Burundi in the Energy Global Value Chain

SKILLS FOR PRIVATE SECTOR DEVELOPMENT

Penny Bamber

Andrew Guinn

Gary Gereffi

Contributing CGGC Researchers: Andrew Hull, Grace Muhimpundu and Thupten Norbu

Duke | CENTER on GLOBALIZATION, GOVERNANCE & COMPETITIVENESS at the Social Science Research Institute

This report was prepared on behalf of the World Bank. It draws on primary information from field interviews in Burundi carried out in August-September 2013 and January-February 2014, as well as secondary information sources. Errors of fact or interpretation remain the exclusive responsibility of the authors. The opinions expressed in this report are not endorsed by the World Bank or the interviewees.

The final version of this report will be available at www.cggc.duke.edu.

Acknowledgements

Duke CGGC would like to thank all of the interviewees, who gave generously of their time and expertise. Duke CGGC would also like to extend special thanks to the World Bank for their contribution to the development of this report. In particular gratitude is due to Cristina Santos, Senior Education Specialist, Reehana Rifat Raza, Senior Human Development Economist, Sajitha Bashir, Sector Manager, Education (Eastern and Southern Africa), and Ifeyinwa Onugha, Competitive Industries Practice – Financial and Private Sector Development, the World Bank Group, for their guidance and insightful comments on earlier drafts.

Duke University, Center on Globalization, Governance and Competitiveness (Duke CGGC)

The Duke University Center on Globalization, Governance & Competitiveness (Duke CGGC) is affiliated with the Social Science Research Institute at Duke University. Duke CGGC is a center of excellence in the United States that uses a global value chains methodology to study the effects of globalization in terms of economic, social, and environmental upgrading, international competitiveness and innovation in the knowledge economy. Duke CGGC works with a network of researchers and scholars around the world in order to link the global with the local and to understand the effects of globalization on countries, companies and the full range of development stakeholders.

www.cggc.duke.edu

Center on Globalization, Governance & Competitiveness, Duke University

Acronyms

ABER	Burundi Agency for Rural Electrification (*Agence Burundaise pour l'Electrification Rurale*)
AfDB	African Development Bank
API	Burundi Investment Promotion Agency (*Agence de Promotion de l'Investissement au Burundi*)
BMZ	German Federal Ministry for Economic Development and Cooperation
BSEs	Barefoot Solar Engineers
CTP	The Workforce Development Agency on Monitoring Standards and Application in Technical Education System (*Centre de Development des Competences Techniques et Professionels)*
DRC	Democratic Republic of the Congo
EAC	East Africa Community
EAP	Electricity Access Program
EAPP	East African Power Pool
EPP	Emergency Power Program
EU	European Union
GWh	Gigawatt Hours
GIS	Geographical Information Systems
GVC	Global Value Chain
HR	Human Resources
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
IPPs	Independent Power Producers
JICA	Japanese International Cooperation Agency
kWh	Kilowatt Hours
kV	Kilo Volt
LEC	Liberia Electricity Corporation
MW	Mega Watt
MEM	Ministry of Energy and Mines
MHI	Manitoba Hydro International
NORAD	Norwegian Agency for Development Coordination
PV	Photovoltaic
REGIDESO	The Water and Electricity Production and Distribution Authority *(Régie de Production et de Distribution d'Eau et d'Electricité*)
RoR	Run of River
RURA	Rwanda Utilities Regulation Authority
SOSUMO	Moso Sugar Company (*Société Sucrière du Moso*)
SWAp	Sector-Wide Approach
TBC	Tanganyika Business Company
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development

Table of Contents

List of Boxes

List of Figures

List of Tables

I. Introduction

Burundi faces high and growing demand for electrical energy.[1] Political and economic instability over the last two decades, however, has undermined the development of the country's energy sector. With very low installed capacity, Burundi faces significant challenges with respect to energy supplies in the country. 90% of the country's energy needs are currently met by the burning of biomass, primarily wood, for cooking and heat contributing to deforestation and health care issues, and the lack of electrical energy supply constrains the development of the country in the long term. As the country continues to rebuild its economy following the end of the crisis, policy makers, donors and the private sector have expressed interest in bolstering the sector, both as a means to promote economic output and also to leverage the sector for improved labor productivity and job creation for the large number of unemployed youth in the country.

Indeed, Burundi has important potential for energy generation. Several large rivers along its borders and throughout the country provide opportunities for domestic and regional hydroelectricity generation operations, while clear skies provide good opportunities for the effective use of solar energy (Hakizimana, 2009; Hartvigsson, 2012; MEM, 2012). Furthermore, regional energy partnerships present opportunities for Burundi to enhance its own energy security through coordination of policies and projects with other East African countries. Several major regional hydro-projects, in which Burundi is a participant, are already underway, while industry groups and companies are turning to solar energy as a means of overcoming power shortages in the country. Significant efforts, however, will be required to develop a regulatory framework to support private investment in the sector and rehabilitate and expand national and off-grid infrastructure to improve both generation and transmission capacity, particularly for rural areas.

In order to address these seemingly overwhelming challenges, whose resolution requires the coordination of multiple actors, this paper makes use of the global value chain (GVC) framework to unpack the multiple issues and constraints facing Burundi's electrical energy sector. GVC analysis examines the full range of activities that firms and workers around the globe perform to bring a product from conception to production and end use. It examines the labor inputs, technologies, standards, regulation, products, processes and markets in specific segments and international locations, thus providing a holistic view of the industry (Gereffi & Fernandez-Stark, 2011). In this paper, we thus seek to understand how the electrical value chain is structured at a global level, in order to assess Burundi's current position in the chain, as well as its strengths and weaknesses. We also apply the GVC framework to identify opportunities for strengthening this position, through specific upgrades to its infrastructure and institutional framework to enhance supply and improve access across the country. The pursuit of these upgrading strategies will contribute to both economic growth and the creation of productive employment opportunities in the country.

The GVC approach, however, has yet to be applied to the electrical energy sector, and its application to this industry requires some conceptual clarification. In many other GVCs, countries can specialize in just one or more segments of the chain, and participation (particularly that of developing countries) is oriented towards an export market. Participation in the electrical energy GVC, on the other hand, requires the development of capabilities through multiples segments. This is due to both the central role the energy sector plays in a domestic economy as well as the massive capital investments required to transmit electricity for import or export use. For example, all countries must have some capabilities to transmit electricity into the homes and businesses within its borders. As

[1] The World Bank estimates that demand is growing at a rate of 10-12% per annum (World Bank, 2013a).

demand grows for electrical energy across the globe, countries must evaluate how to increase their generation or procurement capacities and how to more effectively and efficiently distribute available energy within their territory.

Countries can respond to increased demand in several ways, such as adopting new technologies, improving or expanding existing processes and infrastructure, or engaging in an entirely new set of activities. In the GVC literature, this is known as upgrading and it allows actors in the GVC to capture greater value from their participation in a sector (Humphrey & Schmitz, 2002). Upgrading, nonetheless, is particularly challenging for developing countries and often depends on making essential improvements to a wide range of institutional factors, including the business environment, and trade and investment policy (Bamber et al., 2013). Indeed, both Burundi's Ministry of Energy and Mines (MEM) and the country's development partners have been working on improving these aspects in Burundi over the past decade since the end of the conflict (African Development Bank, 2011; EUEI, 2011; Ministry of Energy and Mines, 2013; World Bank, 2013a).

One of the most critical – yet overlooked – factors that promotes upgrading, however, is human capital; that is, improving individual actors' capabilities within the chain (Gereffi et al., 2011). To be successful, upgrading strategies often require the development of new skills, such as operational knowledge of new equipment or understanding how to handle new products (Gereffi, 1999; Gereffi et al., 2005). In general, however, GVC upgrading efforts are often undertaken without fully unpacking the skills acquisition needs or the feasibility of enhancing knowledge transfer through the chain (Morrison et al., 2008; Ramirez & Rainbird, 2010). This "black box" approach to conceptualizing economic activities makes it difficult to develop adequate policies to support upgrading, especially in least developed countries and even more so in post-conflict countries, such as Burundi. In these contexts, institutions are often weakened and resources scarce, so even establishing basic education levels to support upgrading is challenging (Gereffi et al., 2011). Supplementing the existing institution-building activities in these countries with skills training and other human capital development initiatives that are tailored to specific GVC upgrading activities can be a cost-effective and efficient way to catalyze development.

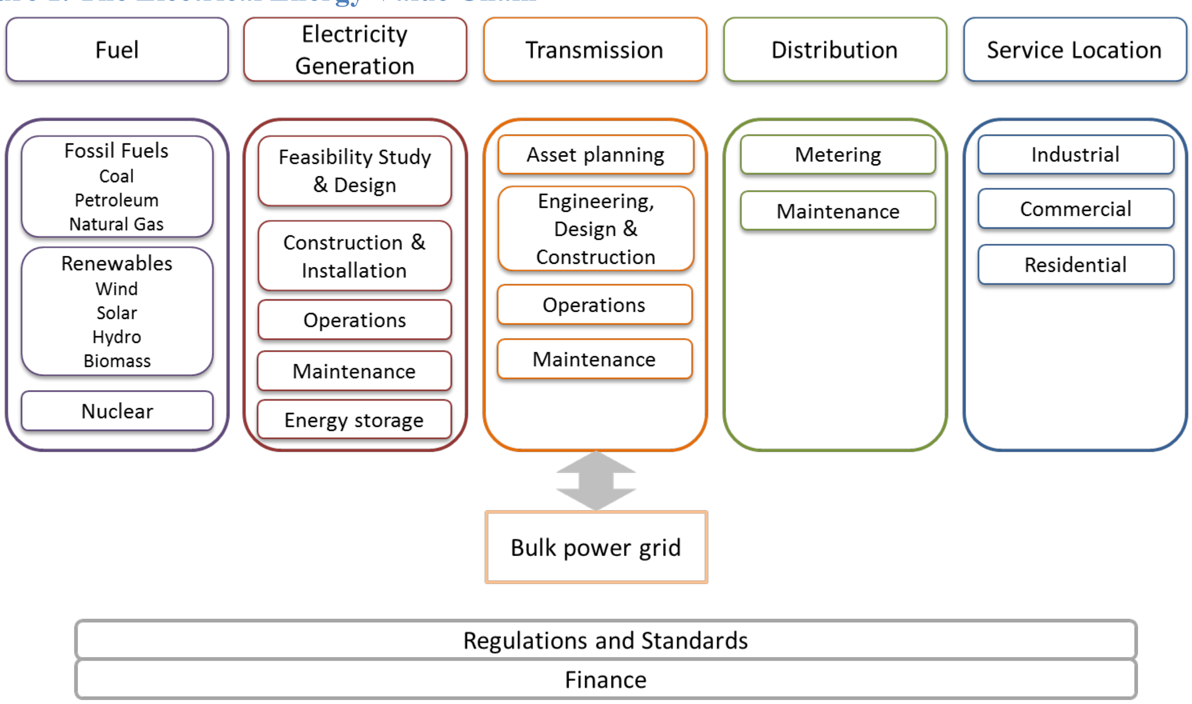
This report is structured as follows: Section II provides an overview of the electrical energy value chain, including a description of the functions and basic activities associated with each stage. It is important to clarify that while the energy sector combines a wide-range of different elements, including petroleum, oil, wood,[2] peat, etc., this report will focus exclusively on the generation of electricity. Section III discusses general upgrading trajectories within the energy GVC and describes key aspects of industry governance. Section IV examines Burundi's current position within the energy value chain. Due to the country's significant energy deficit and the relatively high cost of producing energy in Burundi compared to regional players, the sector is examined from a domestic market perspective only and does not consider scenarios for energy exports. This is followed by a discussion of employment opportunities and current workforce development constraints with a particular focus on the country's principal energy actor, The Water and Electricity Production and Distribution Authority *(Régie de Production et de Distribution d'Eau et d'Electricité* – REGIDESO). Section VI identifies three potential upgrading strategies that Burundi could pursue to expand their energy supply and extend access to electricity. Section VII concludes with specific recommendations for developing the workforce that will enable Burundi to achieve these upgrading strategies.

[2] The use of wood as a key means of fuel is widespread across the country, with most households using firewood for cooking. This has led to important deforestation problems, with knock-on effects such as erosion in the hills and reduction in soil fertility for the coffee and broader agricultural sectors.

II. The Electrical Energy Global Value Chain

This section maps the electrical energy GVC, providing an overview of the electrical energy sector and describes the types of activities that firms and governmental organizations typically undertake at each stage of the value chain. The electricity energy value chain includes all activities necessary for the production, distribution and consumption of electrical energy. There are five major segments: fuel procurement, electricity generation, transmission, distribution and the end-market or service location. Due to scale economies and steep investment requirements, the generation, transmission and distribution sectors of the chain were typically vertically integrated for most of the past century. However, these activities have been unbundled in many countries as a result of technological innovations such as the development of ancillary services which permit the trade of electricity via transmission networks, information communication technology (ICT) applications which permit the coordination of electricity flows across multiple transmission and distribution networks, and smart grid technologies which permit finer monitoring of supply and demand by utilities and regulators (Bacon & Besant-Jones, 2001; Foley et al., 2010; Kaderjak, 2008). Unbundling was also facilitated by the expansion and interconnection of formerly independent transmission networks, a process which made feasible the creation of stand-alone transmission companies. The electrical energy GVC is illustrated in Figure 1.

Figure 1. The Electrical Energy Value Chain



Source: Authors.

Fuel: Fuels can be divided into three main categories: fossil fuels, nuclear and renewables (Sims, 2003). While both fossil fuels and nuclear energy have been widely used fuel sources for electrical energy generation over the past half century, both energy sources have been slowly losing ground to renewable sources in recent years, due to their potentially negative environmental impacts and increasingly expensive technologies required for their extraction and use (OECD/IEA, 2013; WEF, 2013, pp. 27-29).[3] Renewable sources include hydropower, solar, wind, bagasse and biomass. Of these, hydropower is the most common renewable source of electrical energy, representing 13% of global electricity generation and accounting for roughly 80% of all renewable energy in 2013; hydropower is followed by wind energy and then solar power (WEF, 2013). Other alternatives including biomass[4] such as peat and byproducts from the processing of sugar cane (bagasse) and palm oil, are increasingly being researched and exploited in cost-effective ways to generate electricity (Sims, 2003; WEF, 2013).

Electricity Generation: Generating technologies are highly specific to the type of fuel that they employ, so there are strong linkages between the range of fuels that are available to a given country and the range of generating technologies that are feasible for investment. Hydroelectric operations, for example, depend on the potential strength of river networks. These may be built at a variety of scales ranging from the very small, as in the case of "micro-hydro" plants (with generation capacities of 100 kW and below), to the very large, such as the Three Gorges Dam complex in China (22,500 MW) (IEA/MME, 2012). New run-of-river (RoR) systems, in which micro-scale hydroelectric plants generate energy from a river flow rather than a waterfall, expand potential for hydro energy even more (IEA/MME, 2012). Such RoR generators can be placed in sequence, one in front of the other, in order to build greater scale. Smaller RoR operations can be affordable for individual companies to install and manage, and could represent a viable opportunity particularly in geographies where extension of the grid is uneconomical (Moner-Girona et al., 2011). Solar energy depends specifically on average annual sunshine per square meter a particular location receives. These operations are mostly used in off-grid installations in developing countries (Amar et al., 2005) (e.g. photovoltaic (PV) cells in solar panels or water heaters used for individual households or businesses).In developed countries, there are a growing number of initiatives for large solar energy plants, such as the Ivanpah Solar plants in California's Mojave Desert and the European Commission's plan to supply 3% of Europe's electricity from solar energy by 2020 (IVANPAH, 2013; SETIS, 2013).[5]

This stage of the chain consists of several activities that are common to all fuel types: *feasibility study & design, construction and installation, operation & maintenance.* The energy generation segment thus includes firms which not only operate but also plan, design and/or construct electrical generators. While some firms specialize in generation sub-segments focused on particular types of fuel, the activities of *feasibility study & design*, *construction and installation*, *operation*, and *maintenance* are common to all types of power generation projects, and these activities may be integrated within a given large firm or distributed across a number of (typically) smaller firms. *Feasibility study & design* entails the surveying of sites for their suitability for generation facilities as

[3] Nuclear plant closures have occurred for different reasons in different countries, however they are typically tied to political opposition over the perceived dangers associated with nuclear energy. Such opposition has been exacerbated in the wake of the tragedy at Japan's Fukushima Daiichi plant. Thus, many developed countries, including Japan and Germany, are scaling back their reliance on nuclear energy and shifting their mix towards renewables and fossil fuels. However, it is also important to acknowledge that enthusiasm for nuclear energy is still strong among leaders of some emerging economies, including India, Russia, China and the Gulf countries (WEF, 2013, pp. 20, 27-29).

[4] Due to the fact that (under the proper environmental circumstances) biomass can be recreated at a relatively rapid rate, it is often considered a renewable (though by no means carbon-neutral) source of energy.

[5] There are multiple technologies available to generate electricity from solar power, though the two most common are concentrated solar power (CSP) and PV cells. CSP systems use concentrated light from the sun in order to drive an otherwise traditional, steam-based power plant. PV systems convert light into energy using a principle called the photoelectric effect. PV cells have seen many applications in decentralized generation networks (ADB, 2011b; Chineke & Ezike, 2010).

well as the design of power generation projects. Such activities are typically carried out by engineering services firms and are dominated by a small number of highly skilled employees such as surveyors, geologists and civil engineers (Diaz, 2013; Fernandez-Stark et al., 2010). The next sub-segment involves the *construction* of brick-and-mortar facilities containing the generator and the *installation* of the generation machinery such as turbines and PV panels. These activities are relatively labor intensive, drawing significantly on semi-skilled and unskilled labor, and are performed by large construction contractors.[6] *Operation* involves the day-to-day activities associated with running an electrical generator once it has been installed, and this is carried out by utilities companies. Electrical generators must also be inspected and in some cases repaired. Firms specializing in *maintenance* are responsible for these activities. Labor in these activities usually consists of technicians and manual labor, supported by a small cadre of engineers (Diaz, 2013). It is not uncommon for firms operating in the *construction & installation* sub-segment to also participate in the market for maintenance services.

Transmission**:** The transmission network serves to link generation plants with distribution systems, which, in turn, deliver electricity to service locations. Transmission occurs at high voltage levels to minimize inefficiencies; electrical voltage must thus be "stepped up" and then "stepped down" between the generation plant and when it reaches the distribution network. The step-up transformer is generally considered to be part of the generation segment of the value chain, while the step-down transformer typically falls within the distribution segment. This stage of the value chain relies mostly on electrical engineers and network technicians (Diaz, 2013). In the past, transmission lines simply ran from a single power plant to a single load center, such as an individual city or large factory. Individual transmission lines have since been interconnected into vast transmission networks (grids), not only at a national but also a regional level, in order to provide greater resilience against shocks in the demand and supply of energy (Amar et al., 2005; Bacon & Besant-Jones, 2001; Shaw et al., 2010). In many of today's liberal market economies, private transmission companies have emerged, and these companies are responsible for maintaining and upgrading transmission networks and managing the purchase and sale of electrical supply across large distances. Typically, *asset planning*, *operations* and *maintenance* are all carried out by the same firm; *design, engineering and construction* activities may be outsourced.

Distribution**:** The distribution network serves to bring electrical energy from the transmission network to the service location (i.e. individual households, business establishments, hospitals, etc.). Distribution systems are separated from transmission systems for two key reasons (Edison Electric Institute, 2001). First, separation prevents small distribution failures from being widely transmitted via transmission wires. Second, distribution occurs at lower voltage levels than transmission, as the threat of efficiency losses is lower at the relatively short distances that distribution lines cover. Thus, both use different technologies, requiring slightly different skills.[7] Companies active in the power distribution segment of the value chain are responsible for the maintenance of the distribution network, the measurement of consumption (metering) by individual customers, and the collection of tariffs or fees from customers. The unbundling of electricity value chains has seen the emergence of companies specializing in distribution in some countries (Bacon & Besant-Jones, 2001; Shaw et al., 2010). However, unbundled energy value chains introduce challenges in terms of both the business practices and regulatory frameworks surrounding power distribution. Namely, identifying the proper

[6] Some construction firms tend to specialize depending on fuel type (e.g. construction firms specializing in nuclear power plants generally do not also operate in the market for small hydropower plants).

[7] Rural distribution networks tend to operate at higher voltages than urban distribution networks due to the greater area covered.

tariff that is charged to customers becomes more difficult, since the prices of upstream activities (transmission and generation) are no longer set through internal administrative rules and cost accounting, but are instead determined by market mechanisms (Hao & Papalexopoulos, 2002). In addition, generation can be done "off-grid", that is, disconnected from the national electrical grid. Box 1 provides an overview of these operations.

Box 1. Decentralized "Off-Grid" Generation in the Electrical Energy GVC

Distributed, or decentralized, generation has emerged as an alternative to centralized power generation networks based around large-scale, high-capacity power plants. Distributed generation networks include multiple points of electricity generation, which, contrary to the centralized approach, are located very near to sources of demand. Thus, an individual decentralized generation network has no need for a transmission grid. This minimizes energy loss between the generating facility and the load. Nevertheless, distributed generation networks may be interconnected with one another, so that if an individual generating facility fails, nearby residents and businesses can draw on the grid to meet their energy demand. Due to the need to serve limited demand, these operations can afford to be smaller, making investment possible for a larger group of actors. For example, small villages or individual companies may install their own generation capabilities to serve their specific needs (Guerrero et al., 2010; Kaygusuz, 2012; Moner-Girona et al., 2011). Given the costs and complexities of extending the bulk grid, decentralized generation approaches have proven particularly attractive to developing countries promoting improved electricity access in rural areas. For detailed examples of decentralization, see Boxes 6 and 7 on Rwanda and Bhutan. As will be explored further, the Government of Burundi is exploring the use of similar decentralized systems for certain rural community service providers, such as health care clinics (Amadou, 2013).

Service Location**:** A service location is where electrical energy is consumed, either by converting it into another type of energy, such as heat, light or motion, or by using it to power electronic devices like cell phone chargers or computers. These can include industrial complexes, individual residences, businesses, clinics, schools, and so on. The installation and maintenance of electrical systems at the level of the service location typically falls to trained electricians. Though this is sometimes omitted from analyses of the energy sector, upgrades at the service location, including the implementation of efficiency improvements and conservation practices and the installation of pre-paid meters, can have important positive effects across the sector (USAID, 2013b; World Bank, 2013d).

III. Upgrading and Governance in the Electrical Energy Global Value Chain

Unlike many other GVCs, participation in the electrical energy GVC requires the development of capabilities through at least two or more stages of the value chain. While countries can import or export energy generated, they must develop the infrastructure and technical capacity to provide adequate transmission and distribution services to domestic users. The provision of modern electrical services thus requires capabilities in at least the transmission and distribution for centralized systems and in the generation and distribution stages for decentralized ones. Indeed, the reasons that countries engage in the electrical energy value chain are typically different than those for participating in traditional GVCs. Developing an efficient and capable energy sector is important not only for improving international competitiveness and establishing a degree of self-sufficiency vis-à-vis energy trade, but also because the provision of modern energy services helps to improve livelihoods, reduce poverty and enable economy-wide productivity enhancements (World Bank, 2013d).

A. Upgrading

Developing improved provision mechanisms is an important step for upgrading because electricity cannot be easily stored; rather, it must typically be used instantaneously or else go wasted. Thus, the ability of an electrical power supply to closely match demand on a minute-by-minute basis is a key measure of the performance of a given electrical network. In particular, the generating (or procurement) capacity of a network must be able to meet peak load levels in order to avoid rolling blackouts. In the GVC framework, efforts taken to respond to these needs – selling more electricity and improving the efficiency with which it is delivered to consumers – can be considered to be economic "upgrading" initiatives. Strategies to improve the performance at each stage of the chain, such as adopting new and more sophisticated technologies and moving into an entire new set of activities (e.g. shifting from a decentralized to centralized grid) are consistent with the existing framework's descriptions of process and functional upgrading (Humphrey & Schmitz, 2002). Given the un-differentiable nature of the commodity (electrons) delivered by the electrical energy GVC, product upgrading is primarily found in the service aspects of the industry, and in markets where consumers are willing to pay a premium for green energy.

The following types of upgrading may be considered relevant to the electrical energy GVC:

- *Functional upgrading*: moving into the generation stage of the value chain. For example, a country may primarily import their electrical energy, providing transmission and distribution operations domestically. The construction and operation of a power-generation plant which provides a domestic supply of energy would increase the total value "captured" by the country in their energy sector, and could reduce the foreign exchange used to import energy.
- *Process upgrading:* the incorporation of more sophisticated technologies or processes to increase efficiency and productivity. This can occur in generation, transmission and distribution stages of the chain. Examples include the introduction of more efficient generating technologies and reductions in technical and non-technical losses electrical grids.
- *Market upgrading*: shifting of provision of energy for the domestic market to a higher-paying export market. Countries that have strong domestic energy generation can begin to export energy once they have satisfied internal demand. Energy then becomes an important source of foreign exchange.
- *Product upgrading*: moving into more sophisticated product lines or increasing unit value. Though consumers only purchase one, highly specific good within the electrical energy GVC – a flow of electrons – it is still possible to develop higher-value product lines within the sector through the diversification of fuel sources or the provision of new services within the value chain. As environmental concern reshapes demand preferences in advanced energy markets, for example, utility companies are finding that consumers are willing to pay more per kWh of electricity if their energy comes from a green energy such as solar or wind power.
- *Environmental upgrading*: shifting from non-renewable to renewable sources of generation. The use of coal and diesel in the generation of electricity has negative environmental impacts. Shifting to energy generation through hydro-electric or solar reserves can reduce contamination and nets natural renewable resources domestically.

B. Governance

Historically, the electricity GVC has been vertically integrated and typically "led" by a utility company that is granted "natural monopoly" rights (Joskow, 1997) across all segments of the chain. This firm essentially captured all value in the chain. However, as reliable electricity supply is considered a "public good," regulation of how much value can be captured by the firm is an important factor for political economy in any one country.[8] In many countries to overcome this problem, as in Burundi, this firm has been a parastatal organization and understanding the governance of the chain has not been necessary. However, over the past few decades, the natural monopoly model of utilities regulation has given way to liberalization and privatization in countries around the world, resulting in unbundling of the different segments of the chain.

Important prerequisites for the unbundling of the electrical sector has been the reform of the regulatory environment to scale back monopoly privileges enjoyed by utility companies, facilitating private investment, and promoting effective monitoring and enforcement on the part of regulatory agents (Joskow, Forthcoming). Thus, with unbundling, the problem of governance and determining the appropriate distribution of value throughout the chain comes to the fore (Hao & Papalexopoulos, 2002). The creation of an appropriate institutional environment has then become increasingly essential. Key institutional features of the regulatory environment include which segments of the value chain private firms are allowed to operate within, the terms by which independent power producers (IPPs) can sell energy back into the grid, characteristics of the tariffs charged to consumers and rules governing competition (Bacon & Besant-Jones, 2001). The technical and quality standards established through regulation also take on an important role as they are required to ensure compatibility of technologies across a range of different actors in the chain, preventing mismatches between different segments that can derail efficient and effective transmission of electricity, increase the potential for systems failures and undermine the safety of the network as a whole, particularly in the case of regional grids (Amar et al., 2005). Consequently, even when the electrical sector is fully unbundled within a country, firms face important political and economic constraints on the value that they may capture from participation in the sector.

In addition to these domestic regulatory challenges, other coordination and regulation issues may also emerge in developing countries like Burundi, where donor agencies and regional partnerships play an important role in the electrical energy value chain. For example, when large numbers of donors are active within a given country, challenges may arise in ensuring that their investments are properly coordinated and sequenced in alignment with the host country's overall national development goals. Additionally, regional integration initiatives require the harmonization of standards and technologies across multiple national grids. Finally, aligning the expertise possessed by donors with the capacity building needs of organizations within the host country may flounder in the absence of mechanisms to institutionalize transfers of knowledge and technology. Thus, institutional reforms which improve coordination among actors in the domestic (or regional) energy sector are an important route to improving the performance of the energy sector. Box 2, for example, highlights emerging regional cooperation issues in East Africa.

---

[8] The question of governance in value chains characterized by public good is one that has not yet been analyzed by GVC scholars, and the depth of analysis required is beyond the scope of this paper. This brief section thus rather highlights key emerging factors in the sector that have emerged with respect to regulation and standards as a result of unbundling.

Box 2. Regional Cooperation in Upgrading and Governance Issues in the Electricity GVC in East Africa

Within East Africa, several international initiatives have emerged to promote the upgrading of the regional network. Such initiatives help to foster coordination among countries to maximize available investment resources and harmonize the management of shared water resources (for hydroelectric generation). In particular, inter-connectivity across the region can support increased efficiency in the management of seasonal fluctuations in the supply of hydropower (RSWI-Fichtner JV, 2011).

One such project, the East African Power Pool (EAPP) seeks to connect the transmission grids of ten countries in East Africa to create a more resilient regional electricity network and facilitate the sale of electrical energy between member countries (Gebrehiwot, 2013; SNC Lavalin, 2011). The goal of the EAPP is primarily to support the upgrading and interconnection of transmission capabilities across the region. Plugging into the EAPP requires that participants install the 220kV high-voltage transmission lines necessary to meet the initiative's infrastructure standards. Since some participating countries, including Burundi, cannot currently accommodate 220kV technology, constructing the EAPP will likely require additional technical training. The first major project being undertaken through the EAPP is the connection of transmission networks in Ethiopia and Tanzania.

A second important regional initiative is the EAC Strategy to Scale-Up Access to Modern Energy Services (Hakizimana, 2008). The Strategy, which was adopted in 2006 sets four goals: 1) access to modern cooking practices for 50% of traditional biomass users; 2) access to reliable modern energy services for all urban and peri-urban poor; 3) access to electricity for all schools, clinics, hospitals and community centers; 4) access to mechanical power within the community for all productive services (Weggoro, 2013). In spite of the general enthusiasm of stakeholders for the Strategy, the EAC Energy Secretariat's mandate remains too weak to influence its implementation (Viiding & Tostensen, 2013). Nevertheless, the Energy Secretariat may continue to play a positive role in supporting the regional upgrading of energy services, primarily as a coordinator of knowledge (if not resource flows), building regional regulatory capabilities and promoting policy harmonization (Viiding & Tostensen, 2013).

In order to attract private investment in energy infrastructure these regional plans require the establishment of deals surrounding licensing, dispute resolution, guarantees against nationalization, repatriation of profits, and the creation of a common investors' code (RSWI-Fichtner JV, 2011). In addition, regional institutional platforms must be put in place for resolving issues related to short-term surplus period trading as well as the social and environmental impacts of energy investments (RSWI-Fichtner JV, 2011). Long-term power purchase agreements are also required to reduce uncertainty surrounding the recovery of fixed cost elements of generation and transmission investments for the projects intended for trading. Meeting these institutional requirements at the regional level will require strong capacity-building within national governments.

IV. Burundi and the Energy Global Value Chain

A. Introduction

Since the end of the crisis, Burundi has been unable to meet its own domestic energy demand (IMF, 2012b). Current demand, at 390 GWh per year (REGIDESO, cited in Chancelier 2013), is still about twice the country's capacity to supply, and as no new publicly owned plants have been built since 1987, Burundi has turned to energy imports to address the shortfall (IMF, 2012b). Furthermore, fueled by stronger economic growth in recent years, demand for energy is projected to grow at a rate of 10-12% per annum, placing further strain on the country's energy supply (World Bank 2013a). REGIDESO projects that the deficit will increase in the next few years (IMF, 2012b). If it remains unaddressed, this energy deficit is likely to constrain the country's overall economic performance

(Vrijlandt, 2013). For example, sustained participation and upgrading within the agribusiness and mining value chains require large, reliable supplies of energy. Investments – not only in generating capacity but also in the transmission and distribution infrastructure – will also be necessary for Burundi to address the social development of objectives, such as the provision of alternatives to the current dependence on biomass for cooking and lighting (IMF 2012).

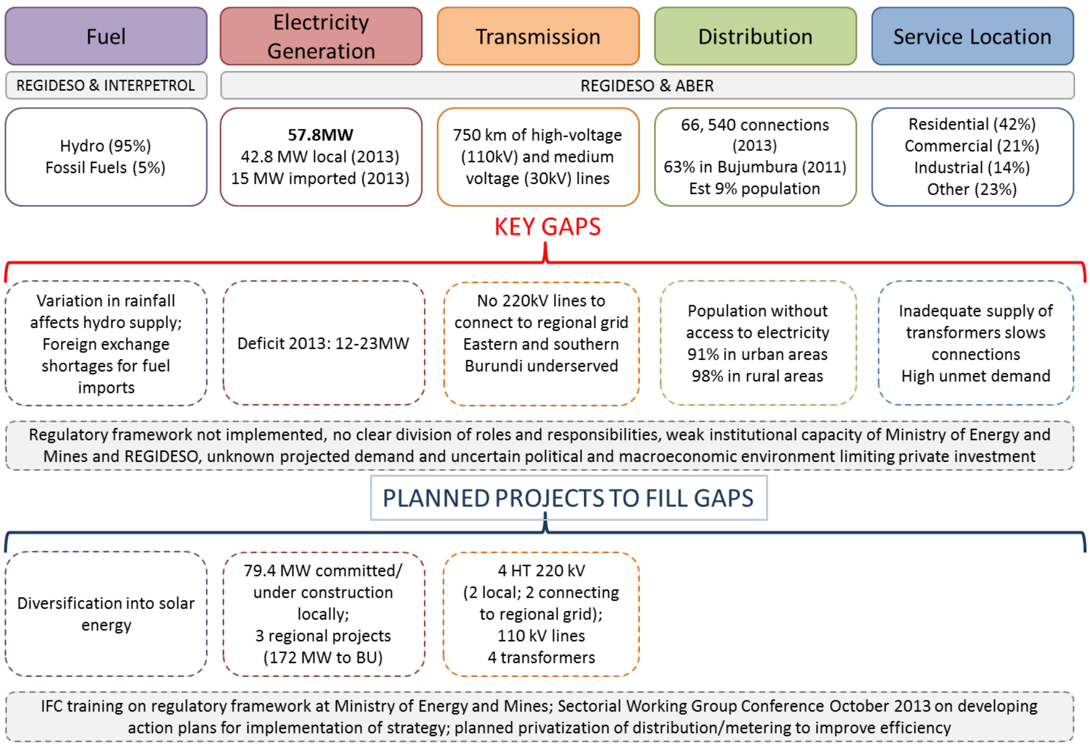
The key goals of upgrading in the energy value chain in Burundi today are thus to increase generation, transmission and distribution capabilities in order to expand access to electricity at the household level, and to facilitate access to a more reliable source of electricity for industrial growth (Ministry of Energy and Mines, 2013). Though regional initiatives, including the EAPP and a handful of regional hydro projects will help to provide generation and transmission infrastructure that will contribute to national goals, it is crucial that Burundi 1) rehabilitate its existing energy infrastructure, 2) expand the transmission and distribution network, 3) support improvements in off-grid generating capabilities. These upgrading strategies will be discussed further in Section VI.

This section focuses on how Burundi can better meet domestic demand for energy, rather than how the country can promote production for export. This choice is deliberate and reflects not only the above-mentioned normative goals of Burundi's energy strategy, which call for the expansion of modern energy services and the promotion of industrial growth, but also the objective market conditions that Burundi is facing on the international market. MEM estimates that current production of hydroelectric energy in Burundi's eight larger hydroelectric plants is US$0.04/kWh, compared to US$0.029/kWh generation at Ruzizi I and US$0.043/kWh at Ruzizi II (Minister of Energy and Mines, 2012). Simply put, Burundi does not have a comparative advantage in energy generation. Consequently, regional integration should be viewed not as an opportunity to generate electricity exports, but rather to reduce the energy deficit through imports, which domestic actors can then leverage to promote upgrading in other sectors of the economy.

B. Burundi's Position in the Energy Value Chain

Burundi's footprint in the electricity GVC is relatively limited, despite the size of its population and the country's plentiful but largely untapped potential hydropower resources. This is not surprising, given the overall state of economic development of the country, the dominant role the state has historically played in the sector and the intensity of conflict and instability that has plagued the country for much of the last two decades. Generation is dominated by hydroelectric power. The transmission and distribution lines are based on outdated technologies and serve only approximately 9% of the population. There are 66,540 service locations connected to the grid (mostly residential). Figure 2 illustrates Burundi's current footprint in the electricity GVC, highlighting key gaps and existing plans to fill these gaps. Each segment of the electricity value chain is discussed in detail below. This information will be used in later sections in order to identify relevant upgrading strategies for the energy sector and how they correspond to existing policies and projects underway in the country.

Figure 2. Burundi in the Electricity Value Chain, Key Gaps and Planned Projects to Fill these Gaps, 2013



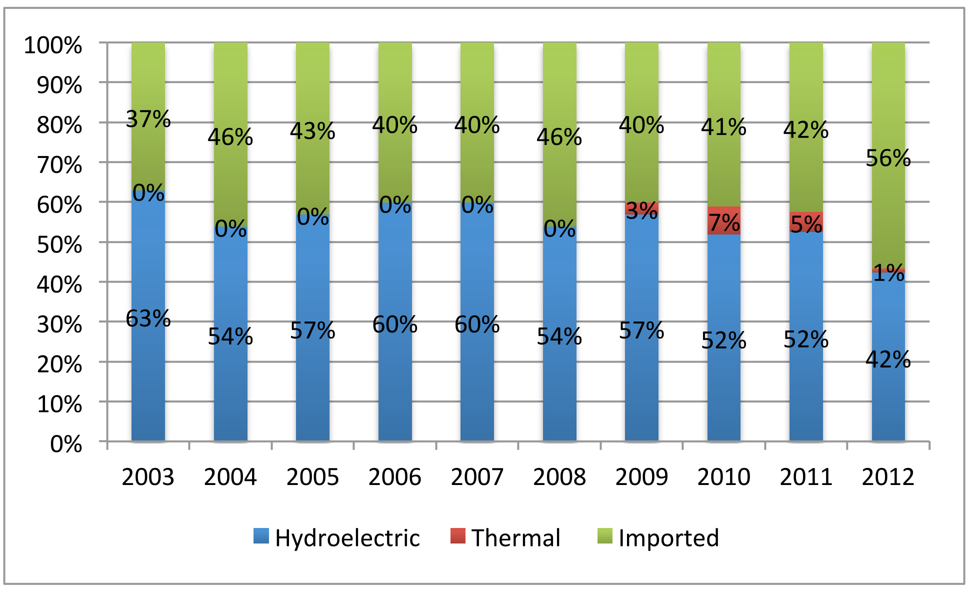
Source: Authors.

MEM is responsible for policy development as well as the supervision, regulation and planning of the electricity sector. The Ministry is supported by the Sectorial Working Group on Energy, which coordinates the actions of development partners with those of the government in order to avoid duplication of efforts. REGIDESO, is currently responsible for all activities within the chain, with the exception of one power purchase agreement with Interpetrol and aspects of rural electrification for which the Burundi Agency for Rural Electrification (*Agence Burundaise pour l'Electrification Rurale, ABER*), created in 2012, is responsible. However, as the generation sector is slowly being liberalized, a growing number of independent power providers could – if the incentives are clear and positive – become involved in the generation segment of the chain. In addition, REGIDESO is currently in the process of privatizing its distribution functions. REGIDESO will nevertheless retain its monopoly over transmission.

Fuel & Generation Activities: Given Burundi's extensive river system, sunlight days and expanding sugar plantations to meet rising demand for food products, hydro, solar and bagasse have been considered the most important fuel sources for the country's energy generation, complemented by smaller and disperse off-grid operations (MEM, 2012; Ministry of Energy and Mines, 2013). At the centralized level, Burundi currently relies almost exclusively on hydroelectric power generation, which accounts for approximately 95% of the country's power supply (see Table 6 Appendix). REGIDESO maintains and operates eight hydro plants, with a combined generation capacity of approximately 32MW (Baruvura, 2013; Minister of Energy and Mines The Republic of Burundi, 2011; SNC Lavalin International Inc and Parsons Brinkerhoff, 2011).[9] In addition to hydropower generation, a 5MW thermal plant contributes to energy generation (SNC Lavalin International Inc and Parsons Brinkerhoff, 2011). Two recent investments in 2013 in new thermal plants (10MW and 5.5MW respectively) should further diversify supply, and although Burundi depends completely on costly fossil fuel imports for the operation of these thermal plants, these plants will increase generating capacity significantly.

To complement domestic generation, the country also has stakes in Ruzizi 1 and Ruzizi II hydropower stations, together with neighboring Rwanda and the Democratic Republic of the Congo (DRC), which are operated by the Economic Community of the Great Lakes Countries which make up an important share of the country's supply. In 2012, imported electricity from these stations accounted for over 40% of consumption (IMF, 2012b).[10] The total power capacity from both regional partnerships and in-country production is currently estimated at approximately 57.8 MW (Baruvura, 2013), though actual supply fluctuates with time. Figure 3 illustrates the breakdown of electricity generation by source between 2003 and 2012. As a result of the country's clear dependency on hydropower, both from local and regional generation, power supply traces seasonal rainfall, and drought years are characterized by important shortfalls, while high rainfall contributes to increased supply (IMF, 2012b).

Figure 3. Share of Electricity Generation, by Source 2003-2012



Source: REGIDESO cited in (Chancelier, 2013)

Estimates regarding the extent of the Burundi's power supply deficit vary according to the source and potential growth scenarios in the country: MEM noted a deficit of 15 MW to 25 MW in 2011, differentiating between the rainy and dry seasons, and 25 MW in 2013. The Chamber of Commerce suggested that in 2013, the deficit has been even higher at approximately 50%, or 40MW, and will be considerably higher if mining operations advance in the country – consistent with predictions by

[9] Figures for energy supply and demand in Burundi at this time differ according to the source. Official figures from the Ministry of Energy and Mines highlight total capacity at 32MW at the end of 2012 (Minister of Energy and Mines, 2012).

[10] 3 MW of power from Ruzizi I and 12 MW of power from Ruzizi II (SNC Lavalin, 2011).

REGIDESO (Nkengurutse, 2013). Efforts are underway to reduce this energy deficit in the future and there are several domestic and regional power plants being planned. These are discussed in Box 3; however, it is unclear whether these operations will be completed on time, or in some cases, at all. As a result, numerous off-grid electricity generation options have been installed.

Off-grid electricity production currently includes four energy sources: 12 small hydro plants (less than 1MW each), diesel generators, Société Sucrière du Moso's (SOSUMO) bagasse operations (4MW),[11] and solar panels (Minister of Energy and Mines The Republic of Burundi, 2011). These off-grid measures are currently used by a range of private and public sector actors due to shortages in the energy supply and poor geographic coverage of the national grid.

Six of the country's small hydro plants are operated by ABER, however two of these are non-operational and one requires substantial maintenance. The agency's generating capacity is less than 1MW; in order to serve its 3,000 customers, ABER has needed to connect its mini-grids to the main transmission grid, which is operated by REGIDESO. However, ABER only retains a very small percentage (approximately 3%) of its total revenues, as the remainder is paid to REGIDESO for the supply of energy. The agency is thus unable to finance the rehabilitation of its existing infrastructure – much less the expansion of off-grid generating capabilities throughout the country – and at the time of writing was applying for donor funding in order to expand its generating capacity.

Solar panels, in particular, have become an increasingly popular way to overcome these problems and also a viable source of power for some households and firms located far away from the transmission grid. As an equatorial country, the average annual sunshine received in Burundi is close to 2,000 kWh / m² annually, equivalent to the best southern European regions (Ministry of Energy and Mines, 2013). For example, Interbank, one of the country's largest commercial banks, and a large number of the country's coffee washing stations, use a combination of solar panels and back-up diesel generators to power their operations around the country, particularly in rural areas where these do not have access to the national grid (Mutabazi, 2013). In addition to private sector operations, several bilateral and multilateral organizations have supported the set-up of solar power plants, particularly to support rural health care facilities and for rural residential homes (Ministry of Energy and Mines, 2013).[12] In response to this growing interest, several small, domestically owned private firms, including ENECSO, ECOGEER, ITCO and Watel Solar, many established by returning émigrés, have emerged to import, install and maintain solar panels (Hakizimana, 2009; Mutabazi, 2013). There are currently 15 firms in the off-grid segment of the sector, focusing primarily on solar applications, according to industry participants. In 2012, importers and service providers in the off-grid generation segment of the chain formed the Burundi Renewable Energy Association. The association received initial funding from the German Ministry for Economic Development and Cooperation (BMZ) and has sister organizations in each of the other members states of the EAC.

---

[11] Currently, electricity generated by Sosumo is used to operate the sugar plant and the company does not sell surplus energy to the national grid. According to several interviewees, this is due to two limiting factors, first, the dated facilities lack the technology required to operate in the off-season and the generator only operates 6 months a year, and second, the company has been unable to come to an agreement with REGIDESO regarding the potential tariff for sales to the grid(Field Research, 2013) .

[12] The Japanese International Cooperation Agency (JICA), for example, funded the construction of a PV power plant at University Hospital of Kamenge in Bujumbura, which has a capacity of 403 kW and is connected to the national grid (Minister of Energy and Mines The Republic of Burundi, 2011). Additionally, the UNDP installed solar systems in 26 administrative centers in rural communities in 2009, and the EU is planning to electrify 25 rural health centers by 2013.

Currently, there are no domestic engineering, construction or project management firms capable of undertaking the design and construction of hydroelectric operations. Generally, international expertise are sought for these projects (Brilot, 2013). For example, the construction of Kabu 16 is being undertaken by the Indian firm Angelique International Limited, while the Chinese group CNMV-CGC was contracted for the provision of work and equipment (Minister of Energy and Mines The Republic of Burundi, 2011). Feasibility studies are also carried out by foreign experts.

Box 3. Generation Expansion at the Domestic and Regional Level: The Role of Government and Donors

Both government and development partners are spearheading initiatives to identify and develop new potential electrical energy generation alternatives. While short-term efforts to increase power generation on the grid using thermal energy plants have been pursued, the long-term strategy is to expand generation capacity through renewable energy sources. This is because imports of fossil fuels have a negative impact on Burundi's fiscal situation. In recent years, the value of fossil fuel imports (including for purposes other than electricity generation) has approached – or even exceeded – the total value of Burundi's exports (IMF, 2012a, p. 86). Minimizing dependence on imported energy for electrical generation activities is an important component of managing foreign reserves. In order to effectively develop a comprehensive action plan to develop the country's energy strategy, the Energy Sectorial Working Group was established, bringing together relevant ministries with a range of aid and development partners, including the World Bank and the African Development Bank (AfDB). Other major donors in Burundi's energy sector include the EU, the Belgian Agency for Development and the German development bank KfW (Hakizimana, 2013). The goal of the group is to help strengthen the capacity of MEM as well as REGIDESO, and to improve coordination amongst different actors to maximize on resources and avoid duplication (Amadou, 2013). Tables 1 and 2 highlight currently planned power generation projects.

In addition to the projects already in the pipeline, a donor-led initiative has also just completed a mapping exercise of the country's hydro-potential (Brilot, 2013; Karuretwa, 2013). This new atlas of potential hydroelectric locations throughout the country is intended to update the previous feasibility and evaluation/survey studies conducted in 1983 by LAHMEYER International. The original study highlighted the country's hydroelectric potential at 1,700MW of which 300MW were economically viable (Minister of Energy and Mines, 2012). This new study estimates there are 156 potential sites for hydro projects, 15 of which are economically viable (Ministry of Energy and Mines, 2013).

Table 1. Planned Power Generation Projects under Development

Name	Estimated Capacity (MW)	Estimated initiation operations	Location	Investors
Kagu 006	12	2016	Kagunuzi River	African Power and Water
Ruzb	17.4	2016	Ruzibazi River	World Bank (Feasibility study)
Mpanda	10.4	2016	Mpanda river	Government of Burundi
Kabu 16 Dam	20	2017/2018	Kaburantwa river	Exim Bank of India
Jiji 03	32	2017	Jiji river	The European Investment Bank, the World Bank and the AfDB
Mule 34	17	2019	Mulembre river	

Source: (Export-Import Bank of India, 2011; IMF, 2011a; Minister of Energy and Mines The Republic of Burundi, 2011; Ministry of Energy and Mines, 2013; SNC Lavalin International Inc and Parsons Brinkerhoff, 2011).

In addition to domestic projects, there are three regional hydropower plants that are being planned and constructed that will contribute to supply: Rusumo Falls (80MW), Ruzizi III (147 MW) and Ruzizi IV (287 MW) (IMF, 2012b) (see Table 2). Furthermore, the establishment of EAPP and joint work on the

Nile Basin initiative suggests an approach that goes beyond bilateral arrangements to foster region-wide power supply operations. These projects are expected to boost the power supply in Burundi and the region as a whole. This requires a significant expansion of inter-regional grid capabilities both within Burundi and neighboring countries, including the establishment of HT 500-600kV transmission lines to reduce energy losses over large distances. This regional approach to power generation is being strongly supported by a number of agencies, including the World Bank, the AfDB and the European Investment Bank.

Table 2. Planned Regional Hydroelectric Power Investments, 2013

Project	Capacity	Est. initiation operations	Location	Participants	Investors
Rusumo Falls	80MW (BU: 27 MW)	2018	Kagera river on Rwanda/Tanzania border	Burundi, Rwanda and Tanzania	World Bank (plant) ADB (HT transmission lines between Gitega (BR), Kigali (RW), and Nyakanazi (TZ)
Ruzizi III	147MW run-of-river hydroplant (BU: 49 MW)	+2020 (initial date -2017)	Ruzizi River DRC –Rwanda border	Burundi, DRC, Rwanda	PPP. Consortium of private investors who developed BUJAGALI in Uganda; 50% of the financing to be provided by Development Institutions
Ruzizi IV	287 MW (BR: 95.7MW)		Ruzizi River on the DRC – Rwanda border	Burundi, DRC, Rwanda	No investors as yet committed to the project.

Source: (European Union Africa Infrastructure Trust Fund, 2013; Hakizimana, 2013; SNC Lavalin International Inc and Parsons Brinkerhoff, 2011).

Finally, donors and the government are also attempting to promote the development of off-grid generating capacity (GTDSE, 2013; MEM, 2013b). MEM has indicated interest in promoting two large-scale solar generating units in Gitega and Bubanza through a public private partnership (PPP) model. Each of which would provide 10MW of generating capacity and would be connected to the bulk grid. The EU, GIZ and UNICEF are also actively promoting the installation of solar PV generators to power schools, clinics and other socially important structures.

Transmission**:** Burundi's transmission network is currently based on outdated technology and is in need of maintenance (Chancelier, 2013; Ministry of Energy and Mines, 2013). Moreover, the network is geographically concentrated in the northwestern and central zones of the country and around Bujumbura, leaving much of the country unserved. As a result, electricity losses during transmission are high, access to electricity in rural areas is limited and the country is not currently in a position to leverage the potential of regional projects, such as EAPP. Electricity power is transmitted and distributed over an estimated 750 km of high-voltage (110kV) and medium voltage (30kV) lines. These lines were installed prior to the crisis, and as they have had minimal maintenance over the past decade, they require urgent rehabilitation work (IMF, 2012b). The technical loss resulting from the use of outdated transmission technologies was estimated at 24 % of total supply in 2012 (Chancelier, 2013), averaging losses between 20 and 30 MW per day (World Bank, 2013a).[13] In previous years, estimated losses ranged from 19% in 2009 to 30% in 2006 (IMF, 2012b). Addressing problems in the transmission network would substantially reduce waste, and maximize on the country's limited generation capacity. In addition, the current network is not sufficient to adequately develop connections between the national grid and regional power lines, limiting the potential to engage in energy trade to meet the country's demand. The current connections consist of two 110kV lines connecting Burundi to Rwanda and the DRC, each allowing for a potential 30 MW in trade

[13] An alternative estimate proposes that technical losses were 18.2% of total supply (World Bank, 2013a).

(RSWI-Fichtner JV, 2011). However, in order for Burundi to effectively connect with the EAPP, the country must develop lines based on the 220kV standard (Ministry of Energy and Mines, 2013). As in the generation stage of the value chain, most or all of the feasibility studies engineering and construction operations for the transmission segment are carried out by foreign experts.

Distribution: Electricity is distributed primarily in the urban areas of the country; Bujumbura accounted for 63% of all connections in 2011, and a significant proportion of national consumption (some estimates are as high as 90%) (IMF, 2012b). The Bujumbura distribution grid is based primarily on an underground medium-voltage network. Following Bujumbura, Gitega has the second most developed distribution grid. Other cities account for a small number of additional connections and represent a minimal proportion of consumption. With just 2% of rural households connected to the grid, rural electrification is almost non-existent (Chancelier, 2013). Table 3 highlights the geographic distribution of connections in the country in 2011.

Table 3. Geographic Distribution of Connections, 2011

Region	Number of Connections	Percentage of total connections
Bujumbura	41,771	63%
North	78717	12%
East	6638	10%
South	4642	7%
West	5672	8%

Source: REGIDESO cited in (Ministry of Energy and Mines, 2013).

In late 2013, the decision was undertaken to privatize all distribution activities. As of the time of writing, several companies (both local and regional) have entered bids for the ownership of the distribution network. It is hoped that this action will help to attract private capital to finance upgrades to the distribution network (for example, installing pre-paid meters) and facilitate entry of increased expertise in the area. The privatization of the distribution function will place pressure on the nascent independent regulatory agency, requiring the employment of regulatory analysts capable of regulating the energy market. As privatization is carried through, there may be upward pressure on subscription fees charged to consumers. Though precise figures are unavailable, it is known that REGIDESO's subscription fees are currently heavily subsidized; 1kWh of electricity in Burundi costs $0.11, compared to $0.24 in Kenya and Rwanda and $0.19 in Uganda and Tanzania.

Service Locations: It is estimated that approximately 9% of households nationally have access to electricity (Ministry of Energy and Mines, 2013), while access to electricity in rural areas is estimated to be just 2% of households (Chancelier, 2013; IMF, 2012b). Between 2009 and 2012, the number of connections increased by nearly 20,000 (approximately 1/3 of total connections) (Mazars, 2013; Ministry of Energy and Mines, 2013). Electricity consumption is led by households, which account for 42% of total consumption, followed by commercial operations (21%) and industry (14%). Other types of connections, including government, diplomatic missions, religious operations account for the remaining 23% (Ministry of Energy and Mines, 2013).

In recent years, REGIDESO has made a strong push to provide pre-paid meters for households (Bucumi, 2013). In 2011, these meters accounted for 27.3% of consumption and the company intends to extend the coverage of pre-paid meters to all users in the near future (Mazars, 2013).

Growth in access to electricity, however, is slow as a result of both cost and delays;[14] it takes approximately 188 days on average to establish an electricity connection and costs 21,482% of per-capita income. This is principally due to availability shortage of transformers in the country, which individuals or businesses must usually import privately from Europe (World Bank, 2013b).

C. Important Constraints Underlying the Development of the Energy Chain in Burundi

While Burundi has clear potential for additional power generation, there are several underlying constraints that limit the improvement of power supply in the country. These constraints, which include lack of an operational legal framework for private investors to sell electricity to the national grid, weak ministerial capacity, operational inefficiencies resulting from REGIDESO's structure, poor access to finance, further impacted by uncertainty regarding future political stability and limited information systems, all serve to undermine the country's capacity to leverage its existing resources and to engage crucial private sector investment in the energy sector. Each of these constraints is discussed in further detail below.

First, while laws have been passed to support private sector generation and distribution investments, the legal framework to operationalize these investments still lacks clarity. As an example, Law No. 1/014 enacted in 2000, liberalized the sector and created a regulatory agency, essentially allowing for private sector investment in all stages of the chain (Ministry of Energy and Mines, 2013). However, the protocols and regulations for the implementation of this law have not yet been established. Efforts are currently underway through MEM, and the Sectorial Working Group on Energy, to provide guidance on policy, regulation and planning in the electricity sector. For instance in October 2013, the third conference on the energy sector focused on identifying both opportunities and constraints to growth, and protocols for the establishment of contracts to sell energy to the grid are supposed to be developed in the near future together with technical assistance from the International Finance Corporation (IFC) (Ministry of Energy and Mines, 2013). Long-term agreements regarding the terms of energy transactions and tariffs are required for securing the recovery of fixed cost elements of generation and transmission investments. Currently, however, there does not appear to be a systematic approach by the government to ensure that tariffs cover the cost of production in the country. Improving this regulatory structure is thereby essential for improving the energy investment climate (Brilot, 2013). Until this occurs investments in the sector by private firms, particularly foreign firms, will likely remain limited to small-scale off-grid operations for internal consumption and with minimal impact on the country's overall energy supply.

Second, establishing this regulatory framework is further undermined by weak capacity at the ministerial level. Several regional energy projects require coordination with three or more countries in key areas including dispute resolution, repatriation of profits, creation of a regional investment code, issues relating to short-term surplus period trading, amongst others. Meeting the demands of these institutional frameworks requires substantial capacity building within the national government (RSWI-Fichtner JV, 2011). Key government groups including MEM, the Ministry of Trade and Industry and the Investment Promotion Agency (API) appear to lack the capacity to attract investors and to negotiate concessions and public private contracts (Field Research, 2013). This process needs

[14] Nonetheless, strong growth in the rate of new service connections is being noted in some parts of the country. In particular, there has been strong growth in the north and east of the country, where REGIDESO saw the number of connections increase by 11.2% from 2011 to 2012 (Ministry of Energy and Mines, 2013).

to be transparent and accountable. Capacity building is also required to help the Ministries translate their strategy documents into implementation plans.[15] Burundi currently has three documents discussing potential strategies, however, no concrete plans have been established for the short, medium and long-term to implement these strategies. Government ministries also need to consider strengthening the English language skills of their employees. English is the official language of most countries in the EAPP, and while translators can be leveraged for regional negotiations, day-to-day operations would streamlined by these skills.

Third, REGIDESO structural effectiveness is hampered by a lack of autonomy and no clear mandate from the government. The government exerts significant influence of the company's management structure, and a 2013 audit of the company found that political appointees to the company's executive teams is adversely affecting the company's ability to develop a talent pipeline based on competency (Mazars, 2013). Government oversight also extends to the approval of REGIDESO's tariff structure. Due to the politically sensitive nature of energy costs, there were no adjustments to tariffs between 2007 and 2012, despite growing marginal costs as a result of the increase in thermal generation. This resulted in a misalignment between tariffs and the associated cost structure of the company (Ministry of Energy and Mines, 2013).[16] Rooted in technical, financial and political challenges, these inefficiencies mean that the country is not using its existing generating resources to maximum effect – exacerbating its reliance on imports (Ministry of Energy and Mines, 2013).

Fourth, access to finance for both public and private sector investment in the energy sector remains a challenge. Investments in the construction and rehabilitation of energy infrastructure can be very costly – ranging from a few million dollars for repairs to hundreds of millions for new facilities. The weak economy and limited government revenue mean that the country is not in a position to self-finance the construction and operation of significant projects to generate electricity for export. This is beyond the capacity of both the government's budget (most of which is based on aid) and the domestic commercial banking system.[17] Foreign investments must therefore be sought. However, despite strong improvements in the country's business environment in recent years (World Bank, 2013b), due to political instability in Burundi over the past two decades, international and regional development banks and commercial banks alike still view long-term investments in Burundi as risky. This lack of access to finance can have a dampening effect on demand as well Peaceful elections in 2015 and the continued consolidation of democratic institutions will be particularly important to attract investments in the country's energy infrastructure (Amadou, 2013).

Fifth, while there is a clear deficit in the country's energy supply, accurately assessing demand for energy in the country is another key challenge discouraging investment in the sector, particularly for rural electrification, as private actors are unable to determine the potential returns on investments (Brilot, 2013). These assessments are undermined by the lack of accurate data regarding the percentage of households with access to electricity, the distribution of households in rural areas, consumer willingness to pay for electricity, and even existing generation capacity. Improving the quality of data regarding potential rural demand and willingness to pay would assist planning capabilities sought by private/public investors wishing to establish off-grid operations in rural areas.

---

[15] In general, Burundi is awash with strategic documents, however, the absences of operational plans to implement these strategies suggests that capacity to translate these strategies into actions is limited.

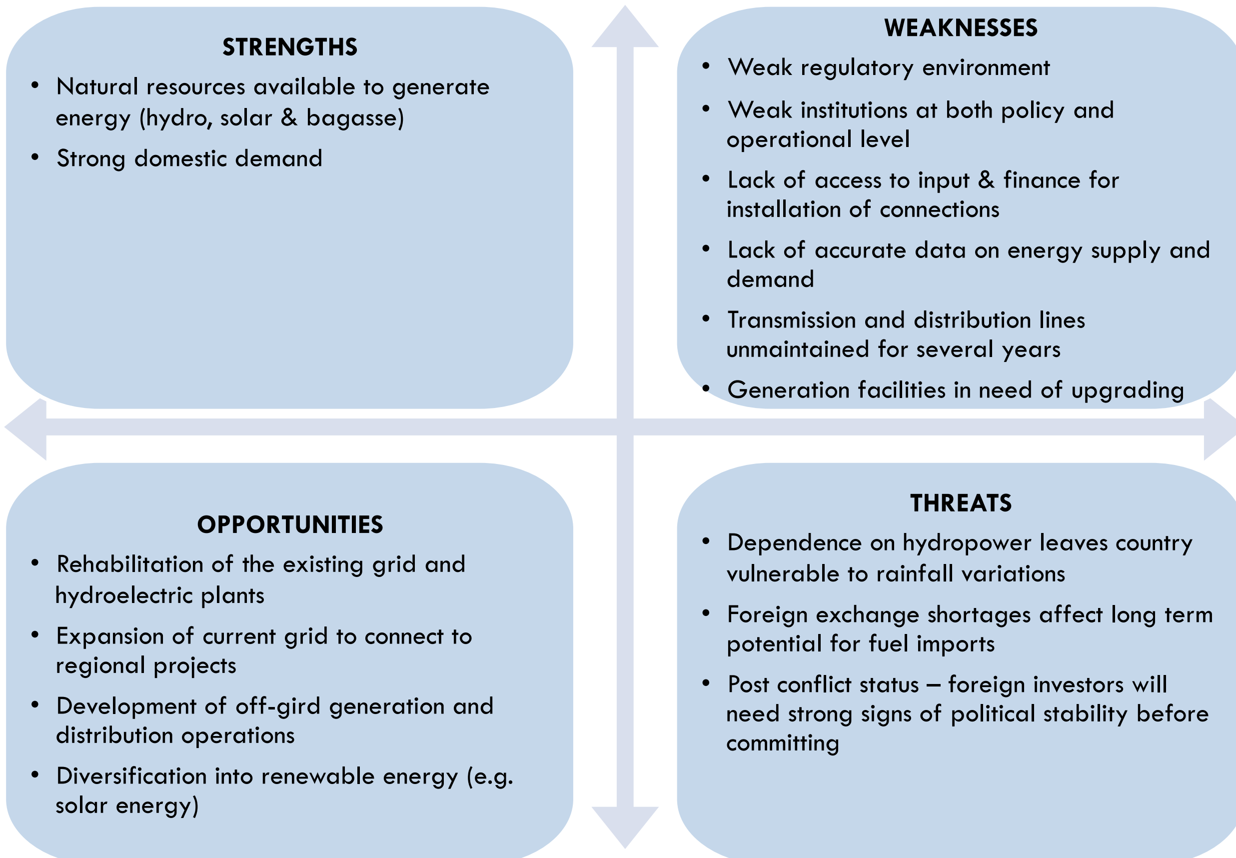
[16] See Table 8 Appendix, for a breakdown of the tariff structure in Burundi.

[17] National savings are weak, and banks are not sufficiently capitalized to finance large investments with long maturities (Karuretwa, 2013; Mutabazi, 2013).

Despite these constraints, Burundi does have important strengths to develop its electricity sector, and some local private sector actors are taking advantage of this. Two large private investments in generation using alternative fuels are already underway: the Burundi Industrial Association's 10 MW solar generation unit and Tanganyika Business Company's (TBC) 12 MW bagasse operations. The Burundi Industrial Association, consisting of firms including the national brewery, Brarudi, and supported by Trade Mark East Africa and the Chamber of Commerce, have formed a consortium for the development of a 10 MW solar generation unit to provide medium-term electrical supply for their businesses (Nkengurutse, 2013). TBC estimates that its new 12 MW generating plant will be in operation before the end of 2015. The sugar plant will consume approximately 2% of this capacity (Barankiriza, 2013). Business plans for both projects include selling surplus energy to the national grid, provided that the regulatory framework can be sufficiently developed in time (Groupe Sectoriel Energie, 2013; Nkengurutse, 2013; Vrijlandt, 2013). Unlike other private investors, these two local groups feel that due to the high energy deficit facing the country, once their new generators come online, the government will quickly come to an agreement on the procurement of surplus energy (Nkengurutse, 2013).

To overcome limited access to capital required for these important investments Burundi needs to draw in foreign investors who have less confidence in the domestic economy and government. Efforts will thus need to be made to improve weaknesses with respect to the regulatory environment, institutional strengths at both REGIDESO and the ministerial level, access to finance and poor information availability regarding the actual potential demand. Fortunately, Burundi and its donor partners recognize that the country's energy sector faces several important constraints and have begun assembling a plan to address them. In November 2013, the IFC announced that the World Bank Group would facilitate the development of a sector-wide strategy to engage stakeholders in the planning and implementation of upgrades to Burundi's energy sector. The coming decade represents a critical juncture in the development of Burundi's energy sector, involving the integration of Burundi with regional power-sharing networks, the expansion of Burundi's generation and distribution capabilities, and the consolidation of regulatory and coordinating institutions. It is vital that government representatives, donors and other stakeholders participating in Burundi's sector-wide arrangement ensure that their actions place Burundi in a good position to encourage further investment through the effective prioritization and coordination of goals. Figure 4 highlights the key strengths, weaknesses, threats and opportunities that the country faces.

Figure 4. SWOT Analysis for Burundi Energy Sector



Source: Authors.

V. Current Employment and Workforce Development in the Burundi Electricity Global Value Chain

While the previous sections provided an understanding of Burundi's existing strengths and weaknesses in the electricity value chain, this section unpacks how the above-mentioned constraints to upgrading can be addressed from the perspective of human capital development. Workforce analysis within the GVC framework focuses on the relative change in skill level required for particular upgrading trajectories (with respect to the status quo), existing structures that can be leveraged to improve those skills and the corresponding investments that are required to fill gaps in that structure. Based on this analysis the most feasible upgrading trajectories can be identified, prioritized, and analyzed with regard to the specific skill packages that must be developed and the particular actors that should be involved. This section examines Burundi's existing workforce in each segment of the value chain, the current workforce development framework in the country, and the key challenges that the country faces to making improvements in these areas.

A. Overview of Current Employment Opportunities in the Energy Sector

REGIDESO is the largest employer in the electricity GVC in Burundi. In 2013, it employed approximately 700 workers in generation, transmission and distribution operations (REGIDESO, 2013). As the second largest generator of electricity, in 2013, ABER employed 120 people, while SOSUMO employed approximately 42 employees in its energy service (SOSUMO, 2013).[18] TBC already had 5 highly skilled employees in its energy operations, despite the fact the processing plant has not yet been constructed (Barankiriza, 2013). Once Interpetrol's 10MW diesel generation plant in Bujumbura begins operations, an additional number of employees will also be hired.[19] Although no specific information was available for the number of employees at Interpetrol's operations, REGIDESO's 5MW plant employees 9 people (REGIDESO, 2013). In addition to the bulk grid, private sector firms with decentralized operations, such as Brarudi and others, also employ some technical staff to manager their in-house generation and backup generator operations. Employment in private firms engaged in the import, installation and servicing of generators powered by renewable energy is estimated to be approximately 200, though employment ebbs and flows with the initiation and completion of large projects for clients in government agencies and donor organizations. Finally, there are a handful of entrepreneurs and microenterprises active as electricians, providing services such as connecting households with the distribution grid and maintaining electrical equipment at service locations. Though a small number of vocational and professional programs in the country provide training for prospective electricians, there currently exists no statistical information regarding countrywide employment in this occupation. Total current employment in the sector, excluding electricians is thus estimated to be approximately 1,120.[20]

Given the relative importance of REGIDESO as an employer in the sector and with the sole mandate for transmission and distribution, the majority of this section focuses its employees' job profiles and its training programs. Employees working in REGIDESO's electricity operations (700) account for almost 50% of the company's total workforce (1,376), which also includes the company's water utility as well as general administrative positions. These employees are divided between 7 job profiles across the different units: Network engineers, network electricians, network technicians, electrician-aides (apprentices), plant operators, guards and other manual laborers (see Table 4). Engineers account for 7.5% of the company's workforce, working either in technical or management roles. In addition to these roles, there are three key bottleneck positions, surveyors, network planners, and civil engineers that employ a very small number of individual but that fulfill essential roles with the value chain (REGIDESO, 2013).

---

[18] Between 2004 and 2008, this number was relatively stable around 29 employees. In 2009, the company hired and additional 11 employees for the department.

[19] The power purchase agreement was signed in April 2013, however, it is unclear whether this project has actually gotten underway.

[20] This is based on the total number of employees listed in the companies above (1,076), plus an estimated 44 employees engaged by private companies to operate internal generators, although the precise number is not known.

Table 4. Employment Breakdown by Job Profile at REGIDESO, 2013

Position	Qualifications	Number in all units
Network Engineer	Engineering degree (Electrical/electromechanical)	50
Network electricians	A3	30
Network technicians	A2	23
Electrician –aides	Primary	74
Plant Operators	A2/None	44
Manual labor	None	137
Guards	None	233
Meter readers	A3/Primary	13
Other (including cashiers, administrative roles, etc).	Varied	96
Total		**700**

Source: (REGIDESO, 2013).

Employment may also be broken down by value chain activity: The company employs 173 workers in generation activities, 85 employees in transmission activities and 218 employees in distribution activities. An additional 145 employees work in the regional electricity centers. There are a further 79 employees in management, logistics and other supporting services.

- **Generation**: Generating plants typically employ an engineer, several operators (both plant operators and dam operators), several guards, and a handful of technicians, aides, manual laborers and usually a driver.[21]
- **Transmission**: 13 employees are in maintenance, 13 in construction and 10 in network planning. There are also 49 workers who operate substations along the transmission network.
- **Distribution**: Of the 218 employees in distribution, 49 are involved in construction and maintenance, 90 in operations, and 79 in metering and other customer-facing activities. The most common occupations in the distribution section of the value chain meter readers, collection agents and manual workers, however, this activity also employs electricians, technicians and engineers.
- **Regional Electricity Centers:** Finally, there are 145 employees working at regional electricity centers, which in practice span both transmission and distribution activities and draw from the range of occupations found in each segment of the chain (REGIDESO, 2013).

B. Current Workforce Development Initiatives in Burundi's Electricity Global Value Chain

As highlighted above, REGIDESO draws on highly, semi-, and unskilled labor. Highly skilled labor consists primarily of engineers with at least a Bachelor's degree in electrical engineering. The University of Burundi Faculty of Science and Engineering, which graduates 22 civil and electrical engineers annually (see Table 9), is the leading provider of engineering graduates in the country and REGIDESO has drawn significantly on these resources since the end of the crisis. 61% of the company's engineers were hired between 2005 and 2009, and a further 16% have been hired since then (REGIDESO, 2013). This relationship was strengthened between 2010 and 2012 during which time the former Dean of the University was appointed General Manager of the company (Bucumi, 2013). There does not appear to be a shortage of qualified engineers in the country. According to the

[21] The company's thermal plant employees 9 workers: one engineer, three operators, one turbine technician, two mechanic-aides, one guard and one driver.

company's human resource (HR) manager, that while they typically recruit from within, it is not difficult for the company to recruit engineering staff, and for any one job posting they have over a hundred qualified applicants (Bucumi, 2013). Conversations with donors, however, indicated that substantial on-the-job training is often required of recent engineering graduates, as university programs provide too little training in practical and applied skills, focusing instead on teaching theoretical knowledge. This emphasis on theoretical, rather than practical, education has partly arisen out of necessity. There is an insufficient supply of equipment, which could be used for hands-on trainings; sometimes university students must undergo practical training sessions at technical high schools, which receive new equipment from donor partners, rather than their home institutions.

For the technical positions at the company (network electricians, technicians, electrician aides and plant operators), approximately half have A2 or A3 qualifications from technical or professional schools in the country, while the other half mostly have primary school education. There are a few employees with no noted education, however, these employees have been at the company for a considerable period of time (REGIDESO, 2013). According to the Ministry of Basic and Secondary Education, Trades, Vocational Training and Literacy, following the reorganization of the technical and vocational training system in the country undertaken between 2011 and 2016, four of the 17 new technical centers at the provincial level will offer technical training for electricians at the A2 level.[22] The Ministry's goal is that these graduating electricians will be able to install and maintain electrical connections for industries, companies/distributors, including REGIDESO, as well as individual homes (Nshimirimana, 2013).[23] In addition, some graduates from professional schools are also employed at REGIDESO. Tables 9 and 10 in the Appendix provide details about the programs at all levels of the formal education system (both public and private) which are relevant to the energy sector.[24] Employees with no formal education account for approximately half of the company's electricity activities and are concentrated in roles of manual labor and security. According to the HR manager at REGIDESO, security guards are an essential part of the company's workforce, as theft of capital equipment is a significant problem (Bucumi, 2013).

REGIDESO also provides in-house and on-the-job training for its new employees, although the effectiveness and regularity of these training programs was called into question in the company's audit earlier this year (Mazars, 2013). According to the HR manager, new employees at the technical level participate in six months of training at the company's training center and in a practical rotation program in different parts of the company. These training programs focus on induction, such as an introduction to the company's protocols, as well as technical aspects. Technical training courses are taught by both experienced employees and external consultants. Most external consultants are Burundian, although occasionally foreign consultants may be hired when the required knowledge is not available locally (Bucumi, 2013). As of the time of writing, REGIDESO had initiated a workforce development needs assessment in order to identify workforce development objectives across each functional division of the company.

[22] Training is currently also provided at the A3 level, but A3 degrees will be phased out of the technical education system in 2016.

[23] No documentation was available to support this claim.

[24] Data regarding the number of graduates from vocational and professional programs was not available at the time of writing. This data is only maintained among universities and technical schools (see Tables 9 & 10 Appendix).

Box 4.Workforce Development in the Bagasse Power Generation Sector

According to interviews with the HR Directors of both SOSUMO and TBC, unlike REGIDESO, the two sugar processing plants have primarily engaged foreign experts in training of their staff to operate the power generation plant, as there is limited domestic expertise in the use of this technology. SOSUMO, the older and only functioning operation, hires primarily engineers and technicians to work in the company's electrical generation plant. In the past, they mostly took staff abroad, both within the region and to Europe, for training. However, given the high cost of these training programs, and poor attendance, the company has altered its strategy and plans to train individual trainers abroad who will come back and lead training programs in Burundi. TBC, on the other hand, recruited its electrical generation staff primarily from current and retired SOSUMO employees who had experience with bagasse electricity generation. Although as the company intends to incorporate newer technology, it has increasingly hired Indian and Chinese trainers to provide training locally. While the company plans on maintaining some degree of foreign expertise in country in the long-term, the former SOSUMO employees are expected to observe training programs and eventually run them independently for employees in the country. According to the manager of the company, there were 15 foreign experts in the country providing training to local staff in 2013.

Companies engaged in the solar generation sector draw to a large degree on knowledge transfer from returning diaspora. The General Manager of ENECSO, for example, holds undergraduate and graduate degrees in physics and energy systems from universities in Libya and the US respectively, while the owners of ITCO also trained abroad (Field Research, 2013). Recognizing the potential for solar generation, both Education Ministries indicated that training in solar energy technologies is currently considered a national priority, including the establishment of a post-secondary 2-3 year technical institute exclusively focused on this issue and on selecting students for donor partner scholarships to study different aspects of the energy sector (Banyankimbona, 2013; Nshimirimana, 2013). When requested, no documentation could be provided to verify these initiatives. However, in 2013, Ecole Technique Supérieure (ETS) Kamenge, a technical school, began providing training in solar panel installation.

C. Challenges

In spite of the large number of unemployed and underemployed workers available to contribute to rebuilding and expanding Burundi's energy infrastructure, the sector faces a number of important workforce development challenges. These include weak HR management practices throughout the country, dysfunctional promotion policies within REGIDESO, a geographical mismatch between demand and supply for labor, shortcomings in the formal education system, and the unavailability of reliable labor market data. Each of these challenges is described in further detail below.

In general, HR management skills in the country remain weak. Neither the head of HR for the two largest employers in the energy sector hold degrees in business administration or HR (Field Research, 2013). This weakens their ability to identify current skills gaps within their organizations, develop appropriate training programs to fill these gaps, or project their skills need for growth. HR practices such as performance based contracts in these companies have also been less effective than hoped. Given the capital intensity of the sector employees often do not have the required equipment to meet their performance targets (Bucumi, 2013). Furthermore, given that both REGIDESO and SOSUMO, the two largest employers in Burundi's energy industry, are public sector entities they are constrained by strict firing protocols making it very difficult to replace underperforming personnel. The 2013 audit of REGIDESO helped to draw attention to these issues and by August 2013, 15 people had been let go. These initiatives should help to contribute to improved accountability.

Existing rules allow for the promotion of individuals based on length of employment with the firm rather than demonstrated competencies (Mazars, 2013). Such a policy does not create incentives to achieve organizational mobility via skill development. Additionally it undermines the company's ability to perform as an efficient organization and also to effectively meet its responsibilities (Mazars, 2013). Poor staffing practices limit management's capacity to promote technically qualified and experienced individuals to strategic positions within the organization, creating a "top-heavy" structure with more supervisors and managers than workers. Subsequently REGIDESO as of 2013 supervisors accounted for 32% of REGIDESO's payroll. An aging workforce and a recent hiring freeze have exacerbated this trend. For example, 45% of the company's workforce is over the age of 45 and approximately 30 employees retire annually(REGIDESO, 2013). The current hiring freeze has only permitted a replacement of essential staff (e.g. engineers and security guards) (Bucumi, 2013). This limits entry of younger workers to fulfill essential entry-level roles.

As with many other professional and technical positions in the country, as a result of years of crisis and comparatively undeveloped rural areas, hiring for rural postings in the country is complicated. REGIDESO find that many engineers and qualified technicians are unwilling to work outside of the country's capital (Bucumi, 2013). Given that most generation and transmission activities are located outside of urban areas, this is an important problem for the company and suggests the importance of providing education and training centers outside of the capital in regional hubs.

Shortcomings within the formal education system also constrain skill development and productivity, both in REGIDESO and in the handful of private firms in the renewable sector (GTDSE, 2013; MEM, 2013a). Technical and professional schools are struggling with rapidly increasing enrollment and lack the facilities, equipment and teaching staff to provide high-quality education to growing numbers of students. Though donors are providing some assistance in the areas of equipment and capacity building at technical, professional and vocational schools, such efforts reach only a handful of schools (BTC, 2013; Field Research, 2014). In response to the worsening resource crisis, schools are shifting their instruction towards the provision of theoretical knowledge at the expense of hands-on training (Field Research, 2014). As a result, graduates lack experience applying their skills and knowledge to specific problems in concrete contexts. This increases costs for employers, as they must expend additional time and resources searching for good candidates and training recent hires. University-level engineering programs face additional challenges. In addition to facing growing enrollment, universities lack donor support to increase their stock of training equipment. Thus, students from the University of Burundi and Ecole Normale Supérieure (two of the most elite universities in the country) use laboratory space at a technical school, ETS Kamenge, as a site for hands-on training sessions (Field Research, 2014). REGIDESO has experienced multiple delays in projects because its workforce does not know the proper procedures to install and operate new equipment. This coordination challenge is especially pronounced because REGIDESO does not always control the procurement process for new assets; donor agencies frequently provide equipment for projects (Field Research, 2014). However, these donor agencies rarely collaborate to ensure that the same brand of equipment is procured. As a result, REGIDESO employees must be frequently retrained in order to handle these new technologies.

In addition, current reforms aimed at liberalizing generation and privatizing distribution could place pressures on the workforce development infrastructure, as new technologies are introduced to the electricity network. These technologies, such as pre-paid meters, IT systems to monitor the transmission and distribution networks, and new generating technologies will require expanded training capacities (GTDSE, 2013). Furthermore, in light of regulatory changes and the entry of new private actors to the energy sector, a new independent regulatory agency will be created in order to monitor and regulate the activities of public and private actors across the chain. Staffing this agency could be a challenge, as relevant skills and knowledge will need to be built essentially from scratch.

Finally, the lack of easily available data regarding the characteristics of the current workforce or even of major workforce development organizations presents a challenge with respect to diagnosing current labor market problems and offering specific solutions. This makes it extremely difficult for potential donors and investors to quantify and locate underemployed skilled personnel available in the labor market.

Under these constraints, the sector does not currently provide significant job creation. Limited budgetary resources, which might otherwise contribute to training, data collection, or other workforce planning exercises, are focused on sometimes underperforming senior staff. This appears to be resulting in a pool of qualified workers – engineers in particular – graduating and remaining unemployed or underemployed in the labor market. The constraints facing Burundi's energy sector are not simply a function of underinvestment, improving underlying HR practices (particularly within REGIDESO) and streamlining labor market data are major contributing factors. Section VII of this report will provide specific upgrading recommendations that target these existing challenges, to strengthen Burundi's workforce development institutions and facilitate upgrading across the chain.

VI. Upgrading Strategies

Drawing on the analysis already conducted, four potential scenarios for the ongoing development of the sector present themselves: 1) maintenance of status quo, with investments only focused on rehabilitation of existing infrastructure; 2) increased generation capacity as a result of planned domestic power plants becoming operational (see Table 1); 3) increased generation capacity as a result of planned regional power plants becoming operational (see Table 2); and 4) increased off-grid power generation capacity. Three primary upgrading trajectories are recommended to meet the needs of these different scenarios in the short and medium term:

1) **Rehabilitation of the grid and existing generating facilities**: Efforts should be focused on improving the efficiency of existing infrastructure and operations. In particular, this involves the rehabilitation of existing hydroelectric plants and the national grid to improve generation capacity and reduce transmission and distribution losses. This strategy is an example of process upgrading. This will be necessary to fulfill goals of scenario 1 and to ensure efficiency of transmission and distribution with scenarios 2, 3 and 4.

2) **Expansion of the transmission and distribution network**: Extending the grid is required in order to increase access to electricity for businesses and individuals in underserved parts of the country, as well as to facilitate interconnectivity with other countries. New technologies should be carefully selected and incorporated in the construction of these new transmission lines to minimize future losses and conform to regional standards. This strategy is an example of process upgrading. This will be necessary to ensure returns on investments in scenarios 2 and 3.

3) **Support for the development of off-grid generating capacity**: Off-grid generation can be expanded to support rural electrification goals and to help private sector firms and other actors to invest in technologies that reduce their dependence on the national supply, freeing up resources for other users. This strategy combines both process upgrading and environmental upgrading. This will be necessary in scenario 4.

These strategies were prioritized due to their feasibility under the current post-conflict context, the existing state of the workforce and workforce development institutions, and, importantly, their potential to contribute to improved livelihoods for a large portion of the population while also offering select, higher skilled job opportunities. The strategies are not mutually exclusive; rather, as highlighted, they complement one another in pursuing the goals of Burundi and its development partners to promote access to modern energy services. Several of these trajectories have also been identified in recently published reports (Chancelier, 2013; Ministry of Energy and Mines, 2013).

Each of the three proposed upgrading trajectories are discussed below. Drawing on case examples from other countries that have followed similar approaches in the past, the text highlights why it may be important to the country to pursue this strategy, how it can be achieved, and what the expected outcomes may be – both with respect to revenue improvements and job creation. Indeed, the commitment of important financial and human capital resources to achieve these upgrading trajectories in the current post-conflict, budget constrained context must be evaluated with respect to these potential outcomes. However, in order to successfully implement any of these trajectories, key institutional reforms related to sectoral governance and the management of REGIDESO, will first need to be addressed. Thus, we thus close this section with a brief discussion on institutional reforms that would help to strengthen the country's potential to implement these strategies.

A. Rehabilitation of Generation, Transmission and Distribution Capabilities for Urban Centers

Extensive rehabilitation of the existing electrical infrastructure, including the reconstruction and maintenance of damaged sections of the transmission and distribution grid as well as repairs to existing hydroelectric facilities, will help to effectively increase the supply of electricity available to REGIDESO's subscribers. Technical losses of up to 25% in transmission (Barampanze, 2012) must be immediately rectified for Burundi to narrow its energy deficit. Such improvements would require maintenance to existing transmission and distribution lines, high- and medium-voltage substations and voltage distribution posts (GTDSE, 2013; Hakizimana, 2013). Likewise, efficiency improvements brought about by the rehabilitation of existing hydroelectric facilities in Burundi will help to raise generating capacity in the short-term without requiring either massive capital outlays or expensive fuel imports.

Technical losses occur due to lack of maintenance and renewal of transmission and distribution infrastructure. As the equipment ages, it begins to resist the flow of electricity, effectively reducing the voltage – and efficiency – of the lines. Sources of technical losses include degraded quality of conductors in lines, transformers (especially distribution transformers) become damaged due to poor maintenance or improper loading, and poorly installed or maintained service connections (Ghosh, 2012). The medium- and low-voltage distribution networks in Bujumbura and Gitega have been identified to be in particular need of repair (Barampanze, 2012). Given the role that these cities play in Burundi's economy – Bujumbura as the main population and economic center and Gitega as a key agricultural hub – rehabilitation projects could have a substantial positive and indirect effect on employment by enabling more sophisticated activities in the agro-processing, manufacturing and service industries. Likewise, given the immediate boost to power supply associated with grid repair, Burundi should prioritize the rehabilitation of existing generation facilities and the grid as a short-term goal for the energy sector. As of 2013, rehabilitation of the Rwegura and Nyemanga hydroelectric dams has been advanced (World Bank, 2013a), and funds have been secured through KfW to rehabilitate Ruzizi II. A handful of smaller hydroelectric plants still require repair, and the entire generation network would benefit from improved attention to ongoing maintenance (IMF, 2011b). Investments in repairs to these facilities can help Burundi to begin to reduce the energy deficit. Stakeholders should use the sector-wide forum to identify and prioritize projects on the basis of cost-effectiveness and their potential to promote productive employment through electrification.

Expected Outcomes:

1. **Reduction in technical losses**: Even small improvements in the efficiency of Burundi's electrical grid will substantially increase the electricity supply available to consumers and reduce the threat of load shedding to the system overall. Improving the efficiency of the network will allow REGIDESO to reach more subscribers, improving access to electricity in the country. Reducing technical losses calls for repairs to old substations, transformers and lines, as well as upgrades in the transmission network, for example converting the 110kV line between Bujumbura and Gitega to 220kV (Barampanze, 2012). These activities will reduce currnet load shedding of 25% as well as reducing further damage to existing equipment and improving future sustainability.
2. **Direct and indirect employment generation** Grid rehabilitation will require the employment of additional workers in Burundi, representing an important opportunity for job creation. Given that only a small number of potentially qualified employees have practical experience in the sector, hiring local workers will need to be accompanied by skills development, especially in semi-skilled technical positions. Field interviews indicated that qualified workers in Bujumbura do not like to leave the city for work, while few outside of the capital are qualified to carry out necessary rehabilitation work. Thus, skill development will need to be emphasized especially in areas outside of the city. Given the long-term needs for maintenance of the electrical grid and generating facilities, as well as expansion of the grid both across the country and to connect with the regional power pool, these trained workers are likely to continue to be able to find work. Aside from direct job creation, grid rehabilitation will fuel employment generation through indirect channels, since a more efficient network means that a greater supply of electricity can be directed towards entrepreneurial activities in other sectors of the economy.

Efforts at rehabilitation have shown strong impact in Liberia – another country recovering its electricity infrastructure following years of war (see Box 5). Successes achieved in Libya's rehabilitation efforts mirror closely to expected outcomes for Burundi: reduced technical losses within the electricity network, and setting the stage for Liberia's ability to attract private-sector investment in the Liberia Electricity Company. As this case suggests, implementing a rehabilitation program requires that well-trained teams of manual laborers, technicians and engineers are available, either within the utility itself or as independent contractors.

Box 5. Private Sector Engagement and Grid Rehabilitation in Liberia

After the second of Liberia's two civil wars concluded in 2003, the country's electrical grid was crippled, and the country was forced to "start from zero" in regaining capabilities for the generation and delivery of electrical energy (USAID, 2013a). With help from the World Bank and other donors, Liberia developed an ambitious series of programs to rehabilitate the electrical grid, expand generation capabilities and develop an institutional framework for the governance and management of the country's energy sector. These programs are particularly noteworthy due their heavy emphasis on workforce development, realized through a coordinated strategy built upon transfers of skills and knowledge from abroad in addition to the formation of skilled and semi-skilled workers at home.

The Government of Liberia took its first step to rehabilitate the country's energy infrastructure in 2006 with the Emergency Power Program (EPP). The EPP re-established the Liberia Electricity Corporation (LEC), the state-owned electrical utility which had ceased operations during the war. International partners such as the United States Agency for International Development (USAID), the Norwegian Agency for Development Coordination (NORAD), the European Union (EU) and the World Bank provided Liberia with US$40 million in grant funding and technical assistance to help construct four small substations while also developing the capacity to run 9.6 MW on high-speed diesel generators (AFTEG, 2011). The government moved into the next step of the energy sector's development in 2009 with the publication of the National Energy Policy (NEP), which outlined a strategy for capacity building phase that would last through 2015 (Republic of Liberia, 2009). Because of the overall state of disrepair associated with Liberia's infrastructure, the goals listed in the document focus exclusively on allowing citizens to meet their most basic energy needs, with a target of providing electricity to 15% of rural residents and 30% of urban residents through the program. It became apparent, however, that the LEC lacked the human and financial resources to rebuild and expand the electricity sector as envisioned by the NEP.

With the support of donors, Liberian government a five-year, performance-based management contract for the management of LEC developed by the IFC. The contract, which also covered training, and capacity-building activities, was awarded to Manitoba Hydro International (MHI), a private Canadian energy company, after a competitive bid process and marked a major shift in workforce development in Liberia's energy sector (IFC, 2013; USAID, 2013a).

In order to re-staff LEC and place the organization in a position to expand delivery, MHI created a strong HR development program. It formalized job profiles, recruited 63 workers from local educational institutions and placed them in comprehensive, paid training programs which included both on-the-job and classroom training. In its trainings, MHI used customized training modules in seven job areas, including maintenance workers, middle managers, financial managers, and customer service representatives. In order to build up the engineering skills required to expand generation capabilities, MHI embedded newly graduated engineers within teams led by experienced Liberian and foreign engineers. This promoted rapid skill diffusion within the domestic workforce in order to reduce long-term dependence on foreign expertise (LEC, 2013).

Over the course of only a few years, these training efforts helped to re-constitute the LEC as a professional organization with the capacity for continued skill development and performance enhancement. Since taking over the management of LEC in 2010, MHI has reduced losses on the grid from 28% to 15%, and projects to further reduce these to 12% in coming years (USAID, 2013b).[25] Additionally, MHI introduced pre-paid meters to LEC's distribution arm, and as a result saw tariff collection increase from 93% to 97%. The introduction of pre-paid meters also created an opportunity for LEC to educate customers about energy conservation, in order to reduce per-capita demand and free up resources for network expansion (USAID, 2013a). Subscriptions have increased by more than 10,000 customers, though MHI expects to dramatically increase LEC's customer base to 87,000 by the end of its performance contract in 2015 (USAID, 2013b).

B. Expanding the Transmission and Distribution Grids

Only 9% of the population has access to electricity, and the vast majority of the connections are in Bujumbura; only 2% of rural households are serviced by ABER or REGIDESO. Opportunities exist to expand the transmission and distribution grid in order to both increase access to electricity, maximize on the projected new generation capacity (see Tables 1 & 2) and to connect the country to the new regional power pool. Donor funding has already been approved for several transmission projects, including a 220kV high-voltage transmission line from Rusumo falls to Gitega, which will not only serve to increase the overall supply of electricity to Burundi's grid but also expand the transmission network into the northeastern part of the country, including important coffee growing

[25] For comparison, technical losses in transmission and distribution in advanced economies average around 6-11% (Ghosh, 2012). A handful of developing countries, including Malaysia, Cameroon and Ethiopia have achieved losses within this range.

and agricultural regions. Another major expansion to the transmission network includes the construction of a 220kV line between Bujumbura and the DRC. As these regional transmission projects are completed, it will become feasible to build out distribution lines in nearby towns.

Given that under the new framework REGIDESO will maintain the exclusive mandate for transmission, the utility will need to expand its capacities in a number of areas. In order to enhance electricity access through grid expansions, REGIDESO will need to hire additional engineers and managers to plan and oversee the implementation of transmission line and substation construction projects. Building out the grid will not only require investments in capital equipment but also in technical skills. REGIDESO will need to employ line operators, technicians and manual laborers to implement construction projects. In addition, barriers to grid access at the level of the service location will also need to be overcome. Currently, many potential residential customers are unable to afford the cost of purchasing and installing a transformer, which usually must be imported directly from Europe (World Bank, 2013c). There may be space for public or private actors to reduce the transactions costs involved with purchasing transformers, for example, through the creation of a procurement initiative which purchases equipment in bulk.

Like Burundi, Rwanda, emerged from years of instability with a geographically limited grid whose expansion required coordinated investments on the parts of government and donors (see Box 6). Following a sector-wide process that resembles the framework recently announced in Burundi, Rwanda successfully planned and implemented the expansion of its electrical grid, focusing on areas within five kilometers of the existing network. Following this strategy, the country more than doubled the number of connections serving residents, from 110,000 to 228,000.

Expected Outcomes:

1. **Expanded access to electricity:** Expansions in the transmission and distribution network increases access to modern energy services, offering a greater share of the population the chance to connect to the electrical grid and bringing Burundi closer to its goal of expanding access to electricity to 15% of the population by 2015 and 20% by 2020 (Barampanze, 2012; IFC, 2013). Given the costs of building and maintaining a large network, it is likely that the grid will not be expanded beyond major towns and cities in the short-term.
2. **Improved returns on investments for planned generation plants and integration with regional power-sharing partnerships:** In order to maximize the potential returns to the planned generation plants at both the domestic and regional level, Burundi must follow through with plans to develop transmission linkages across the country and more broadly across the region. This will require further technical capacitation of the local workforce, as Burundi's current transmission lines and substations cannot accommodate the more efficient 220kV infrastructure required by the regional grid, as well as training workers in geographically appropriate sections of the country where new lines will be installed (SNC Lavalin, 2011).
3. **Direct and indirect employment generation:** Aside from the positive impacts that expanding the grid will have on productivity and quality of life, this strategy will generate a large number of jobs in the electricity GVC, such as planning, engineering and construction. One may extrapolate from Rwanda's recent experience building out its national grid (see Box 6) in order to generate predictions of the approximate employment gains that Burundi might enjoy through pursuing this strategy. The Rwandan Energy Access Program generated 17 jobs for each 10 km of medium-voltage (110kV) transmission line and accompanying expansion of the surrounding distribution network. The AfDB has identified 260 km worth of transmission construction and upgrading projects to expand access and capacity in

Burundi's network. Assuming that these projected transmission expansions are accompanied by extensions of the distribution network analogous to those in Rwanda, these projects should be expected to generate around 442 jobs, around 331 of which will be unskilled or semi-skilled and 111 will be skilled (engineering, management and planning). Employment gains will not be confined only to short-term planning and construction activities; sustaining the beneficial effects of electrification will further require permanent investments in a skilled workforce capable of operating and maintaining the infrastructure.

Box 6. Expanding the Electrical Grid in Rwanda

In spite of Rwanda's economic expansion during the course of the first decade of the 2000's, electricity access in the country failed to keep pace. By 2008, only 6% of the population had access to electricity, and poor grid maintenance and insufficient supply led to frequent load shedding. In response, Rwanda and its donor partners introduced a plan in 2009, the Electricity Access Program (EAP), to strategically expand investment in the electrical network and introduce institutional reforms to improve the performance of the national utility, Electrogaz, and facilitate private sector investment in generating capability.

This program received funding from various donors, including the World Bank, the IFC, the AfDB, the EU, United Nations Industrial Development Organization (UNIDO) and the governments of the Netherlands, Belgium and Germany, and was implemented through various Rwandan government ministries, educational institutions, the national utility and private sector stakeholders (Castalia, 2009). The EAP follows an innovative Sector-Wide Approach (SWAp) to planning and implementing investments and capacity building initiatives in the energy sector, with a goal of expanding connections from 111,000 in 2008 to 228,000 in 2011 (ESMAP, 2012). Under the SWAp model, public, private and donor stakeholders participated jointly in a sector working group (housed within the Government's Energy, Water and Sanitation Authority) to coordinate and properly sequence the activities of the various actors. A central characteristics of this multi-stakeholder arrangement, however, was emphasis on country ownership and government leadership in its process, in order to align program initiatives with national development priorities (ESMAP, 2012).

Two important aspects of the SWAp appear relevant to Burundi's upgrading trajectories in the energy sector are institutional reforms and grid expansion activities. First, institutional reforms were seen as an important initial step to facilitating investment and upgrading in the generation, transmission, and distribution stages of the chain. With technical assistance from donor partners, Rwanda passed legislation that: 1) divided Electrogaz into two organizations, separately responsible for the electrical network (the Rwanda Electricity Company; RECO) and the water and sewerage network; 2) granted new powers to the Rwanda Utilities Regulation Authority (RURA) to issue licenses to IPPs so that they could sell energy into the grid; and 3) reserved for RECO the exclusive right to transmission and distribution activities in Rwanda and provided technical support for network expansion planning (Castalia, 2009). These reforms served to partially liberalize the sector in a way that introduced incentives for private sector investment in generation activities while enhancing the technical capabilities of RECO in order to reduce uncertainty and improve regulatory effectiveness.

Grid expansion activities were coordinated and carried out through the SWAp. An innovative aspect of this phase of the EAP is the use of Geographical Information Systems (GIS) to prioritize and sequence grid expansions and new connections. Investments to expand electrical access to new communities were prioritized based on proximity to the existing grid, population density, and the prevalence of social facilities like schools and clinics (Castalia, 2009). GIS planning exercises indicated a least-cost strategy for gradually expanding electricity access to urban and peri-urban areas in Rwanda, calling for the construction of roughly 500 km of medium-voltage transmission lines (this goal does not appear to have been met) and the construction of additional substations by 2012 (EWSA, 2011). In addition, $88.5 million of donor and government money has been committed to investments in distributed micro-hydro and solar PV units, with the expectation that these will be integrated into the bulk grid in the coming decade (Castalia, 2009). Additionally, the AfDB has approved funds for the construction of 114 km of 220 kV transmission lines to connect the Rusumo hydro plant to Kigali (AfDB, 2013; Lonsway et al., 2013).

In order to ensure that the required skills are available to enable the above investment strategies, the EAP has incorporated workforce development considerations. Current plans call for an additional 464 km of medium-voltage transmission lines and 710 km of low-voltage transmission lines to be built by 2017. These activities are projected to employ 800 workers, of which 600 would be skilled or semi-skilled and 80% would be drawn from the local Rwandan labor market (Negatu et al., 2013). Donors' technical assistance efforts have been focused on in-house knowledge building in the areas of procurement and planning, finance and stakeholder management, and technical skills. RECO has filled these skill gaps through internal training and through the recruitment of foreign contractors. The utility has also created an apprenticeship program for engineers and technicians. Skill development has been further supported by the Kigali Institute of Science and Technology, which is recognized as a stakeholder in the SWAp process (ESMAP, 2012). In addition, the AfDB is working with other stakeholders to identify specific job profiles required and developing new curriculum for four technical schools in areas where existing power plants are being rehabilitated to ensure that the plants have the required workforce available. The program will be divided into two years of classroom based training and one year of internship at a company in the area(Ba, 2014). In spite of these efforts, workforce development initiatives appear to remain too limited in scope. A recent assessment of the EAP has found that RECO's capabilities remain insufficient in the areas of project planning, preparation of project documents, and project implementation (AfDB, 2013).

C. Supporting Off-grid Generation Capabilities in Rural Areas

Burundi's mountainous terrain serves as an important constraint to the country's potential to meet its goals of increasing access to energy to its entire population. Burundi's continued economic growth and stability depend on expanding livelihoods and productive employment opportunities in economically distressed rural areas, so plans to facilitate rural electrification should be extended.

However, building out the transmission and distribution network is not always a cost-effective option. Indeed, in many rural areas, the magnitude of demand is relatively low; many potential customers live under the poverty line, and electrification is important for minimal activities such as safer lighting and for other low-load activities such as charging cell phones. In such situations, even a small amount of electricity can go a long way towards promoting productive employment and increasing rural incomes, given the productivity enhancements that a cell phone can provide to a rural family. Thus, distributed generation, including solar PV and micro-hydro generators, offers a potentially efficient alternative where grid expansions are not cost-effective. These efforts to expand off-grid generation capacity can also be viewed as an opportunity to foster the adoption of renewable energy sources, and diversification away from a primary dependence on hydropower.

Such an approach is not mutually exclusive from a strategy of extending the transmission grid into underserved rural areas, since the solar-based networks can be easily integrated into the centralized grid. In fact, under the proper regulatory framework, such rural communities may have the option of selling surplus energy back into the grid as independent power providers (Lopes et al., 2007) – as evidenced from the Rwanda example above. This approach in Burundi could enhance the overall efficiency of the network by ensuring that unused capacity generated by solar and micro-hydro generators be redirected towards areas of demand. In order to pursue a strategy of integrating distributed generation facilities into the grid, some changes will need to occur at the institutional level (see section on institutional reform).

Expanding access to modern energy services in many parts of Burundi, especially in the northern and western parts of the country, will require investments in off-grid generation technologies, including solar PV and microhydro operations. Several projects are already underway, including an EU-led effort to provide PV technology to 25 rural health centers (Ministry of Energy and Mines, 2013), the Government of Burundi has developed a program to subsidize rural electrification through the collection of a Renewable Energy levy (Hakizimana, 2008), and is evaluating the potential of two 10 MW solar stations in Bujumbura and Gitega respectively.

In addition to scaling up and better coordinating existing programs, next steps could include the development of a procurement program which might help to bring down the costs of imports of solar units by building purchasing volume and bargaining power. Stakeholders should also develop a systematic program to guide the future installation of off-grid generating capabilities in rural areas.

The experiences of Bhutan and Sierra Leone (see Box 7) indicate the importance of skill and knowledge development in implementing rural electrification programs, which depend on the proper installation and maintenance of a large number of relatively small-scale generators. Expanding electricity access in Burundi will likewise require the training of hundreds of solar PV installers and electricians, as well as the provision of basic entrepreneurial skills to support the efficient exploitation and maintenance of installed generating assets. Burundi should develop certification programs through the community college system in order to train electricians. Stakeholders could consider turning to foreign institutes, such as the Barefoot College (see Box 7), as a means of supplementing the existing capabilities of local organizations. Installation of micro-hydro, wind, biomass and other non-solar, off-grid generating facilities will require skills and knowledge relevant to these technologies. Coordinating the development of skills across these multiple technologies, each of which appears to be viable options for Burundi (MEM, 2012), should be supported by the development of a formal program that can identify and help fill skill gaps in particular regions. Beyond training technical workers, Burundi should provide end-users in service locations with information about energy conservation, in order to optimize the effectiveness of investments in off-grid distribution.

Expected Outcomes:

1. **Diversification of fuel sources towards renewables:** MEM and its development partners, including the World Bank, have indicated a preference for renewable over non-renewable generation when prioritizing energy projects (MEM, 2012; World Bank, 2013d). Given that Burundi's access to renewable, hydroelectric energy remains constrained until regional power projects come online in the medium-term, the most promising route for the country to build its supply of renewable energy is through the development of small-scale, off-grid generators, including solar PV and micro-hydro units. Such a strategy of expanding generating capacity and electricity access offers advantages over the use of thermal plants, not only due to the negative environmental impacts associated with burning fossil fuels, but also because of the drain that diesel imports place on Burundi's foreign currency reserves.

2. **Improving rural livelihoods and promoting productive employment:** The Bhutanese Rural Electricians Training Program (see Box 7) allowed rural parts of the country to gain access to modern energy services an estimated 15 years earlier than if they had waited for the grid to reach them. Similarly, there is no reason that Burundi's rural communities

should wait until expansions in the transmission and distribution network to reach them before seeking electricity access. In mountainous and relatively isolated parts of the country, solar PV and micro-hydro generators can supply sufficient electrical energy to power improved living standards, for example by replacing oil lamps with light bulbs, and economic opportunities, for example by enabling rural residents to charge cell phones and exchange information with distant markets. Furthermore, a necessary component of rural electrification initiatives is the training of electricians, technicians and entrepreneurs to enable the installation and maintenance of a distributed electrical network. It is important to address that these skills are different from those associated with the grid upgrades outlined in the above upgrading strategies. Consequently, separate training/certification programs must be developed for each.

Box 7. Off-grid Solar Panel Installation in Bhutan

Similar to Burundi, the small landlocked country of Bhutan has a largely rural population – approximately 70% live in rural areas – with very low rates of on-grid rural electrification. As a result, Bhutan's fuel/wood consumption rate for lighting and cooking has been one of the highest in the world (ADB, 2011a). This significantly contributes to high incidents of respiratory illness and environmental pollution (WHO, 2013). Over the last decade, the Government of Bhutan has thus made rural electrification a national priority (ADA, 2010; ADB, 2010, 2011a). Due to Bhutan's mountainous terrain, on-grid electrification is costly and difficult to install. Therefore, the government has placed emphasis on the development of off-grid solar panel solutions as a way to increase rural electricity connection rates to households, hospitals, schools and businesses (ADA, 2010; ADB, 2010). In pursuit of this goal, the government specifically stressed the need to scale-up technical trainings to teach villagers how to install, maintain and repair solar panels.

A particularly successful initiative supporting the development of solar panel trainings in rural Bhutan has been the Rural Electricians Training Program, implemented between 2007 and 2009 with US$1 million in funding from the Asian Development Bank's Japan Fund for Poverty Reduction. The program was coordinated by the Department of Energy and the Ministry of Trade and Industry in Bhutan who partnered with other government bodies and a PV training school known as Barefoot College, in Rajasthan, India. Encompassing two primary training initiatives, the program aimed to: 1) train 395 semiliterate rural men and women to become certified electricians capable of providing maintenance and repair services to solar panel systems; and 2) send 46 Bhutanese women to the Barefoot College to attend a six month training program, who upon completion would be able to individually install, maintain and repair solar panels in 345 households across multiple Bhutanese villages.

Under the first training component, villagers received eight weeks of training by government officials at the rural district level (cluster of villages) and upon completion were entered into a newly created database of certified electricians to be used for servicing 12 provinces and 79 rural districts (ADB, 2010). Additionally, graduates of this training program were qualified for special concessional loans administered by the government to set up entrepreneurial electrician repair business. Under the second training component, semiliterate middle-aged women with established village residences were recruited from the same provinces and rural districts as the certified electricians were recruited (ADB, 2011a; Barefoot College, 2013). During their six month stay in Rajasthan, the women received in-depth trainings on all aspects of installing and servicing solar panels: from learning to how to fabricate different charge controllers and inverters, to installing solar panels and linking them to develop cycled batteries, as well as in connecting the cycled batteries to newly installed outlets for direct use (ADB, 2011a; Barefoot College, 2013). In addition to technical skills, the Barefoot College also equips women with basic entrepreneurial and business skills to ensure their work is sustainable, which promotes employment and poverty reduction. Once trained, the women became certified 'barefoot solar engineers' (BSEs) and in addition to committing to install solar panel units, they also committed to both maintain the systems for five years under a fee-for-service model, and to administer rural electric workshops in their respective villages (ADB, 2010, 2011a).

The Rural Electricians Training Program has widely been considered a success in Bhutan by its stakeholders. It has been reported that as a result of new solar installations and repair of pre-existing but non-working solar energy systems, 9,206 new rural consumers have been connected with electricity, a 15% increase from estimates at appraisal. As a testament to the proficiencies gained by trainees, average costs per connection and per repair were 11% lower than predicted (ADB, 2011a). These rural communities were able to gain access to electrical power more than 15 years earlier than if they had waited for connection to the national grid (ADB, 2011a).

In spite of these successes, the implementation of the Rural Electricians Training Program faced a handful of challenges. Poor monitoring and evaluation of the post-training outcomes hamper any systematic evaluation of the impact of trainings and business loans on individual workers. However, some barefoot engineers have reported difficulties in establishing and enforcing a standard fee for service, and as a result have been left unpaid for their teaching and maintenance work (ADB, 2011a).

Similar programs have been attempted in Sub-Saharan Africa as well. For example, in 2011, 11 women from Sierra Leone attended the Barefoot College and returned to set up their own Barefoot College in Konta Line village, Port Loko district, through financial support from the Sierra Leone Government and the Government of India. Their version of the Barefoot College trained up to 50 women over four month periods to install, maintain and repair solar panels. Graduates were integrated into the government's scaled-up rural electrification initiative (ADB, 2009, 2011a).

D. Institutional Reforms

As highlighted earlier in the paper, improvements in the institutional framework are a prerequisite for each of the above upgrading proposals. Expanding capabilities in the generation, transmission and distribution segments of the chain will necessitate transformations in the regulations supporting the energy sector, including legal reforms to allow independent power producers to sell energy onto the grid and the improved capacitation of REGIDESO and MEM, in order to improve their effectiveness. This section will outline the current trajectory of institutional reforms in Burundi's energy sector and highlight strategies for maximizing the effectiveness of current and ongoing efforts.

The sector-wide strategy announced by the IFC in November of 2013 (IFC, 2013) presents a promising framework for the coordination of private, public and donor strategies in the energy sector.[26] As the multi-stakeholder process at the heart of the sector-wide strategy takes shape, a number of crucial institutional reforms should be undertaken in the short-term in order to support the upgrading trajectories described in this section: 1) capacitation of REGIDESO; 2) legal reforms allowing for the formation of independent power providers; 3) creation of a master plan to coordinate ongoing upgrading initiatives.

---

[26] The institutionalization of a multi-stakeholder strategy to reforming and upgrading the energy sector appears consistent with the approach taken by Rwanda (see Box 6, p. 31), which was associated with a number of benefits including expanded access to electricity and improvements to the overall performance of the sector. As the public-private partnership framework is put into place over the coming months and years, stakeholders and policy-makers in Burundi should look to the experience of their neighbor in identifying possible challenges during the consolidation of a sector-wide strategy.

First, key public sector bodies, particularly REGIDESO, must become more effective players in the energy sector. Given REGIDESO's role as the sole transmission and distribution operator in the country to purchase and transmit energy within the country, strengthening the agency's organizational capabilities will be especially important to promoting any upgrading at all within the industry. The organization has been struggling for years with financial insolvency, owing to both the destruction wreaked by the conflict on its assets as well as a top-heavy organizational structure. Promotion and other HR policies should be reformed and mechanisms for skill development, such as training modules, should be more firmly instituted in order to consolidate job ladders and place a higher value on skill and performance within the organization. International partners can also play a role in building out REGIDESO's capabilities by assisting with planning, management and training activities. Capacitation of REGIDESO will support efforts to rehabilitate and expand the existing network, as most of this work will be performed either directly by REGIDESO or by outside companies sub-contracting with the organization. Supporting off-grid generating capabilities, on the other hand, will require similar efforts within ABER, which oversees rural electrification.

Second, MEM and REGIDESO, with the support of international donors, should work together to establish mechanisms enabling independent power providers to sell energy onto the grid. This will boost network supply both by allowing organizations with excess capacity, such as SOSUMO and TBC, to transfer electricity generated from bagasse-based generators and other renewable sources, and also by creating incentives for other actors to produce electricity for sale onto the grid. This regulatory overhaul will also be necessary to enable the implementation of plans to construct 10MW solar generators in Gitega and Bubanza. Given the financial constraints faced by REGIDESO, incentivizing private investment in generating capacity will be a critical step towards enabling the expansion of the transmission and distribution grid to new subscribers. A crucial component in crafting regulations allowing producers to sell energy onto the grid will be the establishment of an independent regulatory authority. The creation of such an agency has already been contemplated by the sectorial working group, though it remains unclear whether the necessary human resources are available within Burundi to staff it.

Third, Burundi's energy sector currently lacks a master plan (Hartvigsson 2010, IFC 2013). Though there exists a list of currently planned projects (Hakizimana, 2013), details regarding sequencing and implementation remain unclear. The newly announced multi-stakeholder framework should be leveraged to produce a planning document that can guide the rehabilitation and expansion of the existing network and promote rural electrification efforts. Developing a sectoral plan, including clear objectives, implementation strategies and performance measures will help to align the expectations of stakeholders and potential investors, and to avoid conflicts over how scarce resources are distributed among various upgrading trajectories. Given the importance of skill formation to Burundi's electrical sector, local universities, schools and vocational training organizations, should be brought in as stakeholders in the planning process.

VII. Skills for Upgrading Burundi's Participation in the Electricity Global Value Chain

In addition to making improvements in specific areas such as institutional capacity and access to finance, enhancing the workforce capacity in Burundi is an important, transversal precondition for upgrading the electricity sector. This section highlights the key new job profiles and improvements to existing job profiles that would be needed to support the upgrading initiatives outlined in Section VI. This is then followed by a brief discussion of strategies for building the skills required for each of these job profiles. This discussion draws on the country case studies presented earlier in the paper, successful initiatives that have already been implemented in the country, and additional best practices from other parts of the world.

A. Key Job Profiles Required for Upgrading

A better-prepared and skilled workforce is essential for developing new capabilities, using new technologies and ensuring safety protocols are adopted to support upgrading. Achieving the upgrading trajectories described in the previous section will require important changes to both existing job profiles as well as the creation of new positions within the Burundian electricity sector. Table 5 provides detailed information on the full set of job profiles that would be required to implement all three upgrading strategies. Those job profiles that are new to the country are highlighted in red, while job profiles that need to be improved upon and scaled up are highlighted in green. Other job profiles required are noted in black.

Table 5. Key Job Profiles to Support Upgrading in the Electricity Global Value Chain

Position	Formal Education Requirements	Training/ Experience	Skill Level
	Regulation		
NEW: Regulatory Analyst	Master's degree or higher	Training and experience	
Electrical Inspector	Bachelor's degree or higher	Training and experience	
	Generation		
Plant engineer	Bachelor's degree or higher	Training and experience	
Generation technician	Technical education	Training and experience	
Electrician	Technical education	Training and experience	
Plant operator	Literacy and numeracy skills	Experience	
	Off-Grid Generation		
NEW: Microhydro plant Entrepreneurs	Bachelor's degree or higher	Training and experience	
Microhydro installers & maintenance	Technical education	Training and experience	
INCREASE: Solar Entrepreneurs	Technical education	Training and experience	
INCREASE: Solar Panel Assembler	Technical education	Training and experience	
INCREASE: Solar PV Installer & Maintenance	Technical education	Training and experience	
Electrician	Technical education	Training and experience	
	Transmission		
Management/ planning	Master's degree or higher	Training and experience	
NEW: GIS Analysts	Technical education	Training and experience	
Electrical Engineer	Bachelor's degree or higher	Training and experience	
Transmission Engineer	Bachelor's degree or higher	Training and experience	
Systems Operator	Technical education	Training and experience	
INCREASE: Technician/ Line Operator	Technical education	Training and experience	
Manual Laborer	No formal education	Experience	

Distribution			
Management/Planning	Master's degree or higher	Training and experience	●
NEW: GIS Analysts	Technical education	Training and experience	◑
Electrical Engineer	Bachelor's degree or higher	Training and experience	◑
INCREASE: Distribution Technician	Technical education	Training and experience	◑
INCREASE: Power dispatcher	Technical education	Training and experience	◑
INCREASE: Electrician	Technical education	Training and experience	◑
Meter Reader	Literacy and numeracy skills; experience	Experience	◔
Customer Service Representative	Literacy and numeracy skills; experience	Experience	◔
Management			
Senior Manager	Master's degree or higher	Training and experience	●
Asset Manager	Bachelor's degree or higher	Training and experience	◕
New Project Manager	Bachelor's degree or higher	Training and experience	◕
Financial Manager	Bachelor's degree or higher	Training and experience	◕
NEW: Procurement Manager	Master's degree or higher	Training and experience	●
Middle Management	Bachelor's degree or higher	Training and experience	◕

Source: Duke CGGC, based on review of secondary literature and interviews and survey.

Skill Level	**Low** ○	**Low-Medium** ◔	**Medium** ◑	**Medium-High** ◕	**High** ●
	No formal education; experience	Literacy and numeracy skills; experience	Technical education/ certification	Technical education /undergraduate degree	University degree and higher

B. Required Workforce Development Initiatives for Upgrading

In order to further develop existing job profiles and successfully create the new job profiles in support of these upgrading initiatives, a large number of actions need to be undertaken as part of the country's new National Skills Development Plan. These workforce initiatives include short-term classroom-based learning, on-the-job training, certification programs, and professional degree programs, as well as the targeted hiring of foreign expertise. The following section provides recommendations regarding how training within these new and improved job profiles should be implemented so that it facilitates each stage of the upgrading process. Where appropriate, these recommendations may be highlighted as either short-medium or medium-long term; the former are to be implemented immediately to achieve results in the short-medium term, while the medium-long term initiatives also need to be implemented now but results focused in the longer term.

Prior to initiating these training programs, however, it is essential that the country improve the information available regarding existing qualified workers in the labor market. In addition, while there is information on the number of graduates at both the technical and university levels (see Tables 9 & 10 Appendix), similar information is not available for professional and vocational schools or for private technical schools. In addition, the stock of workers in the labor market with relevant skills (whether employed in the sector or not) is unknown. While the HR managers of firms in the sector suggest that they have no difficulty recruiting qualified staff, it is impossible to assess whether there already exists unemployed or underemployed workers in the labor market who can fill the positions that are required to support upgrading. If there are not, then training programs must be significantly expanded. For the purposes of this report, both possibilities are explored.

1. Rehabilitation of the Grid and Existing Generating Facilities

Key job profiles required to achieve upgrading at this level are:

GIS Analysts, Project Managers, Network Engineers and Technicians and Manual Labor

Identify key lines and develop planning strategy for rehabilitation: First, assessments need to be made and/or centralized regarding the existing state of different transmission and distribution lines in order to prioritize and plan the roll out of line rehabilitation. To facilitate planning, GIS systems like those used in the Rwanda SWAp program can be used. As this is a new system for Burundi, foreign experts will need to be engaged to carry out this analysis. While these can be recruited globally, there may be advantages to recruiting from Rwanda, where they have been implementing a similar approach. These experts can then be engaged to provide training on GIS systems for the eventual expansion of the transmission and distribution network.

Roll out first rehabilitation of transmission and distribution lines: Considering the extent of rehabilitation required, and based on the key lessons of Rwanda and Liberia's programs, strong project management is required. As REGIDESO's promotion policy has been based on seniority rather than performance, it would be reasonable to assume that additional project management training is required or that foreign expertise may need to be engaged as per the case in Liberia. This training initiative should focus on improved project design and planning as well as better identification of skills needs in the organization. Based on this needs assessment, a recruitment strategy should be developed to complement existing internal resources, at both the technical and engineering levels. According to interviewees, there should be sufficient availability of technical workers with A2 and A3 qualifications in the labor force. Nevertheless, implementing new technologies and standards may require further qualification, and so recruitment initiatives should be paired with complementary training.

Develop classroom and practical training program for technicians: In parallel, Burundi should develop a training program to brush up skills of existing workers and new recruits and to provide the latter with some practical experience. These skills include installing/repairing poles, wire and electrical equipment for both overhead and underground distribution and transmission systems, use of relevant hand tools and hydraulic equipment, maintenance of records and adherence to strict safety protocols, amongst others. This training program should be rolled out at the REGIDESO training center using the organization's experienced trainers, in combination with additional regional expertise as required. Local trainers could be sent to other countries such as Rwanda on short exchange visits to learn good practices for the implementation of this training. In the *medium-long term*, this training program needs to be devolved to the provincial training centers in key areas along the transmission lines. This will not only help to institutionalize knowledge transfers to new parts of the country, but will also ensure that technicians may be hired locally. This is important to overcome the current situation in which qualified workers not wanting to work outside Bujumbura. In addition to rehabilitation projects, these staff will be responsible for future maintenance of the lines, so instituting effective workforce development practices in this area will be important to the long-term performance of the industry.

Develop on-the-job training for engineers: Experienced local and foreign engineers should be hired to lead the rehabilitation of transmission lines and substations, and newly graduated and/or qualified engineers not already working in the sector should be placed within the team for on-the-job training. As seen at LEC in Liberia, embedding employees within experienced teams promotes rapid skills diffusion within the domestic workforce, helping to reduce long-term dependence on foreign expertise. With sufficient on-the-job training, experienced local engineers can master the practical skills and knowledge that will allow them to spearhead their own teams in the expansion of the grid. This same diffusion approach can be used for several other job profiles as well.

2. Expansion of the Transmission and Distribution Network

Key job profiles required to achieve upgrading at this level are:

Transmission: GIS Analysts, Project Managers, Network Engineers and Technicians and Manual Labor

Distribution: GIS Analysts, Project Managers, Electricians, Meter Readers, Network Engineers and Technicians and Manual Labor

While these job profiles overlap with those highlighted as essential for the rehabilitation-oriented upgrading strategy, it is important to note here that a large number of new recruits will likely be required to supplement the existing REGIDESO teams in the construction of new transmission infrastructure. In addition, this strategy is also likely to lead to an important increase in the number of homes and businesses seeking access to the grid, so workforce development will be required for job profiles associated with the service location segment of the chain. These homes and businesses will require certified electricians to correctly install electrical wires and connect them to the distribution systems, as well as an increased number of required meter readers to monitor usage at these locations. Finally, the expansion of the grid also contemplates improving the standard for long-distance transmission from 110kV to 220kV lines. Several other non-technical job categories also need to be trained in order to support an expanded grid. These include commercial staff such as customer service agents and meter readers. Effective training in these areas will help the sector to avoid non-technical losses due to theft and mismanagement. This section accordingly focuses on institutionalizing the training approaches suggested for short-medium term rehabilitation programs, with special consideration paid to the inclusion of new technologies.

Develop planning and management oversight: As with grid rehabilitation, adequate extension of the grid requires important design and implementation skills. In particular, it is essential to identify and assess key priorities for expanding lines into regions where they will have the maximum impact on job creation and revenue generation. In addition, planning needs to be coordinated with regional generation activities to facilitate the connection of the grid to key sources of electricity and be planned in such a way that they are ready at the appropriate intervals and do not cause unnecessary delays. In the *short-medium term*, foreign experts should be hired to facilitate the development of the plans and to work hand-in-hand with local employees to facilitate on-the-job training. These experts should also be engaged alongside Professors of Engineering and Business Management at the University of Burundi to provide customized training modules for key job profiles in asset management, middle management, financial management and customer service. As with the grid rehabilitation initiative, training in GIS systems will be important in *the long term*, not only for the electricity sector, but for other developmental activities, such as the improvement and planning of road infrastructure, health care clinics, education centers, etc. While in the short term, local employees can be sent abroad for training, a diploma in GIS technology at the University of Burundi would be an important contribution to the country's policy-making and planning capacities.

Improve skills of new and existing technical workers: It will also be necessary to increase the number technical workers qualified to work on grid expansions. These workers should possess both A2 or A3 qualifications as well as practical experience in the installation and maintenance of overhead and underground transmission and distribution lines at variable voltages (30kV, 110kV, and 220kV). These training programs should be established at the provincial technical centers through a gradual implementation scheme, beginning with centers in provinces that will be prioritized for grid expansion. This of course will require the centers to have access to electricity. Differences related to the voltages should be included as part of the training program. As there are currently no 220kV lines installed in the country, it may be necessary to train trainers abroad or hire foreign consultants to develop this part of the curriculum.

Information regarding hiring policies for the expansion of the grid should be disseminated at these regional centers to encourage youth to pursue careers in this area. As following strict protocols is important for a safe and reliable system, these programs should be combined with a certification process, so that REGIDESO, and any other new actors, can verify the exact training of individuals receive. Instituting a certification process will also be important for public sector personnel recruitment more generally.

Engaging engineering staff: Recruitment of a cadre of skilled civil and electrical (network) engineers will also be required to expand the reach of the grid. As mentioned above, one helpful strategy to rapidly engaging domestic engineering talent is to embed local engineers in teams led by foreign experts. At the same time, it is also desirable to develop training capacity internally within the country to meet medium-long term needs and develop stronger context-specific knowledge regarding the characteristics of Burundi's grid. Current engineering supply is limited to 22 graduates per year, which will likely fall short of both the expansion of the grid, and the staffing needs for the planned new generation plants. A short engineering diploma program at the University of Burundi and/or other universities in the country, combined with mechanisms to provide practical experience to any potential existing, underemployment engineers in the labor market would be a useful addition to the country's workforce development strategy.

Launch training and certification program for electricians: As the transmission and distribution infrastructure expands around the country, there will be a growing need for electricians to adequately and safely install electrical circuits into homes and businesses. As there is virtually no experience in this at the regional level, it will be essential to create not just a formal education and training program, but also a system that allows consumers to verify that the person installing their systems is trained to perform the task. Thereby giving further incentive for the development of a certification system. Even if technicians receive their instruction from third party trainers, they must be able to demonstrate their skills before an accredited board in order to receive certification. In the medium-long term, electricians can further specialize in commercial, industrial and residential operations.

Capacity strengthening for engaging in regional operations: As the grid is connected to other countries, the country will need to develop the skills of government and REGIDESO staff who will be engaged in planning and operational activities on a day-to-day basis. In addition to a solid technical understanding of how to operate shared generation and transmission infrastructure, these individuals will also need to have strong communication skills; including the ability to speak English. Field interviews indicated that Burundi's ability to participate in future regional power-sharing arrangements could be undermined by a lack of English-language skills among key planning and management staff at REGIDESO and MEM. Since Burundi's ability to meet demand in the short-medium term depends on regional support, it will be important to develop the necessary capacities to allow the relevant staff to effectively interface with their foreign partners.

3. Support for the Development of Off-grid Generating Capacity

Key job profiles required to achieve upgrading at this level are:

Entrepreneurs, System Installers and Maintenance Staff and Electricians

Identify key technologies that will be promoted: The first step in developing training programs to support this upgrading trajectory is to identify and isolate the key technologies that will be promoted. This report recommends two key foci: micro-hydropower and PV solar panel operations.

Short-medium term – develop a training curriculum in off-grid technologies for technical training centers: Using off-grid technologies to scale-up electricity access in rural areas will require the creation of training and certification of potentially hundreds of solar PV and micro-hydro installers and electricians. Burundi should develop certification programs through the technical education centers (or a new solar technical institute should it be established) in order to train staff for the promotion, installation and maintenance of these systems. The experience of both Bhutan and Sierra Leone indicate that training programs can be well adapted for semi-literate men and women, making this a particularly promising strategy for job creation in rural Burundi, where literacy levels are generally low. Since several installation and maintenance workers are likely to work as independent contractors rather than as employees of a firm, their preparation will require not only technical training but also entrepreneurial skills (and access to finance) at both the service provision level and the procurement level of individuals aiming to import/manufacture and sell these systems. Relevant entrepreneurial skills include basic arithmetic, accounting procedures, financial management and marketing skills. The Bhutan example illustrates complementing technical training with entrepreneurial training is required to generate sufficient demand to ensure that employment in these positions is productive.

One promising route to developing a training program which provides the right packages of skills to workers could be to leverage private companies already supplying solar systems in Burundi to co-develop curricula with the technical training centers. Again due to safety issues, any individual involved in the installation and maintenance of these electrical systems must be certified. Certification could be managed by the new Centre de Development des Competences Techniques et Professionels (CTP), the workforce development agency established to monitor standards and application in technical education system, as part of the quality assurance infrastructure now that Burundi is a member of the EAC.

Medium-long term – develop engineering competencies in renewable energy technologies: In the longer term, Burundian universities should develop a module on new energy technologies (solar, micro-hydro systems and bagasse systems) to be taught as part of the electrical engineering program. This module should be uniquely tailored to the technologies and challenges that are most relevant to the local context, where hydroelectric and off-grid solar solutions play a more prominent role than in most other parts of the world. Furthermore, while large numbers of installers, electricians and maintenance workers will be required to implement off-grid generation solutions, developing engineers competent in the intricacies of new technologies is a necessary step to ensure trainings and procurement strategies remain consistent with the most efficient and up-to-date technologies. Finally, as the grid expands into rural communities in coming years, engineering talent will be required to integrate small-scale, distributed generators with the broader transmission network.

Upgrading these capabilities in the electricity chain will depend on coherent and collaborative strategies and programs by the government, educational institutions, international development agencies as well as the private sector. Drawing on the lessons of the Rwanda SWAp approach, a multi-stakeholder initiative, with strong government ownership of these initiatives is recommended. A skills development initiative should be featured prominently within this sector-wide framework. This initiative can be developed through a skills development task force in the existing Sector Working Group on Energy. This group is led by MEM and comprised of the key domestic stakeholders in the chain, REGIDESO and ABER, receives strong technical and financial support from the country's numerous development partners. Other key stakeholders, including educational institutions and private sector suppliers of solar panels should be invited to participate in this forum.

VIII. Bibliography

ADA. (2010). Bhutan Country Strategy 2010–2013. Vienna: Austrian Development Agency. http://www.entwicklung.at/uploads/media/CS_Bhutan_2010-2013_July2011_01.pdf.

ADB. (2009). Powering the Poor: Projects to Increase Access to Clean Energy for All. Mandaluyong City: Asian Development Bank. http://www.adb.org/publications/powering-poor-projects-increase-access-clean-energy-all.

---. (2010). Bhutan: Energy Sector Evaluation Study. Mandaluyong City: Asian Development Bank. http://www.adb.org/documents/sector-assistance-program-evaluation-bhutan-energy-sector.

---. (2011a). Gender Equality Results - Case Studies: Bhutan. Mandaluyong City: Asian Development Bank. http://www.adb.org/publications/gender-equality-results-case-studies-bhutan.

---. (2011b). Powering the Poor: Projects to Increase Access to Clean Energy for All. Manila: Asian Development Bank. http://www.adb.org/sites/default/files/Powering-the-Poor.pdf.

AfDB. (2013). "AfDB Board commits US $113 million to Regional Rusumo Falls Hydropower Project - African Development Bank."

African Development Bank. (2011). Burundi Country Strategy Paper 2012-2016. Tunis: African Development Bank

AFTEG. (2011). Options for the Development of Liberia's Energy Sector. Washington, DC: World Bank Group. http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1266613906108/Liberia_Energy_ESW_11-4-11web.pdf.

Amadou, Abou. (2013). Burundi Field Research: African Development Bank. Personal communication with P. Bamber & G. Muhimpundu. August/September

Amar, Amarquaye, Ramon Lopez-Rivera, COLENCO Power Engineering, NIRAS Consluting Engineers and Planners, Nord Pool Consulting, and R. Gopalkrishnan. (2005). Building Regional Power Pools: A Toolkit. Washington, DC: The World Bank Group. http://siteresources.worldbank.org/EXTENERGY2/Resources/toolkit_book_final.pdf.

Ba, Aissatou. (2014). Burundi Field Research: Energy Sector. Energy Expert. Personal communication with A. G. P. Bamber. February.

Bacon, R. W. and J. Besant-Jones. (2001). "Global Electric Power Reform, Privatization, and Liberalization of the Electric Power Industry in Developing Countries." *Annual Review of Energy and the Environment, 26*: 331-359.

Bamber, Penny, Karina Fernandez-Stark, Andrew Guinn, and Gary Gereffi. (2013). Improving Competitiveness in Developing Countries in Regional and Global Value Chains. Working Paper: Duke CGGC.

Banyankimbona, Gaspard. (2013). Burundi Field Research: Ministry of Higher Education. Personal communication with P. Bamber, A. Abdulsamad, G. Muhimpundu & R. Costa. August/September.

Barampanze, Pierre. (2012). Presentation on Burundi Energy Sector and investment priorities projects. Norway. March 8, 2012.

Barankiriza, Nahum. (2013). Burundi Field Research: Energy Sector. Tanganyika Business Company Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpundu. August/September

Barefoot College. (2013). Our Solutions. Retrieved November 20, 2013, from http://www.barefootcollege.org/solutions/solar-solutions/.

Baruvura, Augustin. (2013). "Presentation sur la production, le transport et la distribution de l'electricite". Paper presented at the Conference Sectorielle des Partenaires du Burundi au Developpement. Bujumbura. Octobre, 2013.

Brilot, Roland. (2013). Burundi Field Research: Energy Sector. Energy Expert. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpindu. August/September

Bucumi, Donatien. (2013). Burundi Field Research: Energy Sector. REGIDESO. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpundu. August/September

Castalia. (2009). Rwanda Electricity Sector Access Programme: Investment Prospectus: Castalia Advisory Group. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Prospectus0for1cty0Access0Programme.pdf .

Chancelier, Luc. (2013). Etude diagnostique du secteur de l'Energie au Burundi dans le cadre de lÍnitiative du Secrétaire Général des Nations Unies sur I'Energie durable pour tous Bujumbura: Ministere de l'Energie et des Mines. Réalisé avec le soutien du PNUD. Juin 2013.

Chineke, Theo Chidiezie and Fabian M. Ezike. (2010). "Political will and collaboration for electric power reform through renewable energy in Africa." *Energy Policy, 38*(1): 678-684.

Diaz, Maria. (2013). Human Resources Manager, HydroChile. Personal communication with P. Bamber. August

Edison Electric Institute. (2001). Getting Electricity Where It's Needed: Electric Transmission Systems: Making the Vital Link to Consumers. Washington, D.C.: Edison Electric Institute. http://www.atcllc.com/wp-content/uploads/2011/06/GettingElectricity.pdf.

ESMAP. (2012). Rwanda: Extending Access to Energy, Lessons from a Sector-Wide Approach (SWAp). Washington, DC. http://www.esmap.org/sites/esmap.org/files/ESMAP_Energy_Access_RwandaSWAp_KS013-12_Optimized.pdf.

EUEI. (2011). Energy Strategy and Action Plan for Burundi. Eschborn, Germany: European Union Energy Initiative.

European Union Africa Infrastructure Trust Fund. (2013). Ruzizi Hydropower Retrieved November, 2013, from http://www.eu-africa-infrastructure-tf.net/activities/grants/ruzizi.htm.

EWSA. (2011). Electricity Access Rollout Programme. Kigali: Energy Water and Sanitation Authority. http://www.ewsa.rw/Docs/EMP%20RUKARARA%20-%20KILINDA%20for%20DISCLOSURE.pdf.

Export-Import Bank of India. (2011). Press Releases--Exim Bank Extends A USD 80 Million Line Of Credit To The Government Of The Republic Of Burundi For Financing The Kabu Hydro Electric Project In Burundi Retrieved July 24, 2013, from http://www.eximbankindia.com/press260511.asp.

Fernandez-Stark, Karina, Penny Bamber and Gary Gereffi. (2010). Engineering Services in the Americas. Durham: Center on Globalization, Governance & Competitiveness.

Field Research. (2013). Burundi Field Research. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpindu. August/September

Foley, A. M., B.P. O Gallachoir, J. Hur, R. Baldick, and E.J McKeogh. (2010). "A strategic review of electricity systems models." *Energy, 35*(12): 4522–4530.

The EAPP Master Plan and renewable power options, (2013).

Gereffi, Gary. (1999). "International Trade and Industrial Upgrading in the Apparel Commodity Chain." *Journal of International Economics, 48*(1): 37-70.

Gereffi, Gary and Karina Fernandez-Stark. (2011). Global Value Chain Analysis: A Primer. Durham, North Carolina, USA: Center on Globalization, Governance & Competitiveness (CGGC) Duke University. http://www.cggc.duke.edu/pdfs/2011-05-31_GVC_analysis_a_primer.pdf

Gereffi, Gary, Karina Fernandez-Stark and Phil Psilos. (2011). *Skills for Upgrading: Workforce Development and Global Value Chains in Developing Countries*. Durham: Duke University Center on Globalization Governance & Competitiveness.

Gereffi, Gary, John Humphrey and Timothy Sturgeon. (2005). "The Governance of Global Value Chains." *Review of International Political Economy*: 78-104.

Ghosh, Soham. (2012). "Loss Reduction and Efficiency Improvement: A Critical Appraisal of Power Distribution Sector in India." *International Journal of Modern Engineering Research, 2*(5): 3292-3297.

Groupe Sectoriel Energie. (2013). Compte Rendu de la 10éme Reunion du Groupe Sectoriel Energie. Bujumbura.

GTDSE. (2013). "Rapport du Groupe Thematique 'Developpement eu Secteur Energetique'". Paper presented at the Conference Sectorielle pour le Suivi des Engagements de la Conference de Geneve. Bujumbura. 28-30 October, 2013.

Guerrero, J.M., F. Blaabjerg, T. Zhelev, and K. Hemmes. (2010). "Distributed Generation: Toward a New Energy Paradigm." *Industrial Electronics Magazine, 4*(1).

Hakizimana, Godefroy. (2008). EAC Strategy to Scale-Up Access to Modern Energy Services: Burundi Baseline Report and Workplan. Arusha, Tanzania: East African Community.

Hakizimana, Godefroy. (2009). Country Chapter: Burundi. In D. Kraft (Ed.), *Renewable Energies in East Africa* (pp. 12-26). Eschborn, Germany: Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ).

Hakizimana, Godefroy. (2013). "Presentation des Besoins d'Investissement dans le Secteur de l'Energie et d'Appui Financier Disponble et a Rechercher". Paper presented at the Conference Sectorielle des Partenaires du Burundi au Developpement. Bujumbura. October 29, 2013.

Hao, Shangyou and A. Papalexopoulos. (2002). "Reactive power pricing and management." *IEEE Transactions on Power Systems, 12*(1): 95-104.

Hartvigsson, Elias. (2012). *Technical and economical evaluation of hydropower grid connection in Burundi.* Chalmers University of Technology, Gothenburg.

Humphrey, John and Hubert Schmitz. (2002). "How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters?". *Regional Studies, 36*(9): 1017-1027.

IEA/MME. (2012). Technology Roadmap: Hydropower. Paris: International Energy Agency and Ministry of Mines and Energy, Brazil.

IFC. (2013). Liberia: Liberia Electricity Corp. Washington, DC: International Finance Corporation. http://www.ifc.org/wps/wcm/connect/f0089d80498390df8324d3336b93d75f/SuccessStories_LiberiaElectricityCorporation.pdf?MOD=AJPERES.

IMF. (2011a). "Burundi: Poverty Reduction Strategy Paper—Progress Report."

---. (2011b). Burundi: Poverty Reduction Strategy Paper -- Progress Report. Washington, DC: International Monetary Fund.

---. (2012a). Burundi: Poverty Reduction Strategy Paper II (No. 12/224). Washington, D.C.: International Monetary Fund. http://www.imf.org/external/pubs/ft/scr/2012/cr12224.pdf.

---. (2012b). "Burundi: Poverty Reduction Strategy Paper II."

IVANPAH. (2013). What if we could deliver on Solar's Promise? Retrieved November, 2013, from http://ivanpahsolar.com/.

Joskow, Paul L. (Forthcoming). Incentive Regulation in Theory and Practice: Electricity Distribution and Transmission Networks. In N. Rose (Ed.), *Economic Regulation and Its Reform* Chicago: University of Chicago Press.

Kaderjak, Peter. (2008). Unbundling Vs. Vertical Integration in the Electricity Sector. Pristina, Kosovo: Regional Centre for Energy Policy Research. http://www.naruc.org/international/Documents/Vertical%20integration%20and%20unbundling%20in%20electricity%20sector_Kaderjak2_eng.pdf.

Karuretwa, Kaliza. (2013). Burundi Field Research: International Finance Corporation. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpundu. August/September

Kaygusuz, Kamil. (2012). "Energy for sustainable development: A case of developing countries." *Renewable and Sustainable Energy Reviews, 16*(2): 1116-1126.

LEC. (2013). Vacancy Announcements: Engineers in Training. In L. E. C. M. C. P. I. Unit (Ed.). Monrovia.

Lonsway, Kurt, Uche Duru and Noel Kulemeka. (2013). Environmental and Social Impact Assessment Study, Rusumo Hydro Power Plant: Transmission Lines Component: African Development Bank. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/Multinational%20-%20Rusumo%20Hydro%20Power%20Plant-%20Transmission%20Lines%20Component%20-%20ESIA%20Summary.pdf.

Lopes, J. A. Peças, N. Hatziargyriou, J. Mutale, P. Djapic, and N. Jenkins. (2007). "Integrating distributed generation into electric power systems: A review of drivers, challenges and opportunities." *Electric Power Systems Research, 77*(9): 1189-1203.

Mazars. (2013). Audit organisationnel de la Réie de Production et de Distribution d´Eau et d´Electricité (REGIDESO). Senegal: Mazar. Juin 2013.

MEBSEMFPA. (2012). Politique Nationale de l'Enseignement Technique, de l'Enseignement des Metiers et de la Formation Professionnelle. Bujumbura: Ministère de l'Enseignement de Base et Secondaire, de l'Enseignement des Métiers, de la Formation Professionnelle et de l'Alphabétisation.

MEM. (2012). Investment Opportunities in Renewable Energy: Burundi. Bujumbura: Ministry of Energy and Mines. http://www.eac.int/energy/index.php?option=com_docman&task=doc_download&gid=63&Itemid=70.

---. (2013a). "Energies Renouvelable au Burundi: Realisations, defis et opportunites". Paper presented at the Conference Sectorielle Energie. October, 2013.

---. (2013b). Note Conceptuelle en vue de la preparation de la conference sectorielle de l'enegie. Bujumbura: Ministere de l'Energie et des Mines. Octubre 2013.

MESRS. (2013). Statistiques du Secteur Educatif Burundais. Bujumbura: Ministere de l'Enseignement Superieur et de la Recherche Scientifique, Cellule de la Planification et des statistiques Octubre 2013.

Minister of Energy and Mines. (2012). Investment Opportunities in Renewable Energy Burundi. Bujumbura. October 2012.

Minister of Energy and Mines The Republic of Burundi. (2011). Investment opportunities in Renewable Energy Burundi.

Ministry of Energy and Mines. (2013). Note Conceptuelle en vue de la preparation de la conference sectorielle de l'enegie, Bujumbura, Octubre 2013. Bujumbura: Ministry of Energy and Mines.

Moner-Girona, S. Szabó, K. Bódis and T. Huld. (2011). "Energy solutions in rural Africa: mapping electrification costs of distributed solar and diesel generation versus grid extension." [Text]. *Environmental Research Letters, 6*(3).

Morrison, Andrea, Carlo Pietrobelli and Roberta Rabellotti. (2008). "Global Value Chains and Technological Capabilities: A Framework to Study Learning and Innovation in Developing Countries." *Oxford Development Studies, 36*(1): 39-58.

Mutabazi, Callixtes. (2013). Burundi Field Research: General. Interbank. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpindu. August/September

Negatu, G., H. Cheikhrouhou, E. Negash, and A. Wubeshet. (2013). Appraisial Report: Scaling Up Energy Access Project, Rwanda: African Development Bank, ONEC Department. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Rwanda%20-%20Scaling%20Up%20Energy%20Access%20Project%20-%20Appraisal%20Report.pdf.

Nkengurutse, Christian. (2013). Burundi Field Research: Federal Chamber of Commerce and Industry of Burundi. Personal communication with P. Bamber, A. Abdulsamad, G. Muhimpundu & R. Costa. August/September

Nshimirimana, Pascal. (2013). Burundi Field Research: Ministry of Basic and Secondary Education, Trades, Vocational Training and Literacy Personal communication with P. Bamber, A. Abdulsamad, G. Muhimpundu & R. Costa. August/September

OECD/IEA. (2013). Renewable Energy Medium-Term Market Report 2013: Market Trends and Projections to 2018. Paris: Organisation for Economic Cooperation and Development and Intenrational Energy Agency.

Ramirez, Paulina and Helen Rainbird. (2010). "Making the connections: bringing skill formation into global value chain analysis." *Work, Employment & Society, 24*(4): 699-710.

REGIDESO. (2013). Register de Poste Au 20/06/2013. Bujumbura: REGIDESO. 20 July 2013.

Republic of Liberia. (2009). National Energy Policy: An Agenda for Action and Economic and Social Development. Monrovia: Ministry of Land, Mines and Energy. www.norad.no/en/_attachment/133706/binary/61907?download=true.

RSWI-Fichtner JV. (2011). Nile Basin Initiative Regional Power Trade Project: Comprehensive Basin-wide Study of Power Development Options and Trade Opportunities: RSWI/Fichtner JV, with the participation of Parsons Brinkerhoff. November.

SETIS. (2013). European Industrial Initiative on Solar Energy - Concentrating Solar Power. Retrieved November, 2013, from http://setis.ec.europa.eu/implementation/technology-roadmap/european-industrial-initiative-on-solar-energy-2013-concentrating-solar-power.

Shaw, Rita, Mike Attree and Tim Jackson. (2010). "Developing electricity distribution networks and their regulation to support sustainable energy." *38*(10): 5927–5937.

Sims, Ralph E.H. (2003). "Carbon emission and mitigation cost comparisons between fossil fuel, nuclear and renewable energy resources for electricity generation." *31*(13): 1315–1326.

SNC Lavalin. (2011). Eastern Africa Power Pool and East African Comunity: Regional Power System Master Plan and Grid Code Study. Quebec: SNC Lavalin Inc and Parsons Brinckerhoff. http://www.eappool.org/eng/pub/masterplan/Final%20Master%20Plan%20Report%20Vol%20I.pdf.

SNC Lavalin International Inc and Parsons Brinkerhoff. (2011). Eastern Africa Power Pool (EAPP) and East African Community (EAC)-Regional Power System Master Plan and Grid Code Study-Final Master Plan Report Volume I.

SOSUMO. (2013). Register de Poste Au Julio 2013. Bujumbura: SOSUMO. 20 July 2013.

Universite du Burundi. (2013). Annuaires Statistiques 2010-2011 et 2011-2012. Bujumbura.

USAID. (2013a). Engaging the Private Sector in Liberia's Electricity Future. Washington, DC: United States Agency for International Development.

---. (2013b). Mid-term Evaluation of the Liberian Energy Sector Support Program. Washington, DC: United States Agency for International Development. http://pdf.usaid.gov/pdf_docs/pdacu973.pdf.

Viiding, Marko and Arne Tostensen. (2013). Forward Looking Review of the Regional Strategy on Scaling Up Access to Modern Energy Service in the East African Community: NORPLAN. http://www.cmi.no/publications/file/4866-forward-looking-review-of-the-regional-strategy-on.pdf.

Vrijlandt, Anthe. (2013). Burundi Field Research: Energy Sector. Trademark East Africa. Personal communication with P. Bamber, A. Abdulsamad & G. Muhimpindu. August/September

WEF. (2013). Energy Vision 2013: Energy transitions: Past and Future. Geneva: World Economic Forum. http://www.weforum.org/reports/energy-vision-2013-energy-transitions-past-and-future.

EAC Regional Strategy for Scaling Up Access to Modern Energy Services & Biofuels in East Africa, (2013).

WHO. (2013). Indoor Air Polution, Health and the Burden of Disease. Retrieved November 30, 2013, from http://www.who.int/indoorair/info/briefing2.pdf.

World Bank. (2013a). Burundi - Multisectoral Water and Electricity Infrastructure Project: PO97974 - Implementation Status Results Report: Sequence 11. Washington, D.C.: World Bank. http://documents.worldbank.org/curated/en/2013/06/17810282/burundi-multisectoral-water-electricity-infrastructure-project-p097974-implementation-status-results-report-sequence-11.

World Bank. (2013b). Doing Business 2013 Burundi. Washington, D.C.: The World Bank

World Bank. (2013c). Getting Electricity in Burundi - Doing Business. from http://www.doingbusiness.org/data/exploreeconomies/burundi/getting-electricity.

World Bank. (2013d). Toward a Sustainable Energy Future for All: Directions for the world Bank Group's Energy Sector. Washington, DC: The World Bank Group. http://www.worldbank.org/content/dam/Worldbank/document/SDN/energy-2013-0281-2.pdf.

IX. Appendix

Table 6. Existing Power Generation Plants, November 2012

Hydroelectric plants	Operator	Initiated Operations	Total installed capacity (MW)	Energy production (GWh/year)
Rwegura	REGIDESO	1986	18	55,2
Mugere	REGIDESO	1982	8	45,04
Ruvyironza	REGIDESO	1980-1984	1,5	5,02
Gikonge	REGIDESO	1982	1	4,24
Nyemanga	REGIDESO	1988	2.88	11,10
Marangara	REGIDESO	1986	0,25	1,17
Kayenzi	REGIDESO	1984	0,85	1,53
Buhiga	REGIDESO		**0.24**	
Total Hydro Generation			**30,113**	**123,33**
Existing thermal plant, Bujumbura	REGIDESO	1997	5,5	8,674
Thermal plant for rent	INTERPETROL	April 2013	10	NA
Emergency thermal plant	REGIDESO	2013	5	NA
Total Thermal Generation			**20,5**	

Source: (Chancelier, 2013; Minister of Energy and Mines, 2012; Ministry of Energy and Mines, 2013).

Table 7. Estimated Changes in Urban and Rural Population Size, 2005-2025

	2005	2010	2015	2020	2025
Population (million)	7.562	8.403	9.401	10.379	11.459
Growth rate	-	2.3 %	2.1 %	2,0 %	2,0 %
Urban population (million)	0.756	1.111	1.709	2.753	4.434
Growth rate (%)	-	8,0	9,0	10,0	11,0
Rural population (million)	6.806	7.292	7.692	7.626	7.026
Rate of urbanization	10 %	13.1 %	18.2 %	26.5 %	38.7 %

Source : Vision Burundi 2025 taken from (Ministry of Energy and Mines, 2013)

Table 8. Tariff Structure, 2013

	Tariff (BIF/kWh)	Monthly Fee (BIF)	Real Tariff (BIF/kWh)	Tariff (USD/kWh)	Real Tariff (USD/kWh)
BT residential class 1 (<100 kWh/month)	73	0	86	0,046	0,054
BT residential class 2 (100-300 kWh/month)	138	0	163	0,086	0,102
BT residential class 3 (>300 kWh/month)	260	6497	312	0,163	0,195
BT commercial class 1 (<300 kWh/month)	93	3989	138	0,058	0,086
BT commercial class 2 (300-1000 kWh/month)	149	8000	193	0,093	0,120
BT commercial class 3 (>1000 kWh/month)	190	12000	234	0,119	0,146
Administration	149	0	149	0,093	0,093
Public Lighting	151	0	151	0,094	0,094
Rural	141	0	141	0,088	0,088

Source: REGIDESO

Table 9. Universities and Technical Schools Supplying Skills to the Energy Sector

Level	Organization	Programs	Certification/ Degree	Number of Graduates, 2012	Location
University	Universite de Burundi, Faculte des Sciences de l'Ingenieur	Civil engineering	Civil engineer	14	Bujumbura
University	Universite de Burundi, Faculte des Sciences de l'Ingenieur	Electrical engineering	Civil engineer	8	Bujumbura
University	Initelematique	IT and telecommunications engineering	Industrial engineer	27	Bujumbura
University	Ecole Normale Superieure	Civil engineering	Teaching diploma	43	Bujumbura
University	Ecole Normale Superieure	Electrical engineering	Teaching diploma	47	Bujumbura
University	Ecole Normale Superieure	Mechanical and electromechanical engineering	Teaching diploma	9	Bujumbura
University	Institut Superieur des Tecnologies	IT	Diploma	27	Bujumbura
University	Universite Espoir d'Afrique	IT	Diploma	13	Bujumbura
University	Universite du Grands Lacs	IT	Diploma	48	Bururi
University	Universite de Ngozi	IT	Industrial engineer	19	Ngozi
Technical	ETS Kamenge	Industrial electricity	A2/A3	82	Gihosa, Bujumbura
Technical	ETS Kamenge	Electromechanics 1	A2	90	Gihosa, Bujumbura
Technical	ETS Kamenge	Electromechanics 2	A2	82	Gihosa, Bujumbura
Technical	ETS Kamenge	Electronics	A2	68	Gihosa, Bujumbura
Technical	ETS Kamenge	IT operations	A2	53	Gihosa, Bujumbura
Technical	ETS Kamenge	Mechanics	A2/A3	107	Gihosa, Bujumbura
Technical	LTAR de Ngozi	Electromechanics	A2	23	Ngosi, Ngosi
Technical	LTAR de Ngozi	Electronics	A2	16	Ngosi, Ngosi
Technical	LTAR de Ngozi	IT maintenance	A2	19	Ngosi, Ngosi
Technical	LTC Ruyigi	Electromechanics	A2	8	Ruyigi, Ruyigi
Technical	LT Nyanza-Lac	Electromechanics	A2	18	Nyanza-Lac, Makamba
Technical	LT Nyanza-Lac	Industrial electricity	A2/A3	18	Nyanza-Lac, Makamba
Technical	ETM Nyabigina	Electricity	A2	13	Makamba, Makamba
Technical	LTC de Rugombo	Electronics	A2	6	Rugombo, Cibitoke
Technical	LTC de Rugombo	Industrial electricity	A2	5	Rugombo, Cibitoke

Technical	ETP	Project management	A2	26	Gitega, Gitega
Technical	LT Nyakarambo	Electronics	A2	18	Ryansoro, Gitega
Technical	LT Maramvya	IT management	A2	26	Gatara, Kayanza
Technical	ETS Kiryama	Industrial electricity	A2	21	Songa, Bururi
Technical	ETS Kiryama	Electromechanics	A2	31	Songa, Bururi
Technical	ETS Kiryama	Industrial electricity	A3	12	Songa, Bururi
Technical	LT Kiremba-Sud	Electronics	A3	23	Bururi, Bururi
Technical	LT Kiremba-Sud	Industrial electricity	A2/A3	39	Bururi, Bururi
Technical	LT Kiremba-Sud	Project management	A2	24	Bururi, Bururi
Technical	ET Bubanza	Project management	A2	45	Bubanza, Bubanza
Technical	ET Bubanza	Industrial electricity	A2	66	Bubanza, Bubanza
Technical	ET Bubanza	Industrial electricity	A3	19	Bubanza, Bubanza
Technical	ET Bubanza	Mechanics	A2/A3	18	Bubanza, Bubanza

Source: (MEBSEMFPA, 2012; MESRS, 2013; Universite du Burundi, 2013)

Table 10. Other Schools Supplying Skills to the Energy Sector

Type of School	Program	# Schools	Locations
Private Technical	Electronics	2	Bujumbura
Private Technical	Industrial Electricity	6	Bujumbura (5), Bururi (1)
Private Technical	Electromechanics	6	Bujumbura
Private Technical	Project Management	3	Bujumbura (1), Gitega (2)
Public Professional	Electricity	2	Bururi
Public Professional	Plumbing	1	Bujumbura
Private Professional	Industrial Electricity	1	Bujumbura
Vocational	Welding	5	Bubanza (1), Bujumbura (1), Bururi (1), Gitega (1), Ruyigi (1)
Vocational	Plumbing	5	Bubanza (1), Bujumbura (1), Bururi (2), Gitega (1)
Vocational	Plumbing	1	Bujumbura
Vocational	Plumbing	2	Bururi
Vocational	Plumbing	1	Gitega
Vocational	Electricity	1	Bubanza (1), Bururi (1)

Source: (MEBSEMFPA, 2012)

Table 11. Interviewees, August/September 2013 and January/February 2014

Contact Person	Organization
Abou Amadou	African Development Bank
Frederic Bangirinama	Ecole Normale Supérieure
Gaspard Banyankimbona	Ministry of Higher Education
Nahum Barankiriza	Tanganyika Business Company
Roland Brilot	Consultant to the Ministry of Energy and Minies
Donatien Bucumi	REGIDESO
Dan Clay	Michigan State University
Celine Demagny	UNICEF
Kimba Dodo, Prosper Kiyayila Ntema and 2 staff	Association pour la Promotion de l'Education et de la Formation à l'Etranger
Frederic Gahungu	University of Burundi Planification et Statistique
Godefroy Hakizimana	Ministry of Energy and Mines
Sylvie Hatungimana	National Commission of Higher Education
Kaliza Karuretwa	International Financial Corporation
Rama Kant Pandey	Palm Oil Processing Company (SAVONOR)
Theodore Kwigize	Association Burundaise des Energies Renouvelables (ABER)
Kaat Matthys	Embassy of Belgium
Immaculee Mpeberane	Ministry of Eastern African Community
Calixte Mutabazi	Interbank
Reema Ndayishimiye and technical staff	Ministry of Basic and Vocational Education
Christian Nkengurutse	Federal Chamber of Commerce & Industry
Canisius Ntahe	Brarudi
Esaie Ntidendereza	Burundi Investment Promotion Agency

Audace Ntisumbwa	REGIDESO
Leonard Ntirwonza and three technical staff	Agence Burundais pour la Electrification Rural (ABER)
Pascal Nshimirimana and technical staff	Ministry of Basic and Vocational Education
Nyandwi Venant	University of Burundi – Ministry Campus
Jan Vlaar	Netherlands Embassy
Anthe Vrijlandt	Trade Mark East Africa
Director Academique	Institut Superieure de Developpement
Director General	Ministry of Industry
Human Resources Director	SOSUMO
Head of Solar	ITCO
Technical Director, General Director	ETS Kamenge