically, this will be done through:

- **Regular meetings** will be held with the Energy SWG, which will participate in joint sector review meetings to assess the performance of the sector
- **MININFRA website** will be updated quarterly, with significant information about the Strategy and key sector achievements, opportunities as well as plans in pipeline, accessible to the public.
- **Local media** (newspapers, radio and television) will be used to communicate about the Strategy and state of the sector. This will be partly meant to raise mass awareness on new sector initiatives such as energy efficiency technologies.
- Through MINALOC, the OGS and MINAFFET, MININFRA shall arrange and organise **UMUGANDA** purposely to address the citizens on both strategy and policy both within the country and outside through our Embassies.

Data Sharing

The ESSP calls for the development of intricate databases in the form of more detailed planning and new databases in the areas of biomass, off-grid, and EE/DSM. This data needs to also be shared effectively between MININFRA and REG, across government and the NIS in particular, and other stakeholders as well. The SWG, technical working groups, Energy Steering Committee, and IT software upgrades going on at REG and MININFRA will facilitate internal data sharing and sharing of information across government. REG has developed a public data portal on their website which is in its infancy and requires updating. REG will champion this portal for sharing data with MININFRA to assist so data is available to all stakeholders. MININFRA will also develop the capacity to carry out regular reporting, bulletins and policy briefs with the support of the energy SWAP. Additionally, RSB will place standards online for purchase to make it easier for customers to access them.

3.3 Risk Analysis

The Rwandan energy sector is exposed to significant risks. There is therefore a need to integrate risk screening into planning, particularly at the sectorial level. Some especially critical risks worth highlighting include:

Import Dependency: Diversifying the portfolio of energy sources both domestically and also externally through regional integration to import from multiple countries (e.g., geothermal from Kenya and hydropower from Ethiopia) is a main strategy to increase energy security. Short and long term supply gaps is a risk factor, driven by the fact that our partners also face strong growth in petroleum-based products and electricity consumption; therefore, they might renege on supply and export commitments in order to meet domestic demand. To mitigate this risk, MININFRA is looking at alternative routes for the import of electricity from a broader set of countries, within the context of the EAPP. The legal framework of partner countries regarding private investments in generation will be examined to ensure that only

projects with a very high probability of success are included in MoUs and plans from countries Rwanda imports power from.

Environmental and climatic shocks: These pose a significant challenge. Extraordinary events such as volcanic eruptions could destroy energy investments and disrupt service provision. Oils spills or methane gas explosions can be catastrophic to humanity and the surroundings. The long-term impact of climate change on rainfall and available hydropower generation capacity could also be detrimental to meeting the country's long-term energy plans. A Disaster Recovery Plan therefore needs to be integrated into energy sector planning.

Insufficient and un-integrated planning and exploratory work: All government stakeholders have an obligation to contribute to electricity planning processes in an accurate and timely manner. This is especially true for the areas of agriculture, mining and industry. The Industrial Policy and other relevant policies shall be integrated into plans to reflect this. In addition, failure to develop a full feasibility study for a project in advance of its development is likely to result in inefficient allocation of resources. The high risk premium attached to an unknown resource or project raises financing costs, and ultimately hinders the country's power generation potential. The ESSP includes a number of measures to increase attention to integrated planning and improve planning capacity more generally.

Urbanisation rates: Under the previous auspices of MINALOC a slower than anticipated rates of urbanisation has occurred. This is a key risk factor to the successful achievement of the electricity access targets. Reducing the marginal cost of new grid connections can be achieved indirectly through greater densification and growth of settlements. To reduce this risk factor and to promote resettlement, an inter-ministerial Human Settlement National Steering Committee was established in late 2014 with MININFRA as chair. The steering committee is responsible for coordinating on and the monitoring of urbanisation rates, and reports quarterly to Cabinet. MININFRA is also establishing an inter-agency taskforce to coordinate infrastructure projects related to urbanisation and will report to the national steering committee. The Energy Unit in MININFRA will play an active role on the taskforce.

Annex 5 covers a full list of risks facing the sector and associated mitigation responses. Some solutions to highlight include:

- Conduct vulnerability and risk assessments for all energy-related investments specifically on the exploitation of Methane Gas and fuel storage facilities.
- Institutional reforms to improve planning capacities and reliable service delivery such as the EWSA Reform
- promoting alternative energy technologies (e.g., biogas) as a means to diversify energy supplies as well as for environmental protection and disaster risk reduction
- Develop domestic resources to increase energy security, and at the same time regional interconnections to reduce load-shedding risks.

4 MONITORING AND EVALUATION

The importance of evaluation cannot be overstated. Effective M&E contributes to a variety of core principles outlined in the EP, including: increased accountability and transparency to the Treasury and DPs on the use of public funds; enabling a timely resolution of implementation issues that can build investor confidence, and uncovering lessons on the effectiveness of activities so as to justify scaling-up and alternative procurement mechanisms or market-based approaches. . This section provides an overview of areas that need to be monitored as a result of the ESSP, existing systems already in place, and further institutional capacity needs and requirements to carry out M&E more effectively.

One of MININFRA's core mandates is to carry out monitoring and evaluation (M&E) of strategic projects, programs, and strategies in the energy sector that reflect national policies and that are required to achieve the targets set out in the ESSP. High level monitoring of energy sector performance in line with EDPRS II targets will be jointly done by MININFRA and MINECOFIN. The government energy agent, currently REG, is herein mandated with the provision of accurate and up-to-date information and reports, to enable MININFRA to meet its M&E role. Procedurally, the Ministry will monitor and evaluate performance utilising results based management frameworks, i.e., comparing outcomes to pre-defined targets.

4.1 Targeted Areas

Key indicators to be measured under the ESSP are: generation capacity, grid access to electricity, fuel storage capacity and promotion of biomass. Based on the Energy Policy this strategy goes beyond these indicators, to target by 2018: 563MW generation capacity, 10% reduction in grid carbon intensity, 48% on-grid access to electricity access, 22% off-grid access to electricity, 10% increase in energy efficiency through Demand-Side measures and 8% grid-loss reduction, increasing penetration of improved cooking technologies to 80% and increasing fuel storage to 150 million litres[61]. These changes in priorities in the energy sector will require the development of monitoring systems in new areas and updates/significant improvements to the existing systems as summarised in Annex 4. In short, these include: improving generation databases, including new indicators such as imports, solar and grid carbon intensity; inclusion of productive users, and monitoring their growth; an off-grid meta-database; a clean cooking meta-database; a complete new energy efficiency database with associated indicators and others.

[61] Please see Annex 3 for a more detailed description of the targets up to 2018

4.2 Monitoring and reporting systems

Current Situation

Structure: The Sector Working Group acts as the main coordination forum for the sector; providing information and evaluating progress against targets set during the bi-annual joint sector reviews. Below this, technical working groups/taskforces exist to deal with specific sub-sectors/issues. Relevant stakeholders are present at all levels. Information is fed to these coordination groups through a Sector-Wide Approach (SWAP). The SWAP secretariat is housed in MININFRA and mandated to coordinate and provide information on the sector from REG's Management Information System.

Systems: Currently REG is equipped with a Management Information System (MIS) and database to support planning and M&E of the sector. It covers:

- Development of an energy sector baseline database, annually updated
- Maintenance of a comprehensive set of statistics on energy which will be useful for researchers and policy makers
- Designing and implementing a system of planning, monitoring and evaluation of the financial status and physical progress of energy projects
- Creating a system to give regular, comprehensive reports on the execution of the Energy Sector Strategic Plan (ESSP) for 2013/2017

The MIS acts as the main monitoring tool, and evaluation practices such as readiness assessments, baselines estimations, indicator matrices, and reports are developed utilising the MIS tool. The REG will collaborate with the National Institute of Statistics to ensure compatibility and synergies between National data collection surveys and the web based MIS. These systems then inform the coordination groups mentioned above.

Capacity: Each project has a project manager and teams exist for GIS, MIS and the M&E of EARP. However, current systems are neither well-integrated nor modern, and information flows between the utility and ministry are disjointed. Furthermore the focus at the ministry is on monitoring and training and expansion are needed to set up a dedicated M&E Unit and seek external support.

Solutions

In the face of new demands on the monitoring system as given in the table in Annex 4, and the inadequate existing systems, the following solutions are proposed:

1) Expansion of the MIS in the Energy Utility Co to cope with the new datasets required
2) Full endorsement and integration of the MIS in the utility at all levels of its functionality
3) MININFRA is mandated to ensure its IT system can cope with centralized sharing and also host a light version of the utility's MIS to better exchange information

4) REG shall continue to send updates and project information to the SWAP Secretariat
5) The Secretariat will be empowered as a portal of information and for coordination
6) New databases and associated training are to occur as per Annex 4. For example: the holistic off-grid database, and the investment tracking system to be housed at RDB.
7) Management training is to be given on how to manage monitoring teams and systems

4.3 Evaluation

Evaluation of the Energy Sector

Beyond project tracking, all activities will need to be evaluated. It must be clarified that two distinct styles of evaluation exist, with the first considered the norm at the moment:

1) On-going and final assessments against targets set;
2) Assessments of the impact of activities on beneficiaries and the economy at large

Both these types of assessment will permit lessons to be learnt to improve strategy formation and project delivery, and also increase the accountability of MININFRA. Led by MININFRA, standard evaluation and reporting formats will be drawn up and agreed upon between Districts and central government. Regular sector reviews will be organized internally and with other partners, particularly in the EDPRS thematic working groups to evaluate sector performance in line with commitments reflected herein. The expansion of the M&E unit in the Ministry will receive the required external expertise and training in various evaluation methodologies to be able to carry out internal evaluation projects. Additionally the ministry will explore how best to engage with external evaluators, when final evaluations are not part of project packages, and seek support to do so.

Evaluation of the ESSP

In terms of monitoring the ESSP, this will be carried out on a quarterly basis in addition to regular monitoring activities. This will result in quarterly briefs to highlight successes, and makes suggestions to improve any areas where little progress is being made. Mid-year evaluation exercises will be carried out to better inform the Sector Working Group Joint Sector Reviews. An interim report and final report will be made internally, rather than externally, given the Draft ESSP has already been followed since 2012/13. The M&E Unit within the Ministry will assist in this exercise. Finally a full assessment of the ESSP will be carried out by an independent evaluation consultancy for accountability and transparency.

5 COST AND FINANCING

5.1 Costing

Total financing: Total financing requirement for remaining 4 years (2014-2018) of the energy sector plan is estimated at roughly US$4 bn. This includes electricity generation and transmission, electricity access, as well as EE and DSM, petroleum and biomass energy as summarized in Table 21 below. The total financing requirements are split between: public (US$ 2 bn or 48%), private sector (US$ 1.5bn or 30%), development partners (US$ 771 m or 19%) and district contributions to EARP ($87 m or 2%).

Expenditure on electricity: Total expenditure on electricity investments is estimated to be 81% of the overall energy sector financing requirements. Roughly two-thirds of this is required for generation and transmission activities to deliver 563MW projected. The remaining one-third is earmarked for electricity access which includes the current EARP program and off-grid electrification, to reach the combined 70% electricity access target.

The remaining 19% is mainly consumed by petroleum activities at 18%, and the rest is required for biomass and EE and DSM activities. For biomass energy, resources will mainly be directed to meet the cost of subsidy[62] for the installation of biogas digesters as well as awareness and sensitisation programs.

Petroleum: Government plans to have storage facilities capable of storing three[63] months of petroleum consumption equivalent as reserve for commercial and strategic purposes. In addition, a regional project to develop an oil pipeline is underway, which represents 89% of required expenditure in the petroleum sub-sector. The pipeline will greatly reduce the cost of transporting petroleum and increase energy security in Rwanda.

[62] Government policy is to provide a flat subsidy of 300,000 to whoever is installing a biogas digester.

[63] 3 months fuel consumption equivalent will be kept by the private sector while 1 month will be kept by government

Table 21 SSP costs and financing requirement (2014/15-2017/18)

	2014/15	2015/16	2016/17	2017/18	Total ($M)
ELECTRICITY	**$613.9**	**$429.9**	**$603.9**	**$547.5**	**$2,195.3**
Generation (to deliver 591MW)	**$289.4**	**$318.6**	**$524.2**	**$510.5**	**$1,642.8**
Project Preparation	***$56.3***	***$28.4***	***$56.0***	***$0.6***	***$141.3***
Peat	$1.0	$0.5	$0.0	$0.0	$1.5
Hydro	$7.0	$0.0	$0.0	$0.0	$7.0
Geothermal	$38.6	$22.7	$55.2	$0.0	$116.5
Methane	$0.6	$0.0	$0.0	$0.0	$0.6
Solar	$0.5	$0.0	$0.0	$0.0	$0.5
Other sector studies	$8.7	$5.2	$0.8	$0.6	$15.2
Public	$26.3	$26.4	$54.9	$0.6	$108.2
Dev Partner	$30.0	$2.0	$1.1	$0.0	$33.1
Generation	***$233.1***	***$290.2***	***$468.3***	***$509.9***	***$1,501.5***
Peat	$71.5	$116.4	$152.9	$103.1	$443.8
Hydro (Domestic)	$69.9	$26.6	$46.3	$24.8	$167.6
Hydro (Regional)	$19.5	$39.1	$62.4	$85.7	$206.8
Geothermal	$0.0	$0.0	$0.0	$0.0	$0.0
Methane	$0.0	$54.0	$176.0	$255.0	$485.0
Thermal	$24.2	$54.0	$5.7	$11.3	$95.2
Solar	$48.0	$0.1	$25.0	$30.0	$103.1
Public	$76.9	$75.0	$39.7	$90.9	$282.5
Private	$136.6	$176.2	$389.6	$366.0	$1,068.4
Dev Partner	$19.5	$39.0	$39.0	$53.0	$150.5
Transmission	**$324.5**	**$111.3**	**$79.7**	**$37.0**	**$552.5**
Domestic Lines and Substations	$147.8	$104.0	$70.0	$6.7	$328.5
Regional Lines and Substations	$176.7	$7.3	$9.7	$30.3	$224.1
Public	$143.9	$75.3	$50.6	$37.0	$306.8
Dev Partner	$180.6	$36.0	$29.1	$0.0	$245.7
ELECTRICITY ACCESS	**$163.8**	**$264.0**	**$346.8**	**$403.1**	**$1,177.7**
EARP	**$160.9**	**$252.3**	**$314.6**	**$347.9**	**$1,075.7**
Direct Connections	$59.5	$92.9	$123.7	$166.0	$442.1
Relocations and Fill ins	$62.8	$75.7	$72.8	$86.9	$298.2
Productive Users	$38.6	$83.7	$118.1	$95.0	$335.4
Public	$84.2	$212.8	$209.6	$139.7	$646.3
District	$5.3	$34.3	$34.2	$13.2	$87.0
Dev Partner	$71.4	$5.20	$70.80	$195.00	$342.4
Off Grid Electrification	**$2.9**	**$11.8**	**$32.2**	**$55.2**	**$102.0**
Public	$0.6	$0.3	$0.0	$0.0	$0.8
Private/Consumer	$2.3	$11.5	$32.2	$55.2	$101.2
BIOMASS	**$2.9**	**$2.6**	**$2.6**	**$4.7**	**$12.8**
Biogas	**$2.7**	**$2.5**	**$2.5**	**$2.4**	**$10.2**
Public	$2.6	$2.4	$2.0	$2.4	$9.5
Private/Consumer	$0.1	$0.1	$0.0	$0.0	$0.2
Cook stoves	**$0.22**	**$0.11**	**$0.04**	**$2.28**	**$2.6**
Public	$0.22	$0.11	$0.04	$2.28	$2.6
PETROLEUM	**$9.4**	**$323.8**	**$413.3**	**$0.0**	**$746.5**
Government (Storage Facilities)	$0.8	$0.0	$0.0	$0.0	$0.8
Private (Storage Facilities)	$8.6	$70.4	$0.0	$0.0	$79.0
Pipeline (Investments)	$0.0	$253.3	$413.3	$0.0	$666.7
EE& DSM *(Public)*	**$3.9**	**$8.7**	**$6.0**	**$5.2**	**$23.8**
Total ($M)	**$793.9**	**$1,029.1**	**$1,372.7**	**$960.5**	**$4,156.1**
Public	$339.45	$654.37	$776.16	$278.09	$2,048.1
District	$5.34	$34.28	$34.20	$13.20	$87.02
Private	$147.57	$258.26	$421.78	$421.20	$1,248.8
Dev Partner	$301.5	$82.2	$140.0	$248.0	$771.7

5.2 Financing strategy

In general, wherever possible, finance secured from development partners, government, and other sources such as climate finance[64] will be used to crowd-in private investment. The private sector will also be encouraged through the various incentives to de-risk investment mentioned in chapter 2.6, including establishing the REDF. The REDF will support both off-grid and renewable energy projects. Sector specific financing strategies are described below, and provide a guideline to the approach to the investment needs for each sector. ***Ref. Annex 6 for the overview of the Financing strategy.***

Generation: The preferred approach to implementing new generation projects is to initially reduce their risk profile in the resource assessment phase through feasibility studies undertaken mostly with Government support. Following this initial phase, the EDCL will tender each project to independent power producers (IPP), therefore the capital investment requirements will be covered by the private sector. Following the conclusion of the tender, the private operator will perform further detailed feasibility studies to enable specific projects. Under IPP schemes, projects are contained within dedicated special purpose vehicles owned by private investors (typically foreign private equity funds or large operators of generation projects) and financed under non-recourse project finance. Lenders will provide loans to the special purpose vehicles in amounts equal to 60-80% of total project costs depending on the level of the project risk and on the prevailing conditions of the international capital markets. Project owners will provide in the form of equity the balance of the funds required.

In IPP schemes, the generated electricity is sold by the project to the EUCL under a long term PPA (term of 20 to 25 years). As the EUCL does not have a track record of financial sustainability and creditworthiness, such non-recourse project finance arrangements may require some form of sovereign risk guarantee, as long as this is allowed by the financing capacity of the government, and/or the involvement of multilaterals or export credit agencies, including the World Bank, the African Development Bank, etc. In all cases, including the REFIT, the tariff paid by the EUCL for the electricity will be recovered through the electricity tariff paid by its customers.

The Government will continue to grant subsidies and tax exemption to certain equipment necessary to facilitate IPPs as an incentive to boost investment in this sector and also as a means to mitigate the potential business risks. Additionally, in renewable investments, particularly micro-hydro, REDF will be used to reduce the upfront cost of engaging in projects through financial instruments such as soft loans. Development partners are also working in this area to build local capacity both in banks and with private developers to

[64] MININFRA is mandated to develop a climate finance strategy in line with Rwanda's Green Growth and Climate Resilience Strategy (2012)

further reduce barriers and costs to doing business. Private developers will also be encouraged to engage in climate finance through the National Climate Fund; FONERWA.
In the few situations whereby, due to strategic or emergency considerations, it will not be possible or not recommendable to build a project under an IPP scheme (one example is a thermal peaking plant, which is a strategic generation reserve for the country), the approach will be to implement the schemes using government funds allocated in the budgeting process. The EUCL and the Government will recover the investments through the regulatory asset base depreciation component in the energy tariff.

Finally, Development Partners are financing through loans the construction of the international hydro power plants in Rusumo and Rusizi, which will not be implemented in the period covered by this SSP.

Further details for the implementation of the generation projects are provided in the table below.

Table 22 Summary of Generation Pipeline

Technology	Project	Capacity	Expected Commissioning	Financing Scheme
Hydro	Mushishito HPP (RukararaV)	5	2014/2016	IPP
Hydro	Nyabarongo I	28	2014/15	GoR
Solar	Rwamagana Solar	8.5	2014/15	IPP
Methane	Kivu Watt I Methane	25	2014/15	IPP
Peat	Gishoma Peat	15	2014/15	GoR
Hydro	Micro Hydro (IPPS)	20	2015/18	IPP
Solar	RwinkWavu solar	10	2015/16	IPP
Hydro	Micro Hydro (REFIT)	15	2016/18	IPP
Thermal	KSEZ HFO	50	2016/18	GoR
Peat	Hakan Peat	80	2016/17	IPP
Solar	Nyagatare	10	2016/17	IPP
Hydro	Ntaruka B HPP	5	2017/18	IPP
Solar + Bioenergy	Solar + Bioenergy (REFIT)	12	2017/18	IPP
Thermal	Additional HFO Unit	10	2017/18	GoR
Methane	Additional PPA	50	2017/18	IPP
Peat	Akanyaru Peat	50	2017/18	IPP

Domestic transmission and distribution: With regard to the transmission and distribution power lines, necessary to transport the electricity from the generation centres to the users, the Government will invest its own funds through the REG. The investment will be recovered through components in the tariff, so that part of the future capital needs will be

financed through the utility revenues. In alternative, Development Partners might provide grants or soft loans to finance these assets.

Electricity Access Roll-out Programme: The EARP is financed through a basket of funds from both the Government, District contributions and a variety of donors. Most of the non-government funds are supplied in the form of grants or soft loans from donors with minimal interest. Private contractors will be used to roll-out the grid.

Interconnection lines with neighbouring countries: Given the strategic importance for regional trade and energy security, multilateral and development banks are keen to finance interconnection lines with neighbouring countries. Financing is provided in the form of soft loans with low interest rates. Private contractors will carry out the implementation.

Off-grid electrification: The off-grid electrification is very suitable for the participation of the private sector. For individual solar systems, private operators will be invited to supply their products to individual households with the government either providing various modalities of financial support in the initial phase or some form of guarantees to reduce the business risk. Also microfinance institutions are good candidates to provide to individual customers the sources of finance needed to purchase the equipment and will be part of the overall solution. In case of mini-grid solutions, the EDCL will likely issue tenders to allow private operators develop, build and operate the assets, following the payment of a tariff.

As these are new types of business model for Rwanda, and for now perceived to have low return on investment the Government is undertaking measures to encourage private sector participation. As mentioned previously REDF will be established and provide subsidies, soft loans or other types of financial instruments to encourage private sector developers. In this case of mini-grid solutions, the Government is partnering with research institutions to develop demonstration projects. Some of the Donors are keen to support programmes in this area also by introducing innovative schemes, as results based financing, whereby donors will provide financial rewards on the basis of the achievement of certain results (example: number of installed devices), rather than upfront grants during the programme set up. It is still unclear whether sovereign guarantees may also be required in the case of mini-grids, and developing the regulatory environment will be another key factor to reduce private sector risk.

Energy Efficiency, Demand Side Management: In the near future the Government will provide the necessary funds to support the studies, investment and subsidies required for this sector. Once the commitment of the Government to the sector is established, possibly after the successful rollout of major pilot projects, it is envisaged that Donors will provide support for some of the programmes. At the same time, some programmes will become sustainable business initiatives on their own due to potential energy savings; such as

Industrial Audits which are proposed to be funded 50/50 by the Government and industries themselves. The electricity tariff structure will also play an important role in creating incentives to undertake projects in this area.

Biomass: In the near future the Government will provide the necessary funds to support the studies and investment and subsidies required for this sector. There is also interest from Donors in supporting the various programmes within the biomass sub-sector (e.g. biogas, ICS).

Petroleum: For the construction of the storage tanks for petroleum products, the approach will be to involve the private sector to build the infrastructures under government responsibility through lease contracts, whereby private investors will build and operate the storage facilities and receive an annual payment in exchange for the services. It is also envisaged that a portion of the storage facilities will be financed and built directly by the private sector.

With regard to the Eldoret – Kampala – Kigali, the Governments of Kenya, Uganda and Rwanda are currently working on the assumption of financing the portion of the infrastructure in each country's territory. In the future, various schemes are under consideration, including borrowing part of the financial needs from commercial banks or give the project in concession to a private operator for a period of 20/25 years.

5.2.1 Crowding in further finance

Other sources of finance will be used to crowd-in private investment, and free up Donor and Government resources to be more effectively utilised. For example, the private sector shall be encouraged through the various incentives to de-risk investment mentioned in chapter 2.6, including establishing the REDF. Furthermore climate finance sources shall be mainstreamed as an alternative source of capital, in particular for the construction or implementation of clean energy projects or programmes. MININFRA is currently investigating possibilities in this area and will launch a climate finance strategy within the next 12 months[65].

In the event of a continued major financing gap for the energy sector, projects will be reprioritized and balanced according to demand and supply objectives, and further support asked of central government during the annual budget cycle.

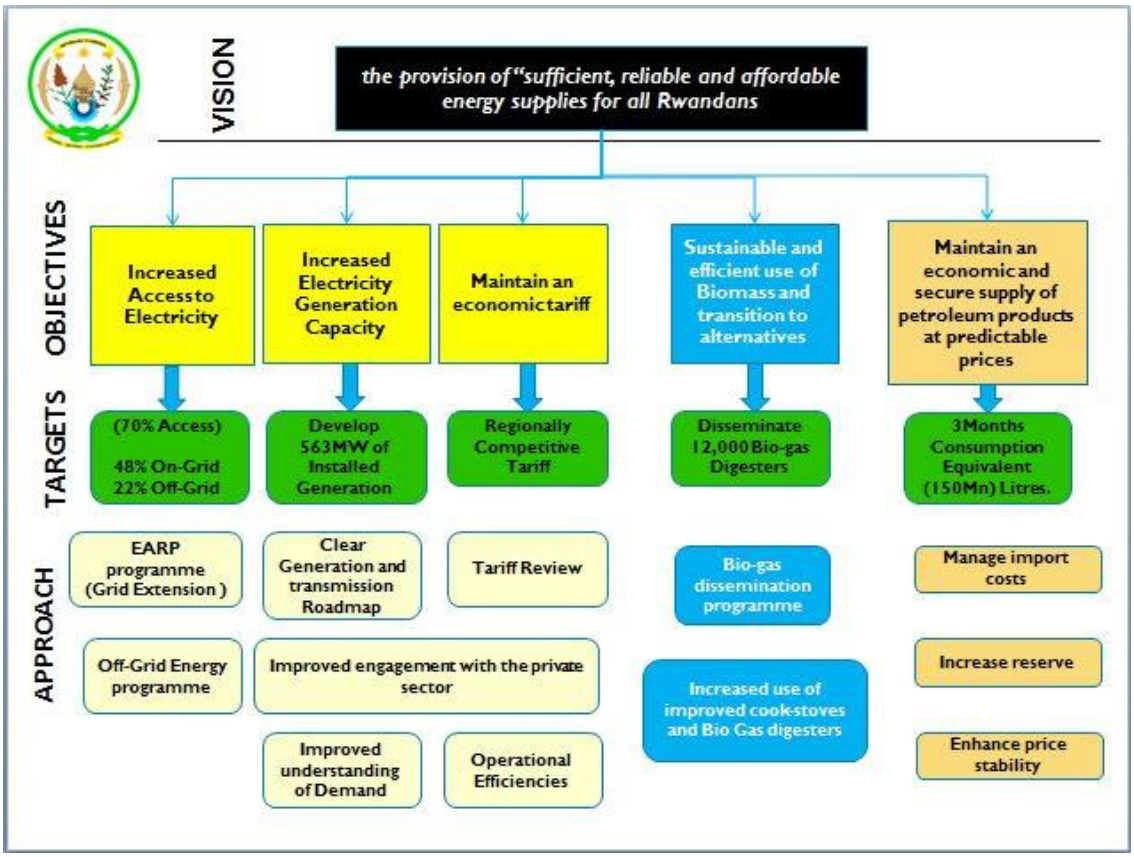
[65] MININFRA is mandated to develop a climate finance strategy in line with Rwanda's Green Growth and Climate Resilience Strategy (2012)

6 EDPRS II & CROSS-CUTTING THEMES

6.1 Contribution to EDPRS 2 thematic Areas/Priorities

Rwanda's economy has been growing at an annual average rate of 8.3% and government is targeting to achieve an annual average growth rate of 11.5% over the EDPRS period (2017/2018). The third generation of Rwanda's development strategy (EDPRS II) aims at achieving rapid economic growth, rural development, productivity and youth employment, and accountable governance. Ensuring access to affordable and modern sources of energy is essential if these objectives are to be achieved. In order to meet our macro-level objectives, respective targets have been set within the energy sector as highlighted in the figure below:

Figure 10 Summary of EDPRS Vision, Objectives, Targets and approach.



As a productive sector, the energy sector is one that enables other sectors to grow, and serves as a catalyst to facilitate socio-economic transformation and improved livelihoods. The provision of cost effective, appropriate energy solutions supports poverty alleviation, particularly in rural areas where energy services are currently scarce or expensive. The table and discussion below illustrates how the ESSP contributes to EDPRS II priority areas.

Table 23 Impact of ESSP on EDPRS II thematic areas and priorities

Economic transformation for rapid growth	**Diversifying the economic base for exports**	Energy must be available and cost effective to drive economic growth; this requires minimising the tariff through efficient investment. Petroleum products as a form of energy drives the transport sector and petroleum price movements impact on macroeconomic balances. The price of petroleum and electricity is one factor driving the cost of other goods and services produced, that bears on levels of inflation and Rwanda's competitiveness.
	Private sector development, competitiveness and service delivery	
	Unlocking infrastructure requirements	
Rural Development	**Urbanization**	Availability of energy services will accelerate urbanisation and human settlements. There is a tendency for the exodus of households from un-electrified to areas with electricity. This comes with emerging rural socio-economic amenities that are engines of rural growth.
	Human settlements	
	Agriculture modernization	The availability of sufficient, affordable energy solutions will drive agricultural mechanisation. Through irrigation in rural areas that will lead to higher agricultural productivity.
	Environment and natural resource management	Improved biomass solutions, such as biogas and ICS, preserves the environment and promotes clean growth.
Productivity and youth employment	**Education and skills development**	Access to electricity is essential to facilitate education on use of modern technologies. Youth training centres such as TVETs require affordable electricity.
	Ensuring a healthy workforce	Transitioning away from traditional biomass to cleaner energy forms will promote a healthier workforce.
	Job creation	Significant employment will be generated in the installation of modern energy infrastructure. Additionally cost effective energy solutions open the door to increased job opportunities through improved business productivity thus being able to create sufficient off jobs annually.
Accountable Governance	**Judiciary reform; rule of law**	Energy products are less appropriate here. However, providing affordable electricity is a form of government accountability to the electorate.
	Citizen-centered approach and public accountability	
	Development communication	

6.1.1 Economic transformation for rapid growth

Economic growth is inextricably linked to energy. As energy is tied to our economy, our required economic growth is dependent upon equitable access to energy, and sufficient supply at affordable rates. Energy and private sector development are the leading sectors under EDPRS II, accounting for over half the total cost of financing. Most of this comes from exploring and developing power project that promote Rwanda's self-reliance in power supply. Key benefits include:

Boost on business development: The cost of power impacts greatly on the overall cost of production in Rwanda. Power systems optimization and increasing imports will promote

more affordable and sufficient power supply. This will also boost local investment, increase income generating activities positively impacting on the state of people's welfare.

Promoting agricultural transformation: Agriculture constitutes the backbone of Rwanda's economy employing over 80% of the population, contributing approximately 35% to Rwanda's GDP. Under Vision 2020 it is planned to grow from the current annual average growth rate of 5.8% to 8.5% by 2020. The planned structural shift from conventional farming methods to agro processing, and increasing use of irrigation will require affordable and sufficient energy supply in powering machines and pumping water. The ESSP is therefore targeting 70% electricity access to communities and in turn agro-businesses.

Promotion of mining and mineral value addition: The mining and minerals sector is a key focal point for export-driven growth in the country. Increasing access to affordable and sufficient power supply will render mining and minerals beneficiation investments more viable and regionally competitive. Currently some mining companies lack sufficient electricity and their operations are constrained by the high cost of electricity.

Energy efficiency: EE measures will reduce power consumption without negative consequences on output. These savings will reduce the energy bill to the households, businesses, as well as government, which can then be used for other productive activities.

Boosting industrialisation plans. For Rwanda's economy to be transformed, we need a structural shift from traditional agriculture to industry and service sectors. The switch to focus on productive users, ensuring 100% sufficient access at economically affordable tariffs over the next 5 years, will be a formidable tool for economic transformation.

Reduce declining trade Balance. By fast tracking oil exploration, and developing appropriate supply routes and bulk purchasing, the trade balance burden will be reduced.

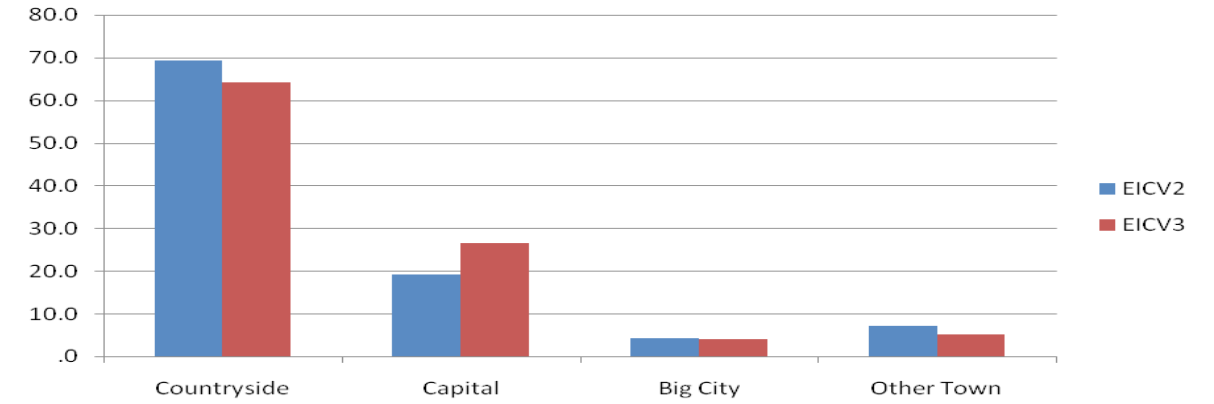
Demand stimulation: Increased energy prices reduce demand by reducing use of energy services and motivating selection of higher conversion efficiency equipment. Reducing this cost will stimulate demand and business growth.

6.1.2 Rural Development

There are visible disparities between rural and urban areas in terms of access to electricity and income levels. EARP will mainly target rural areas and a great deal of rural households and business units are set to benefit from this program. This effort will bridge the rural-urban disparity in access to electricity, thereby improving on businesses start-ups, enable long working hours and promote rural based employment.

EDPRS-II aims to create Special Economic Zones (SEZs) in other regions on top of the existing Kigali-based one. Rural electrification will support initiatives to construct better schools, hospitals and other social amenities; removing the need for rural-urban migration in search of better quality of life. In the last five years, the proportion of the migrant population opting for the capital city increased from 19% to 27% (see Figure 13). Providing energy services to secondary cities will help stem this potentially unsustainable flow.

Figure 11 Rwanda's internal migrations



Source: National Institute of statistics: Integrated Household Survey (EICV3, 2012/2011)

6.1.3 Productivity and youth employment

According to the last integrated households living conditions (EICV 3) survey, youth makes up 39% of the population (i.e. 4,159,000 people between age 14 and 35). This population group could be a formidable tool to Rwanda's future prosperity. However, this requires skills development in order for youth to meet labour market demands. The ESSP will ensure TVETs equip youths with skills in a variety of areas related to sector needs.

6.1.4 Accountable Governance

It is the responsibility of any pro-people government to provide socio-economic necessities. Given that a large part of public resources comes from tax revenue paid by residents, these receipts ought to be spent strategically. This is applied to fulfilling commitments related to electricity and other energy services. Government plans to ensure more local participation in the development of energy resources and solutions. This reflects a deliberate effort to empower citizens as part of governance reforms, though direct or indirect ownership of their development process.

6.2 Mainstreaming cross cutting issues

6.2.1 Capacity building

Current levels of human and institutional capacity are insufficient to deliver on sector commitments. To implement energy sector projects on time and scale up delivery, an enabling institutional framework and skilled personnel is a pre-requisite. The ESSP puts in

place measures to improve energy sector organization and management and a capacity building plan will be developed to cover skills gaps.

Human resource development: Capacity gaps identified among energy sector staff include procurement, project management, and contract management skills. In response to this, capacity will be enhanced through knowledge transfer from long term experts to local counterparts through the support of the Strategic Capacity Building Initiative (SCBI), and through short training courses. There will also be recruitment of external expertise for major transactions in order to ensure that government is getting beneficial deals.

Institutional capacity development: Institutional reforms are underway in both EWSA Ltd and MININFRA to ensure capacity to deliver on the EDPRS II objectives. Detailed proposals on institutional and human skills development are highlighted in the Implementation Plan in Annex 5. Additional guidelines to support capacity building and skills development include:

- Each institution in the energy sector shall have a clear responsible focal point with the mandate to deliver on specific objectives and targets related to capacity building.
- Senior management and administrative personnel of all energy-related agencies shall develop clear policies on training needs and priorities to address key bottlenecks and capacity gaps by the end of FY 2014. Attendance at these training courses shall be incorporated into performance contracts and annual reviews.
- Opportunities for peering and short-term staff exchanges or rotations should be developed as a way to rapidly build capacities.
- Senior management and administrative personnel of all energy-related agencies shall develop clear guidelines and policies for internships reflecting selection criteria and expected outputs so that they are effectively utilised.

6.2.2 Environmental conservation, risk mitigation and green growth

Rwanda is embarking on a low-carbon development pathway as reflected in its recent National Strategy on Climate Change and Green Growth. The ESSP concentrates on developing domestic, cleaner energy resources in the power mix such as geothermal, methane and solar to replace petroleum-based power generation and reduce the environmental impact of electricity consumption.

Rwanda's energy sector is heavily dependent on environmental resources with around half of its electricity coming from hydropower and more than 80% of the population depending on fuel wood for their energy needs. This combined with the country's high climate change and natural disaster vulnerability (as shown by the impact on hydro power in 2005), mean that efforts to adapt and mitigate against the impacts of climate change and preserve the environment will be required. These include, among others:

Reduce reliance on traditional biomass energy: Government is working on a campaign to reduce reliance on traditional forms of biomass from 85% to 50% by 2018. This is being

planned through the use of improved cooking technologies that reduce demand for wood fuel and emit less GHG to the environment. Other initiatives related include the biogas program that is proposed to replace wood fuels for cooking as well as improved charcoal carbonization techniques, reducing charcoal yield and demand for wood fuel.

Increasing energy efficiency: This will be done through appliances and technologies such as CFLs and Solar Water Heaters. Solar water heating systems shall be mandatory for large water consumers to reduce use of electricity for boiling water. In line with the above, regulations requiring new buildings to incorporate green design and use of efficient energy solutions shall be enacted. These include provisions for solar water heating systems, natural lighting, ventilation and open office design among others to reduce energy demand.

Mandatory Environment Impact Assessment (EIA): All power projects are presupposed to have environmental clearance and the Impact certification before project implementation. This is even compounded in the RDB's requirements before issuing an investment certificate to any investments into energy resource development. Where plants are operational before environmental clearance, a mandatory Environmental audit is proposed by REMA.

Disaster Mitigation Activities: These include: the development of a Disaster Recovery Plan over the next 5 years, conducting vulnerability and risk assessment in all energy related investments specifically on the exploitation of Methane Gas and fuel storage facilities, developing contingency and evacuation plans in case of methane explosion in Lake Kivu, and promoting alternative energy sources for environmental protection.

Safety: MININFRA is responsible for mainstreaming disaster prevention guidelines into its operational policies as well as environment, health, and safety (EHS) guidelines to be followed by its implementation agents. International EHS standards shall be applied in all energy infrastructures both public and private owned so as to ensure the safety of both personnel and equipment as well as the conservation of the environment. This shall be especially applicable in tendering of PPPs and IPPs and in the activities of REG.

Elaboration of these plans shall involve all relevant stakeholders and peer review by disaster management experts. Plans including clear protocols to be followed in the event of a "catastrophic" event or "system failure", such as a total power grid blackout, will delegate clear responsibility for alerting and providing emergency response measures. Fire outbreaks and oil spills, which are the main EHS risks in the petroleum industry, can be mitigated by ensuring strict compliance and enforcement of regulations and the adoption of international best practices in handling safety concerns. Other concerns associated with hazardous materials will be addressed through use of high standard equipment and use of personal protective equipment. In the medium-term all power plants shall also be equipped with emission control systems to reduce exhaust.

6.2.3 Regional integration

Rwanda fully supports the deepening of regional cooperation and integration in the energy sector and the sector vision foresees a fully integrated regional exchange of power resources in the long-term. In particular, Rwanda is committed to participating actively in the formulation of the Regional Energy Master plans being coordinated by the EAC, and similar regional energy planning with COMESA and its subsidiary the Communauté Economique des Pays des Grands Lacs (CEPGL), and other regional initiatives such as:

- Regional strategies for efficient procurement, transportation and storage of petroleum products;
- Regional electrical power projects promoted under the auspices of EAPP;
- NELSAP, which falls under the NBI;
- Joint development with the DRC of Lake Kivu methane gas and petroleum exploration.

Existing challenges: The sector is in its infancy, and this is reflected in high transmission losses reaching above 15%, eroding some of the cost advantages at generation stage. There are country specific risks and challenges to be considered. For example, Ethiopia is vulnerable to climate change given its reliance on hydropower, even if it does have a diverse watershed system to mitigate some of the risk, and energy demand is currently growing at 20% a year on average. Such internal conditions will need to be considered in regional trade supply guarantees. Nevertheless regional integration represents an attractive option for Rwanda given its location and small amount of natural resources.

Energy related initiatives to promote regional integration include:

Regional Strategy on scaling up access to Modern Energy Services in EAC: The strategy has 4 main targets, approved by EAC Energy Ministers in August 2005, to be fulfilled by 2015, in line with MDG framework in Scaling-up Access to Modern Energy Services. These are:

a. Provide access to modern cooking practices for 50% of the population that currently uses traditional cooking fuel;
b. Provide access to reliable electricity for all urban and peri-urban poor;
c. Provide access to modern energy services for all schools, clinics, hospitals and community centres; and
d. Provide access to mechanical power for heating and productive uses for all communities.

The Strategy has four service areas that include:

- Policy harmonization at regional and national level;
- Capacity building of both public and private sectors to implement the strategy;
- Formulation and implementation of investment programs; and
- Strategic coordination and Programme management at regional and national level.

The EAC Regional Cross-Border Electrification[66] Policy and Model Power Supply Agreement: Cross-Border Electrification (CBE) allows consumers to benefit from resources across the border that are nearer than domestic alternatives, and can allow marginal projects to become feasible when aggregating loads at both sides of the border.

EAPP and EAC: Under the EAPP-EAC initiative, power generation and interconnection projects are identified at Master Plan level, to interconnect the power systems of EAPP and EAC countries.[67] A common Transmission Interconnection Code exists to facilitate the integrated development and operations of the regional power systems. The initiative also contains institutional capacity building for members through the training of counterpart staff to enable the implementation of subsequent activities. Additionally, trade in electricity and ancillary services will be available and coordinated at the soon to be established Coordination Centre for the EAPP.

[66]The extension of the distribution network and services from the network of one Partner State to communities and other load centres of a neighbouring Partner State. It can also be meant to mean the development of a trans-boundary energy resource with its associated distribution network for the purpose of supplying electricity to the communities and load centres within the borders of two or more Partner States.

[67] The EAPP - EAC covers the following countries in alphabetical order: Burundi, Djibouti, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda.

7 Annexes

7.1 Annex 1: Electricity Generation Investment Roadmap

Peat-to-Power Generation

A Peat master plan was developed in 1993 indicating Rwanda's potential to develop around 700MW of generation from indigenous peat resources. This study however was undertaken at a high level based primarily on a small number of samples and desk based research. The study does not constitute a basis on which to undertake multi-million dollar investments in generation and significant time and finance must be dedicated to developing a full understanding of Rwanda's peat resources if we are to avoid the pitfalls outlined in Section 2. Time and finance to undertake such studies have been factored into our planning. Peat assessments in the bogs in the North and in Akanyaru have been carried out. These studies estimate the resources and areas to prioritize for mining. These are prerequisites to proceed to detailed feasibility studies.

The table below outlines peat projects planned to be implemented over the EDPRS II period to deliver the demand driven roadmap.

- Gishoma Peat to Power (15MW) expected to deliver in fiscal year 2015/16
- Hakan (80 MW) expected to deliver in 2017/18.

Gishoma is currently under construction and COD is expected by 2015; however, full scale operations will be reached only in fiscal year 2015/16. Implementation is already underway for Hakan with detailed work on hydrology and peat testing on-going. The project has the option for a 40 MW extension to be exercised at a later stage. The option protects the government from an excessive exposure to the same supplier.

Furthermore, GoR will prepare a peat energy strategy action plan to further explore the resource, assess its economic potential, the environmental and social impacts and develop private sector participation. The action plan will ascertain also the optimal use of peat across a range of applications: power generation, direct industrial heat, steam applications, or use as domestic charcoal substitute. As part of the activities, the REG will undertake a detailed resource assessment of remaining existing bogs and create a national resource database. A series of small (10 – 15 MW) projects in the Northern bog could be developed after EDPRS-II period.

Hill top and hill side peat bogs are the quickest to develop as the topography of the land provides natural drainage. It should be possible to prepare such sites within 2-years of

completing a full feasibility study. Once prepared, it is necessary to harvest the site for around 6-months to build up sufficient stock pile of peat for generation. Harvesting/peat mining should ideally be undertaken by the private sector and if possible by the same party that will develop and own the power station. There are clear benefits to keeping the supply chain intact, as each interface between companies poses additional risk.

Following the conclusion of the PPA with Hakan, there is considerable private sector interest in developing generation from our peat reserves. Based on the expressed interest, we propose to initiate a competitive tender for a private sector developer to develop and operate mining and generation infrastructure to provide an additional 100 MW to the grid. We have a number of potential sites including the Akanyaru and around Akagera. As a priority, government must conclude feasibility studies in these areas before progressing to competitive selection of a private partner.

Hydropower Generation

Where correctly sited, hydropower can deliver an economic supply of base load power. We plan to complete the 28 MW Nyabarongo power plant, and develop around 55 MW of domestic hydro projects between now and 2017/18, as illustrated in the roadmap at the start of this chapter. As with peat, the individual nature of each Hydro site necessitates a feasibility study to be carried out in advance of development or contracting with the private sector. The table below outlines the projects we are undertaking during the EDPRS II period:

- 28 MW from Nyabarongo I: to be commissioned early in 2014/15.
- 5 MW of generation from Mushishito HPP (Rukarara V) in 2015/2016
- 20 MW from small scale Micro-hydro (IPPs) for the majority of which feasibility studies are on-going and whose commissioning is expected over the period 2015/16 to 2017/18.
- 15 MW of micro hydro to be developed under the REFIT mechanism over the period 2016/2017 to 2017/2018
- 15MW from Akanyaru MHPP in 2017/2018

Projects under implementation/contracted: Nyabarongo, the Micro-hydros, and Rukarara V are all either under implementation or we have already signed a PPA.

Potential projects for competitive tendering: Feasibility studies are currently underway on a number of projects identified through a Hydro Atlas which was complete in 2008. Upon their completion we will undertake a competitive process to identify a private sector partner, as outlined in chapter 2.6.

Possible addition of Nyabarongo II Multipurpose Dam: A feasibility study was undertaken in 2007 which proposed the placement of a dam along the Nyabarongo River approximately 30km North East of Kigali. The projected cost of the project was significantly above the

benchmark for a hydro project purely for electricity generation. The development of the site is however likely to generate other benefits such as irrigating local land to increase the agricultural yield and supplying drinking water. A full feasibility study is currently underway which will be reported this year. Based on this feasibility study we will take a decision on whether the project should go ahead and how the costs can best be shared between the water and electricity consumers and the beneficiaries of the newly irrigated land.

Methane gas-to-power Generation

The reserves of methane held in suspension in the depths of Lake Kivu represent a significant natural resource which can be used for the generation of electricity. As KivuWatt is the first of a kind for this type of plants the project has had some delays: we expect commissioning to take place within 2014/15 and that by 2015/16 the plant will be operational at least at 15 MW (it's wise maintaining a conservative approach in the first year of operation) and to reach full generation capacity by 2015/16. In addition to providing much needed additional generation, this will prove the technical feasibility of extraction and generation at this scale. The table below outlines the projects which we will need to achieve over the following 5-years:

- 25 MW from KivuWatt I in 2014/15
- 50 MW of additional Methane in 2017/18.
- 3.6 MW from the rehabilitation of REC generation plant in 2014.

Feasibility work: Whilst we expect the commissioning of the KivuWatt plant in 2014/15 we will define an action plan to further assess the resource in Lake Kivu while considering alternative scenarios for resource extraction. The plan will include a study to assess the feasibility of the overall methane gas resource, and thereafter it will be necessary to assess the range of opportunities available for investors, including projects of differing sizes and based on different technology types, and even the separation of gas extraction from the activity of power production. The GoR will prioritize technologies which allow the maximum sustainable extraction of supply subject to be being value for money.

REC: REC is currently looking for technology providers and investors to partner on rehabilitating KP1.

Geothermal power development

Geothermal energy is a clean and reliable source of energy, which is not affected by short-term fluctuations in the weather or international oil prices. When installed, most geothermal plants have relatively very low maintenance costs and high availability. Geothermal energy is not dependent on the time of the day (as solar) or on fluctuations of the weather (as hydropower or wind).

As geothermal exploration is at an early stage across most of the prospects (Ethiopia started the first geo-scientific studies in in 1969 but geothermal exploration is only part of recent history) and the resource potential is characterized by a high level of uncertainty, the Government is undertaking an approach of resource de-risking by exploring the prospective geothermal areas until proven resources are available, including carrying out step-wise exploration and ranking of all prospects. The activities expected to be undertaken are:

- Surface exploration;
- Exploration drilling and
- Develop a pilot plant as proof of concept.

However, the exact scope of work undertaken by the Government will depend on the resource estimation and on funds available.

In spring 2014, MININFRA developed a programmatic approach to geothermal exploration comprising two areas of activities:

- Setting up the necessary institutional arrangements to govern the geothermal sector and improving the strategy and regulations that govern it: and
- Feasibility through exploration of the key prospects, starting from executing more accurate surface studies in Kinigi, Gisenyi and Bugarama and drawing a lesson learnt from the drilling in Karisimbi.

Institutional arrangements and exploration and commercial strategy: international experience shows that countries with consolidated geothermal exploration programmes have set up the necessary institutional, policy and legal environment to allow the sector to prosper.

The following step will be an upgrade of the legal and regulatory framework to address the unique needs of geothermal energy activities. This will include also a close coordination of the mining and energy concessions between relevant Ministries. In the end, a detailed Geothermal Strategy will be developed which will be formally approved. A Geothermal Law has already been drafted and is pending approval once the policy and strategy are refined.

Feasibility of Rwanda's geothermal Resource: Based on surface studies conducted in the past four sites with geothermal potential have been identified: Karisimbi, Kinigi, Gisenyi and Bugarama. In Karisimbi, a drilling campaign was concluded in March 2014, leading to no conclusive, positive results. In the other prospects, on-going or planned geo-scientific surface surveys are being performed using best available technical information and methods. As lessons are being analysed from Karisimbi drilling activities, a geothermal master plan is being developed, based on a refined estimation of the resource potential. As part of resource feasibility assessments, a broad range of applications of geothermal energy, beyond power (including: industrial heating/cooling), shall be considered.

7.2 Annex 2: Sub-sector Additional Tables

Table 24 Electricity Access: The EARP Connection Policy

Service offered	Time taken to process	Cost requirements
Connection to electricity	1 working days	56.000 RWF
Industries in Economic zone	15 calendar days	Free of charge
Industries between 1 and 5.3Km to the national grid	15 calendar days, after completion of the line	20.000.000 RWF. The transformer substation for the industry (factory) is not included in the price
Industries falling beyond 5.3Km to the national grid	15 calendar days, after completion of the line	20,000,000 RWF, for 1 to 5.3Km and 20,500,000 RWF per Km beyond 5.3Km, excl. transformer substation for the industry
Supplementary meter three phase	1 working day	86.000 RWF(VAT included)
Supplementary single phase	1 working day	53.300 RWF (VAT included)
Supplementary water meter	1 working day	47.436 RWF (VAT included)
Alteration to metering equipment	10 working days	Free
Meter reading	From 15th - 30th of each month	Free
Billing: *Bank payment contract service*-Payment on EUCL account previous to consumption from 6 months onwards	From 6 months onwards	Free
Correction of errors if any	Immediate	Free
Changing address	Immediate	Free
Ending contract	Immediate	Free
Outsourcing of prepayment cash power	Through SMS MEDIA, etc.	Domestic Company Registration; Non fiscal taxes of local government.
Reconnection	Immediate	1,000 RWF
Planned power or water interruptions	2 days advance notice via national media	Free
Change of pipe or change of ferrule size	5 working days	Quotation fee
Change of cable size or additional supply phase	5 working days	Quotation fee
Services and products put out to tender	30 days until opening date of the offers	Fee to purchase the tender document
Disconnection notice	5 days advance notice	Free

Major reforms are suggested to improve the effectiveness of the biogas subsidy and NDBP. The minimum technical requirements for a family to qualify for a capital subsidy for installing a biogas plant shall include the following: (i) own at least 2 cows that are home fed (zero grazed); (ii) have adequate space for biogas construction; (iii) have a permanent settlement; (iv) have easy access to water for mixing with cow dung; (v) able to financially co-contribute a reasonable share of total cost, after the government subsidy top-up is taken into consideration. In order to better target the effectiveness of the subsidy, the following categorization is tentatively proposed:

Table 25 Proposed Biogas Subsidy Amount Scaled to Income

Ubudehe Income Category	Subsidy amount	Justification
Category 1	Full coverage, less unskilled Labour costs (RWF 495,000)	These are the poorest households in Rwanda and hence affordability is very low. By definition, they may own no livestock and therefore may lack the minimum required feed-stock which is a criterion for obtaining the subsidy. Very careful scrutiny thus needs to be placed on customers in this category applying for a capital subsidy.
Category 2	Increase from RWF 300,000 to RWF 400,000	These households comprise the majority of potential target customers for the program (over 60% of total). By increasing the subsidy afforded to this category, an increase in market uptake is likely.
Category 3	Reduce from RWF 300,000 to RWF 200,000	These households are among the self-sustaining household categories. They can afford top up or access credit from lenders.
Category 4	No subsidy	These households have the capacity to raise their own revenues and have the required collateral to secure credit from lenders.

7.3 Annex 3: Energy sector performance indicator matrix

Table 26 Energy sector performance indicator matrix

Sector Outcome	Indicator	Baseline 2013/14	High Level Targets			
			2014/15	2015/16	2016/17	2017/18
563 MW of electric power installed capacity	MW of electricity system equivalent installed capacity (domestic generation + imports)	119.6	188	255	332	**563**
70% of households have access to electricity: -48% on-grid -22% off-grid	% of all households with electricity access	20.6%	25.5	35%	50%	**70%**
	% households with access to on-gird electricity	21%	23%	30%	38%	**48%**
	% households with access to off-gird electricity	0.5%	2.5%	7%	12%	**22%**
80% of all households employ cleaner cooking energy technologies	% of households using cleaner cooking energy technologies	60%	62%	68%	74%	**80%**
10% electricity output saved from efficiency measures	Total MWh saved from Demand-Side EE Measures calculated as % equivalent of total system output	8.3%	8.3%	8.5%	9%	**10%**
Realization of EAC Regional Integration Policy Priorities for the Energy Sector	Number of Fully Implemented EAC Regional Integration Priorities	-	-	2	4	**5**
150 million litres of strategic fuel reserves/ storage capacity	Million Litres of Fuel in Strategic Reserve	50	70	85	115	**150**

7.4 Annex 4: Energy sector Monitoring & Evaluation Plan

Table 27 Energy sector Monitoring & Evaluation Plan

Sub-sector objectives	Areas to be Monitored	Indicator(s)	Data Sources/Tools	Responsible	Reporting
Increased Electricity Supply	Installed Capacity	MW of electricity	REG Planning Units	MININFRA	Monthly/ Quarterly reviews. Bi-annual report
	Import/ Export Capacity	Imports <20% capacity*			
	Solar generation	Solar <20% capacity*			
	Generation development	Project Status	REG Project Managers	eSWAP Secretariat	Weekly/ Monthly report with Quarterly/ Bi-annual review
	Grid carbon emissions	Emission estimations*	UNFCCC Tool and REG	REMA	Annual review
	Projected Demand: Productive Users	Project Status, Macro indicators	MINICOM, MINAGRI, MINIRENA, NIS	MINICOM	Annual report
	Projected Demand: Households/ SMEs	KWh per annum	EARP	MININFRA	3 yearly study and interim/ final report
	Autonomous Generation	Generation details[68]	License applications; Bi-annual surveys	RURA	Annual report
Increased Electricity Access	Availability for productive users	MWh of productive user power-cuts	EUCL and MINICOM Ind. Survey	MININFRA	Year End Reports
	EARP projections	Household assumptions[69]	EARP	MININFRA	Bi-annual review
	Public service access to electricity	% schools, hospitals and district administrative centres connected	EARP	MININFRA	Year End Reports
	Settlement rates	Rural to urban migration, urban population growth	RHA	MININFRA	Bi-annual review
	Off-grid activities: National Database[70]	Generation details, T&D (Mini/micro grid[71]), household penetration[72]	REG	MININFRA	Monthly report with Annual review
	System Grid losses	Technical losses	EUCL	MININFRA	Monthly report, Bi-annual

[68] These include: location, plant size, MWh per annum
[69] For example: Kwh per household assumed by geographic location, urban or rural etc.
[70] Will include: all ad-hoc projects, progress of PPP pilot projects, and where feasible private sector efforts
[71] These include: size, location, supporting generation, operator and developer, O&M schedule
[72] All types of pico products such a solar, kinetic, biogas energy

Increased Energy Efficiency/DSM	Buildings	No. Energy Audits	RHA	MININFRA	Year End reports
	Regulations	No. regulations and standards in place	RURA	MININFRA	Annual review
	Demand-side database	MWh saved, penetration rates for EE appliances and lights	REG DSM Unit	MININFRA	Monthly reports, Annual review
	Supply-side database	MWh saved	REG/DSM Unit	MININFRA	Monthly reports, Annual review
Increased Household Access to Cleaner Cooking Energy Technologies	Clean cooking activities: National Database[73]	Project status, Emissions, Health impacts, Efficiency, Penetration rates, Costs, Sustainability, O&M, Technologies	REG, MINISANTE, MINIRENA	MININFRA/ MINALOC	Interim/ Annual reports
	Efficient Charcoaling	Charcoal efficiency rates, N$^{o.}$ of cooperatives trained, N$^{o.}$ of licenses	REG/ MINIRENA, Local Gov.	MININFRA / MINALOC/MINIRENA	Year End reports
	Sensitization Programs	No. of attendees, Behavioural impact	Surveys	Institution carrying out program	Final reports
	Biogas	Institutions with units, Households with units	REG/ Local Gov.	MININFRA / MINALOC	Quarterly review, Annual report
Increased Supply and Security of Petroleum-Based Fuels	LPG Market	Market growth	MINICOM	MINICOM	Year End reports
	Petroleum storage and distribution	Litres of stored fuel Quality Control regulations adopted	MINICOM	MINICOM; MININFRA; RURA	Monthly report, Annual review
Cross-Cutting	Private Sector Engagement	% system MW delivery by IPPs # of Energy Sector PPPs REDF Established	REG, RDB	RDB	Bi-annual reviews
	Regional Integration	# of EAC Regional Integration Priority Actions fully implemented	REG, RURA, MINICOM	MININFRA with MINEAC	Year End reports
	Capacity Building	No. of trainings, No. local counterparts, No. technical certificates gained	Capacity Building database*	Each institution, MININFRA to coordinate	Quarterly reports and Annual review

[73] This will incorporate all areas of clean cooking including the efficient charcoaling and biogas programs

7.5 Annex 5: Implementation and risk mitigation plan overview

Table 28 Energy sector implementation plan

Sector Outcomes	Risk	Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution	Mitigation
ELECTRICITY SUB-SECTOR									
Increase grid electricity to 563 MW	1. Insufficient or unexplored energy resources 2. Delays in project delivery 3. Under-delivery due to lack of finance **4.** Import supply risks	**Demand/ Supply Balance**	Annual review	Dedicated planning unit established; demand forecast undertaken	-Translate plans into a National Power Master Plan. -Annual reviews undertaken. -Inform EAPP Master Plan			REG, MININFRA	Government undertakes exploration of resources and feasibility study development Increased imports with close collaboration with partner countries Improved planning tools and frequent reviews. Looking for different sources of finance e.g SE4ALL, SREP, NAMAs, Exim Banks, etc.
		Generation Studies	Further geothermal studies	-Detailed Peat resource assessment -Methane Action plan		-Develop Peat strategy and action plan. -Other studies		REG, MININFRA	
		LCPDP	Review Interim Report	Finalize and implement LCPDP	Annual update of LCPDP as part of overall planning exercise			REG	
		Reduce Carbon intensity	Incorporate target into Power Master Plan; Recalculate Grid Emission Factor Annually; Increase Rwanda's share of global climate finance					REMA with MININFRA	
		Timely maintenance and servicing		Full operations and maintenance plan of all power plants and grid network developed				REG	
		Cost-reflective tariff	'Ability to pay' assessment New methodology calculated		Annual reviews as with previous years. Targeted industries approved			RURA, MININFRA, MINECOFIN	
		Regional Integration	Development of Action Plan to operationalize import opportunities		Implementation of Action Plan			MININFRA	
		REFIT	Analysis and draft	Adopt new REFIT regulation	Execute PPAs	Evaluate and expand coverage to other project types		RURA with MININFRA	

Sector Outcomes	Risk	Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution	Mitigation
			revision						Crowding-in the private sector
		Autonomous Generation		Research on optimal system integration and simplified regulation developed		Pilot projects to test impact of net metering		MININFRA, RURA	
ELECTRICITY ACCESS SUB-SECTOR									
Ensure 70% of households have access to electricity: 48% on-grid and 22% off-grid	1. Lack of resettlements for on grid connections. 2. Lack of uptake of off grid energy products. **3.** Inability to raise required EARP finance.	**On and off-grid harmonization**		-Update of on-grid electrification plan -Publish 3 year grid development plan	Harmonization of off-grid plans with EARP Phase II plans		Publish 3 year plan	eSWAP Secretariat	RHA to develop secondary city infrastructure. Encouraging micro grid development. Off-grid PPPs to encourage private sector.
		Off-grid strategy	Propose concept	Development of strategy	Strategy approved	Implement and develop national off grid database		MININFRA	
		Regulatory Environment		Develop legal and regulatory environment alongside and informed by the off-grid strategy				RURA, MININFRA	
		Productive User prioritization	Concept approved	Reflect in 3-year Electrification Plan	Close monitoring and annual reviews. Re-evaluate impact of strategy as needed.			REG(EARP), MINICOM	
		Public service connections	Implementation of school and hospital electricity access projects		Analysis of EARP expansion	Development of rigorous feasibility studies for schools and hospitals		REG with MININFRA	
		Innovative PPPs for off-grid		Develop PPP pilot concept	Undertake pilot PPP projects. Apply for climate finance, carry out awareness campaigns and evaluate projects			MININFRA	
		Small-scale off-grid distributors	Revision of simplified licensing framework		Analyse eventual inclusion under REFIT with grid expansion			RURA with MININFRA	
		Financial Partnerships	Collaboration with local financial institutions to set-up support		Implementation on support via local financial institutions			MININFRA, MINALOC	
ENERGY EFFICIENCY AND DEMAND-SIDE MANAGEMENT SUB-SECTOR									
Increase energy	-Low EE awareness	**Grid Loss Reduction Plan**	Final report	Raising funds for implementation	Phase I	Phase II		REG	-EE sensitization campaigns

Sector Outcomes	Risk	Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution	Mitigation
efficiency by 10% through Demand-Side measures and 8% grid-loss reduction.	-Lack of effective monitoring of EE activities.	**EE/DSM Unit**		Develop staffing and business plan and establish EE/ DSM Unit	Outsource behavioural change campaigns, investigate bulk procurement and distribution of CFLs, assess viability of other incentives (retrofit subsidies)		Project Expansion subject to savings made. Provide TA.	REG with MININFRA	-Develop effective monitoring tools.
		Industry Energy Audits		Develop strategy and business model	Develop performance benchmarks		Develop and adopt minimum energy performance standards	MININFRA with RSB	
		Green procurement		Develop and institutionalize green procurement guidelines				RPPA and REMA	
		EAC Standards and Labelling	EAC Scheme	Development and adaptation of EAC –wide energy standards and labelling scheme				RSB	
		Surveys		Develop surveys	Undertake household energy end-use, public water pump, industrial motor, boiler and furnace surveys			EE/DSM Unit	
		EE Strategy and Law	Draft Strategy	Finalize strategy. Develop and submit law for approval			Streamline	MININFRA	
		Buildings	Revise Building Code	Adopt new SWH regulations with two-year phased compliance timeline		Close monitoring. Re-evaluate impact as needed.		RHA, RURA and MININFRA	
BIOMASS SUB-SECTOR									
Ensure 80% of households employ clean cooking	-Rigidity and resistance to change by different groups	**Biomass Strategy**			Update strategy	Implement strategy		MININFRA	- Sensitization campaigns about clean cooking energy technologies.
		Promotion	Sensitization workshops and training seminars including the latest technology					REG, Local Gov.	
		Technical Support for cook	ICS program	Large awareness campaign	On-going ICS program		Review of appropriate ICS	Local Gov. with	

Sector Outcomes	Risk	Strategic Action	2013/14	2014/15	2015/16	2016/17	2017/18	Responsible Institution	Mitigation
energy technologies	-lack of review and evaluation.	**stoves**					technology	MININFRA	-Regular reviews of projects.
		Biogas program	Program on-going	Detailed analysis on subsidies	Subsequent strategy and action-plan development on end-user finance/market			MININFRA	
		Train charcoal professionals		Design training program	Local level training programs and sensitization workshops			Local Gov. with MININFRA	
		Biogas Technology		Feasibility study on technologies	Convene Energy Standards Committee, and develop subsequent guidelines			MININFRA	
		Database / Survey		-Develop National clean cooking database -Carry out Energy Balance survey for Rwanda		Gather data	Monitor	MININFRA with REG	
PETROLUEM SUB-SECTOR									
Increase fuel storage capacity to 150 million litres by 2018	International Price Volatility 4 month strategic reserve insufficient/ too high -Safety	**Upstream Policy**	Finalized and adopted	Implement policy				REG with MININFRA	-Develop strategic storage -Oil pipeline investment -Careful demand and supply planning
		Exploration Licenses		Develop liberalized license		Adopted and enforced		RURA	
		Regional Investments	Oil pipeline study	Extend pipeline study	Identify other opportunities	Engage in projects and perform feasibility studies		MININFRA	
		Fuel pricing	Develop appropriate domestic fuel methodology		Adopt			MININFRA MINICOM, RURA	
		LPG	Develop and track market with surveys		Develop awareness and uptake campaign. Develop TVET capacity for LPG stove assembly			MININFRA	

7.6 Annex 6: Overview of the Financing Strategy

Table 29 Overview of Financing Strategy

Sources of Funds/ Financial Instruments	Generation	Transmission and distribution		Electricity Access		Energy Efficiency	Biomass	Petroleum
		Domestic	Inter-connection	On-grid (EARP)	Off-grid			
Private Sector (Equity & Debt)	IPP (Equity & Debt), Feasibility studies	–	–	–	Funding though private investors, Microfinance institutions, Funding (PPP)	Financing of projects, Purchase of EE products	Funding though private investors. Microfinance institutions.	Equity & Debt (both for public and private storage facilities; pipelines)
Government of Rwanda	Funds for strategic generation through REG, Feasibility Studies, sovereign risk guarantees	Funds to be injected into REG	Funding contributions to projects and expropriation	Funding of some projects	Subsidies, Funding (PPP), sovereign risk, project risk guarantees	EE fund, funding for auditing, financing of projects and pilot projects	Subsidies	Equity (pipelines)
Development Partners and Multilaterals	Debt, guarantees (incl. partial risk), Export credit	Possible loans or soft loans	Debt (soft loans)	Funding of some projects through grants and/or soft loans	Debt, result based finance, grants	Possible support in form of grants and/or soft loans	–	–
Alternative Finance (Climate, REDF)	Equity & Debt (RE projects only)	–	–	–	Equity & Debt (RE based solutions only)	Equity & Debt	Equity & Debt	–