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Brain Drain in the Energy Sector in Rwanda

A case study of how the energy sector in Rwanda is not affected by a brain, but
rather of a skills gap

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Brain drain in the energy sector in Rwanda: “A case study of how the energy sector in Rwanda is not affected by brain drain, but rather of a skills gap”

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ABSTRACT

This thesis aims to explain how the energy sector in Rwanda is affected by brain drain, what causes brain drain and how to overcome brain drain. The main purpose of the study was to investigate how brain drain could affect a new setting, in other words the energy sector in Rwanda, as previous studies within the field have mainly focused on the health care sector in other countries in Africa.

To conduct the research, a case study has been used, with semi-structured interviews to collect the data. The empirical findings show that the energy sector in Rwanda is rather affected by a skills gap rather than a brain drain. The skills gap creates a mismatch in the workforce supply-demand and has its roots in the poor education standard. Furthermore, the findings indicate that the energy sector is crucial for the economic growth of the country and requires innovation and high expertise for further development, which is hard to find due to the lack of skills. In the context of the energy sector in Rwanda, we have come to the conclusion that the departure of executives and university graduates to other countries is more of a brain gain, than of a brain drain. This sector in particular, can benefit from more skilled workers, as sending them abroad to gain more knowledge, experience and contacts can be beneficial in the long run.

KEYWORDS: brain drain, energy sector, Rwanda, Africa, brain gain, skills gap, workforce migration, human capital



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1. INTRODUCTION

The increased globalization and highly advanced information technology have led to many of the shifts that take part of the daily life in the 21st century. The opening up for international borders has facilitated trade of goods and labor, which today can be seen as the key strategy in the current liberal global economy we are living in (Dodani and LaPorte, 2005; Stillwell et. al, 2004). In most of the current literature, these movements are discussed as a positive effect on the continuing welfare development. However, many of the scholars that study the migration of skilled workers argue for a highly political issue, namely brain drain (Dodani and LaPorte, 2005, Meyer, 2001). The problem with brain drain first emerged in the 1940s, when many professionals emigrated to the UK and North America from Europe and this loss of skilled labor consisting of mainly scientists and technologists, caused a major public concern in the countries of origin (Dodani and LaPorte, 2005, Mejia, 1981). The definition of brain drain is said to have been coined during these post-war events (Cervantes and Guellec, 2002), even though there are several definitions today, one of the commonly used is “the departure of educated or professional people from one country, economic sector, or field for another, usually for better pay or living conditions” (Merriam-Webster, 2015). Dodani and LaPorte (2005) state that this problem can be overcome by connecting highly educated/professionals and opportunities in research, to retain and attract regional talent. In fast growing developing countries like Rwanda, brain drain has become one of the major concerns for the continuing growth of the economy (Commander, Kangasniemi & Winters, 2004; Docquier and Rapoport, 2004; Beine et al. 2001, 2006; Docquier, Lohest & Marfouk, 2007). Even though Rwanda is a country that is still highly linked to its dark past of the genocide in 1994, it has managed to recover from a destroyed infrastructure and a shaken economy and now has a high growth rate, rapid poverty reduction and real GDP growth, averaged at about 8% per annum during the last decade, which lays a good foundation for a bright future. (Worldbank, 2015; Sida, b., 2014). According to Saravia & Miranda (2004), one of the core components to overcome brain drain is to focus on research and training in specific sectors based on national priorities and orientations. One of Rwanda’s capacity building priorities focuses on electricity generation and distribution (National Capacity Building Secretariat, 2016).

Worldwide, the number of skilled workers who leave their home country, has increased significantly in recent decades and several case studies and other anecdotal evidence imply that the brain drain is expected to intensify even more in the future due to gap in salaries and

demographic trends (Docquier, 2006). In an African context, 23,000 university graduates and 50,000 executives leave Africa every year (Chetsanga, 2003). Moreover, Chetsanga (2003) states that estimations implied that 40,000 African Ph.D. students lived outside of the continent. Even so, the majority of those expatriated Africans strive to stay in contact with their loved ones back at home. Of those who leave to work abroad, many wish to go home and hence leave that door open. However, it is not always that easy, due to immigration policies in the host countries (Chetsanga, 2003). Looking at the departure of executives and university graduates one can see a clear exponential curve in terms of people leaving Africa from the 1960s and onwards (Hague and Jahangir, 1999). As reported by Chetsanga (2003), African governments have promoted their residents to go abroad to study or to get training. Labor migration trends have in general gotten more intense, in post independence Africa, due to main difficulties, such as “violation of human rights, bad governance, civil wars and poorly targeted educational systems” (p.29).

As stated by International organization for migration (2016), the continent of Africa is affected by the phenomenon called brain drain as well is Rwanda (Commander, Kangasniemi & Winters, 2004; Docquier & Rapoport, 2012). Thousands of skilled workers, such as executives and university graduates leave Africa annually, where some main factors can be pointed out as the causing of brain drain. This large-scale shortage of qualified human resources, results in a dependence on foreign expertise, which is very costly and not sustainable for the African economies. (International Organization for Migration, 2016).

1.1 Definition of brain drain

In order to facilitate the purpose of this study, a clear definition of brain drain needs to be stated. Even though the chosen definition for the study is easy to understand, it does not capture the complexity of the phenomenon that has been developed, since the late 1960s (Milio et al, 2012). Due to the fact that different scholars and organizations have established several definitions, we have chosen to make a comparison between some of them to reach the most accurate one for this study and also provide with some bearings within this immense and complex field. The chosen definitions for the comparison are taken from scholars that are among the most cited within the field of our research or from other reliable sources. Since theories of growth and the increased need for skilled human resources are important factors when researching the economic growth and development of a country, brain drain has naturally been discussed and many definitions have arisen (Romer, 2001).

Scholar	Definition	Content
Adams (2003)	<i>The international migration of people endowed with a high level of human capital.</i>	<ul style="list-style-type: none"> ● Migration ● High level of human capital ● International
Carr, Inkson & Thorn (2005)	<i>Where skilled personnel leave their country.</i>	<ul style="list-style-type: none"> ● Skilled personnel ● Leave their country
Docquier (2006)	<i>The international transfer of resources in the form of human capital and mainly applies to the migration of relatively highly educated individuals from developing to developed countries.</i>	<ul style="list-style-type: none"> ● International ● Relatively highly educated ● From developing to developed countries
Dodani and LaPorte (2005)	<i>Brain drain is defined as the migration of health personnel in search of the better standard of living and quality of life, higher salaries, access to advanced technology and more stable political conditions in different places worldwide.</i>	<ul style="list-style-type: none"> ● Migration ● Health personnel ● Worldwide
Grubel(1994)	<i>By the term brain drain, what is intended is the phenomenon of abandonment of a country in favor of another by professionals or people with a high level of education, generally following an offer of better pay or living conditions.</i>	<ul style="list-style-type: none"> ● High level of education ● Abandonment of a country ● Better pay or living conditions
Merriam-Webster (2015)	<i>The departure of educated or professional people from one country, economic sector, or field for another, usually for better pay or living conditions.</i>	<ul style="list-style-type: none"> ● Departure of ● Educated or professional people ● Country, economic sector or field
Straubhaar (2000)	<i>Brain drain is the permanent emigration of qualified persons.</i>	<ul style="list-style-type: none"> ● Permanent emigration ● Qualified persons
World Bank (2000)	<i>Brain drain is the migration of skilled human resources for trade, education, etc.</i>	<ul style="list-style-type: none"> ● Migration ● Skilled human resources

Table 1. *Definitions of brain drain.*

When looking at the content of the different definitions, we can see that more or less all of them touch upon something similar to “migration”, “highly skilled people” and “international”. Therefore, we can draw the conclusions that the majority of the definitions are to a great extent the same, but with small differences. Nevertheless, the one we have chosen to refer to during this study is saying that brain drain is:

“the departure of educated or professional people from one country, economic sector, or field for another, usually for better pay or living conditions”

Merriam-Webster (2015).

According to us, this definition does not limit our study to only consider educated or professionals. By professional people we do not necessarily mean people who have an education, as it could also be people who have developed skills from work. Furthermore, we do not want to strain our study by only considering the departure of skilled people to another country, but to also include within an economic sector or a field.

1.2 Purpose

In developing countries such as Rwanda and many other African countries, brain drain is a problem (Commander, Kangasniemi & Winters, 2004; Docquier and Rapoport, 2004; Beine et al. 2001, 2006; Docquier, Lohest & Marfouk, 2007). Investing in education is costly and yields no returns for the incumbent, since the returns are received abroad, which creates a problem, when the skills are really needed in the country of origin, for further development of the country (International organization for migration, 2016). The majority of the already existing research within the field of brain drain has focused on the negative impact on the health care sector in the home country, with very little research on Rwanda in particular (Kline, 2003; Muula, Mfutso-Bengo, Makoza, Chatipwa, 2003; Stilwell, Diallo, Zurn, Vujicic, Adams, Dal Poz, 2004). In Rwanda, the government has developed Vision 2020, an action plan for the further development of the country, in which the effort is largely concentrated in the energy sector. Since the energy sector in its turn affects many other sectors, such as agriculture, industries, health care and so on (Republic of Rwanda, 2012). Many other industries are dependent on a working energy infrastructure and in order to foster national economic development, as in the western societies,

this is necessary and highly relevant (Rwanda Development Board, 2012; African Development Bank Group, 2013). A developed energy infrastructure is necessary in today's digitalized society and could potentially attract corporations, to establish business in Rwanda in many different sectors. This will consequently lead to opportunities in the labor market and better economic development in Rwanda.

The main goal of this research is to assist with valuable information to a real life problem, which could perhaps also contribute to development beyond the borders of Rwanda. Apart from the practical implications for Rwanda, the outcomes of this research will add significant academic value to other scholars, who are researching the issue of brain drain in developing countries, by adding new perspectives to this emerging problem. We believe that the conclusions of this thesis could provide new insights to a sector, which as far as we know is unexplored within the research of brain drain in Rwanda. This is leading us to the purpose of this research project, which is to investigate how the energy sector in Rwanda is affected by brain drain.

1.3 Research question

In order to answer the purpose, the following research-question has been developed;

How is the energy sector in Rwanda affected by brain drain?

To be able to answer these, the following sub-questions have been developed.

SQ1: What is causing brain drain?

SQ2: How can brain drain be overcome?

1.4 Problem discussion

According to several scholars, brain drain is in many cases seen as a curse or a huge problem for economic development (Commander, Kangasniemi & Winters, 2004; Docquier and Rapoport, 2004; Beine et al. 2001, 2006; Docquier, Lohest & Marfouk, 2007). The phenomenon of brain drain is furthermore a problem for developing countries such as Rwanda (International organization for migration, 2016). Since the economy is on the rise (Worldbank, 2015), more and more people graduate with higher education levels, but it is not enough when there are not enough qualified jobs for these highly skilled laborers (Rwanda Development board, 2012). A

consequence of this could be that many highly educated and professionals leave the country (Meyer & Brown, 1999). This means that the country loses its investment in education of future professionals, as the contribution of these workers is lost to other countries, economic sectors or fields (Dodani and LaPorte, 2005). Cyranoski (2001) and Dodani and LaPorte (2005) state that this problem can be overcome by connecting this highly educated people and professionals with opportunities in research and development to attract and retain regional talent.

Much has been written about brain drain and the continent of Africa, although focused on the health care industry, since it is a core component in a working society, and part of a more traditional industry and have hence been more researched than the energy sector (Kline, 2003; Muula, Mfutso-Bengo, Makoza, Chatipwa, 2003; Stilwell, Diallo, Zurn, Vujicic, Adams, Dal Poz, 2004).

1.5 Delimitations

To limit our research, we have made necessary limitations to frame our research and get the most information out of it as possible. Brain drain is a large issue and applies to other industries, than the energy sector. However, we have chosen one of the most critical industries for the development of Rwanda, in need for competent human capital with knowledge about the local market.

Furthermore, we have chosen to look at no other country but Rwanda. Comparing different countries, would benchmark the strategies used in Rwanda, however with respect to the limited timeframe for the research, we believe that it would be better to focus on one country thoroughly instead.

2. LITERATURE REVIEW

This chapter is divided into two main topics: brain drain and the energy sector. The first part includes previous research on brain drain in general, as well as an overview of how it has evolved. Moreover, this part accounts for what existing literature says about what causes brain drain and how it can be overcome. The second part clarifies the characteristics of the energy sector in Rwanda and the existing skills gap.

2.1 Brain drain

The subject concerning “human capital flight” or the more commonly used name brain drain, is strongly debated among many scholars, but no consensus has been able to be reached so far (Hunter, 2013). The concept of “human capital” itself, refers to the amount of competencies and knowledge matured by an individual, through education or experience (Dae-Bong, 2009). The majority of the literature within this field usually gives examples from the health care industry and names these skilled workers as doctors, scientists and engineers. The movement of these skilled individuals from the developing countries to the developed countries is what usually is referred to as brain drain (Kapur, 2001). Least Developed Countries (LDCs) and members of the Organization for Economic Co-operation and Development (OECDs) are commonly used to describe the concerned members of this phenomenon. How emigration of these individuals affects the development of the country of origin has been broadly studied, e.g. by Grubel and Scott, 1966; Bhagwati and Hamada, 1974; Stark, Helmenstein and Prskawetz, 1997; Docquier and Marfouk, 2005; Dumont and Lemaitre, 2005; Kapur 2001; Kapur 2004. The topic usually has two major directions. Both are based on an externality argument, which entails that there are several costs and benefits to society associated with emigration (Grubel and Scott, 1966).

The problem of brain drain first arose during the 1940s when many skilled workers emigrated to the UK and North America from Europe (Dodani and LaPorte, 2005, Mejia, 1981). During these post-war events, the British Royal Society coined the term brain drain as the loss of first-rank scientists overseas (Cervantes and Guellec, 2002). However, it was not until the start of the 1960s, that brain drain really had been identified as a major concern (Meyer, 2001). Originally, it has been used in the more broad sense of movement of skilled workers from country to country (Schultz, 1967). Nowadays, the traditional view of brain drain has changed to how the emigration

of skilled workers from developing countries increases the already existing inequalities between low-income countries and higher income countries (Saxenian, 2005; Bhagwati and Hamada, 1974). Due to the increased global knowledge-based economy we are living in, we depend more and more on science and technology skills. In combination with progressively more open borders thus facilitated movement of people has made it an increasingly crucial issue to study (Meyer, 1999). As educated people increase the level of human capital in a country, which in turn increases productivity and enables them to earn money to greater extents. This benefits society directly by increased taxes, growing overall productivity and correspondingly the growth of the economy. Trends show that these benefits are often transferred from poor to rich countries, which creates problems for the LDCs (Bhagwati and Hamada, 1974). However, brain drain has for long been regarded as a critical issue and an unsolved problem, although it increasingly points to the positive outcomes of brain drain (Mayr & Giovanni, 2008).

The idea that brain drain induces negative effects on the drained country is an issue that later on has been argued against in favor of the concept of brain gain, which implies the opposite. This view proposes that emigration of highly skilled workers will actually contribute to the development of their home countries (Mayr & Giovanni, 2008). The arguments states that there are several incentives, for example the additional motivations to invest in education in order to improve their marketability abroad, if they have the option to emigrate. Having the option to emigrate, the country might get more educated citizens, as some will not go through with their intended plans and consequently stay (Mountford, 1997). Moreover, Mayr & Giovanni (2008) and Gibson & McKenzie (2011) argue that people who emigrate will often come back with new skills, knowledge and perspectives from abroad, which benefits the country's development as it increases the country's human capital. This advantage is referred to as "brain circulation" or the creation of a "brain bank", a pool of knowledge that will circulate and finally transfer back to the homeland (Agrawal, Kapur and McHale, 2008). By having a stock of knowledge set abroad, the country of origin can also avoid the risk of having a "stagnant pool" referring to people who stay at home but necessarily do not contribute with necessary skills (Agrawal, Kapur and McHale 2008). Additionally the diaspora can lead to some feedback effects for development in the country of origin, in forms of financial and social remittances such as ideas, values and information. Money sent home or spent during visits to the country of origin, as well as increasing foreign direct investments can also have such positive feedback effects (Meyer, 2001).

2.1.1 Causes of brain drain

In general, research shows that people who migrate from developing countries are often young people aged between 15 to 45 years and possess a higher education and also have higher income than other people with the same characteristics, who remain in their home country (Saravia & Miranda, 2004). What is causing this movement of skilled people are discussed by many scholars, but some gradients are more used than others in the discussion of this matter.

Push and pull factors

Because of the complex nature of brain drain, the reasons for leaving a country of origin to work abroad are defined in several manners. Still, it is often discussed under two broadly identified factors that lead to brain drain: push factors and pull factors. Push factors refer to the conditions within the country of origin that provoke the professionals to leave. Pull factors on the other hand, refer to the favorable conditions in the receiving countries, which can be deliberate and/or unintended actions that make immigration attractive (Krugman and Obstfeld, 1991, Filler et al, 1996; Jovanovich, 1997; Tassinopoulos & Werner, 1998; Dovlo, 2003). However, it has to be pointed out that even though the cause is distinguished as twofold, the line between them two is somewhat blurry as they represent two sides of the same coin (Dovlo, 2003). Furthermore, some scholars argue that push factors are more prominent during a large-scale migration of unskilled workers and pull factors during the migration of more high-skilled laborers (Brandi et al, 2003).

A combination of both push and pull factors can lead to the decision to emigrate if it passes a certain threshold. Dovlo (2003) refers to these combined ingredients consisting of both kinds of factors, in terms of gradients between the situations in the receiving and sending countries. The six most common gradients are also in accordance with the main reasons for leaving the country of origin, as stated by International organization for migration (2016).

Gradient	Definition
The income gradient	<i>The difference in salaries and living conditions between the sending and receiving countries</i>
The job satisfaction gradient	<i>The perception of good professional working environment, qualification of job requirements, professional and technical proficiency that contributes to international recognition with one's peers.</i>

The organizational environment/career opportunity gradient	<i>The possibility for professionals to advance and develop themselves within their specialization. A well- structured HR management will help to attract and retain staff.</i>
The governance gradient	<i>The governance gradient constitutes the organizational environment mentioned above, as well as includes the administrative bureaucracy and in which level of efficiency services are managed.</i>
The protection/risk gradient	<i>The concern to what extent it is safer to work in another country due to several indicators. Factors might include the lack of protective gear or the perception of a higher occupational risk from HIV/AIDS, when working in Africa compared to working in developed countries.</i>
The social security and benefits gradient	<i>Have to do with the basic comforts such as security after retirement. Big motivation to work abroad can thus be created by retirement and pension benefits.</i>

Table 2. *Examples of gradients and their respective definitions, Dovlo (2003)*

Some scholars divide brain drain into hard and soft brain drain (Muula, 2005). An example of hard brain drain may be the loss of skilled personnel, while an example of soft brain drain is about the lack in availability of research results to users in Africa. This can then, according to Muula (2005), be compared with push and pull factors, where “the “pull” factors of “hard brain drain” include better remuneration and working conditions, possible job satisfaction, and prospects for further education, whereas the “push” factors include a lack of better working conditions including promotion opportunities and career advancement (Muula, 2005).

Geographical movement

Skilled workers leave their home countries for a variety of reasons as described by the push and pull factors (Dovlo, 2003). However, Chetsanga (2003) divides the concept of brain drain into three different categories, depending on where the skilled workers are moving.

Category	Definition
Primary external brain drain	<i>The case where professionals leave their country of origin (Rwanda) to work overseas in places such as Europe, North America and Australia where the countries are more developed.</i>
Secondary external brain drain	<i>The occurrence of professionals leaving their country (Rwanda) to another country in the region e.g. Tanzania, Kenya, Namibia etc.</i>
Internal brain drain	<i>The case of professionals who stay in their country, but who are not employed in their field of expertise. Skilled workers can get forced to move from the public sector to the private sector or within a sector. Examples include engineers becoming bus drivers or nurses become cashiers at supermarkets.</i>

Table 3: *Categories of brain drain according to Chetsanga (2003)*

Lack of data

The movement of skilled workers across countries has always been very hard to measure and is generally not known, due to the lack of data (Docquier, 2006; Carrington & Detragiache, 1998, 1999; Meyer, 2001; Commander, Kangasniemi & Winters, 2004; Saravia & Miranda, 2004). Therefore, the task to understand and measure the phenomenon of brain drain is major and complex in order to get the magnitude of the problem (Docquier, 2006). Comparable data concerning international migrants across countries is difficult to assess, since a systematic data collection system that shows the migration flows by origin of country and education level is required (Carrington & Detragiache, 1998, 1999; Meyer, 2001; Beine, Docquier & Rapoport, 2003). Furthermore, Zlotnik (1998, p.429) argue that many countries “either lack a system for the continuous registration of international migration or, if they have such a system, do not process and publish the data emanating from it”, and that “among those countries that do produce statistics on international migration, the meaning and scope of those statistics vary considerably”. Saravia & Miranda (2004) also note that definitions of immigrants vary a lot, which also inhibits the construction and utilization of statistics. As Rwanda is strained politically and has a censorship as well as limited freedom of press and speech, this also results in a lack of existing data (Sida, b., 2014). Therefore, estimations can only be made from the existing data, which

according to Carrington & Detragiache (1998) can be constructed by using several data sources in a way to get some indications about the magnitude, even though the numbers are not perfect.

2.1.2 Overcoming brain drain

The movement of highly skilled and educated people between countries is to some extent a response to the lack of opportunities in the home country and simultaneously opportunities in another country. Therefore, the foundation of seeking a solution to the problem and overcome brain drain is to find a sustainable strategy for changing the migration patterns. Learning from what other countries have previously done to overcome brain drain can help and underpin the underlying factors for a solution to the problem. (Saravia & Miranda, 2004)

If one look at what has been the key success factors and common denominators of the few emerging countries, including India, Singapore, Taiwan and China, to successfully retain their nationals or convinced them to return. For this, domestic investment innovation and research and development have been crucial (Meyer and Brown, 1999). One can by looking at these examples see that these investments have created demand for progress in science and technology, increased productivity, developed new opportunities to make a career and increased employment (Saravia & Miranda, 2004).

Remittances from citizens living abroad

Since a large part of the income derived from abroad, consists of remittances from citizens living abroad, it is an important aspect to take into consideration, when looking at the movement of skilled workers in developing countries (Ratha, 2003). Several examples demonstrate the importance that remittances have on the country's revenues, which, for example, in Colombia, remittances now exceed by almost a factor of 3 the foreign exchange earnings from coffee exports (Ratha, 2003; World bank, 2003). Another example from Mexico shows that remittances from expats consisted of over US \$ 10 billion in 2002 (Ratha, 2003), which is the same amount as the one generated by tourism (Weiner, 2001).

These revenues can be used to develop the social and economic development of their home country and thus redirect the brain drain. In the 1990s, the growth of remittances led to a growth rate, which was equal to 20% per year, worldwide between 1991 and 1996 (Orozco, 2002).

Conditions for knowledge creation

From what have been estimated, about a third of all professionals in research and development in developing countries, seem to be concentrated to live and work in a few developed countries (Carrington & Detragiache, 1999). According to statistics, these people produce about 4.5 more publications and 10 times more patents, than those who work with the corresponding at home in the country of origin (Meyer and Brown, 1999). This is due to prerequisites and differences in research and development between countries. Factors such as political decisions, financing, infrastructure, technical support and the scientific community are often inadequate in developing countries, to benefit production capacity in the same way as in the industrialized conditioned world (Meyer and Brown, 1999). For knowledge building to be possible, a scientific synergy is vital to strive for a favorable environment for research and development (Meyer and Brown, 1999).

Building capacity for research and development

Developing countries can also prevent brain drain by building research and development capabilities as well as investing in education and research and development. Thus, there is a reason to stay and work in their home country if they can perform their research and emigration reduced. Brazil, for example, has made a difference with respect to this. In 1985, more than 40% of doctoral degrees were issued abroad, which two decades later was reduced to less than 10% because of such changes (Nchinda, 2002).

Building opportunities for national development

Building opportunities for national development can be illustrated by China becoming a leader in biological research and biotechnology. By participating in the Human Genome Project, the collaboration has provided a platform for developing biotechnology, which could be used within the areas for human diseases and agriculture. This has lead to an attraction of both international collaborations in joint ventures and professionals from China and abroad. More examples from developing countries with similar problems can be drawn from expats that have helped their home countries, through the knowledge they developed abroad (Dodani and LaPorte, 2005). Dodani and LaPorte (2005) further argue that these targeted educational possibilities with political decisions and investments in research and IT-infrastructure are an example of a solution to controlling brain drain. Dodani and Laporte (2005)

In addition to this, Saravia & Miranda (2004) further states that the core of overcoming brain drain is to focus on research and training in specific sectors based on national priorities and orientations. For this to succeed, the following points are necessary to achieve:

- Implement educational strategies that highlight these priorities through targeted national programs, but also training abroad.
- Invest in infrastructure for research and development and create opportunities that enhance the growth of the public sector and the private sector for research, technological development and innovation.
- Create a leadership that will enable a unified collaboration both internally and externally, of scientific and technological capacity.

2.2 The energy sector

2.2.1 Characteristics of the energy sector in Rwanda

As the energy sector is a vital sector for the development and growth in the economy of Rwanda, it could potentially improve living conditions for the entire nation. This is because reliable power affects quality of life and the infrastructure, as well as businesses. In the western world and developed countries, the average energy consumption per capita annually is estimated to 1,200 kWh. In comparison to Rwanda, the same consumption is 20 kWh annually per capita. (Rwanda Development Board, 2012; African Development Bank Group, 2013). The purchasing power of the population is also relatively low, due to a poverty rate of 45%, which limits their buying capacity (Sida,b., 2014).

According to the energy sector strategic plan, only approximately 20% of the population were on the grid in Rwanda in June 2014. However, the energy access is expected to reach 70% in 2017/2018 (Republic of Rwanda, 2015). This transformation of the energy access as well as an increased usage of sustainable energy sources are priorities in Vision 2020, a development strategy for the Rwandan government (Republic of Rwanda, 2012).

To increase the electrification rate and transform the electric landscape in the region, regional grid integration projects could make use of economies of scale and lower the prices. An example of a regional grid integration is the East African Power Pool, which aims to increase the

integration of energy into a power corridor in East Africa and by doing so, also increase the energy access for the population in the region (East African Power Pool, 2016; International Renewable Energy Agency, 2013). It is estimated that by using a power trade to its full potential, African countries could save as much as 2 million USD annually (International Renewable Energy Agency, 2013).

The power structure that currently operates in Rwanda induces frequent interruptions, which reduces output and forces factories and businesses to use back-up energy. The losses due to electrical blackouts are estimated to mount upwards to 2 % of GDP a year, in Rwanda for businesses (International Renewable Energy Agency, 2013). The back-up sources are often fueled by polluting sources like diesel-generators and otherwise by costly fuels. Furthermore, the current primary energy sources, is biomass based, which accounts for approximately 85% and consists mainly of wood and charcoal (African Development Bank Group, 2013). The consumption of these energy sources comes with negative externalities that lead to severe complications to the environment, due to for example pollution and deforestation. About two thirds of the country's forests have disappeared, since the 1950's (Rwanda Development Board, 2012). With the development of the energy sector, power could potentially be generated closer to where it is actually required, which would not only be more sustainable but also more reliable (International Renewable Energy Agency, 2013).

The private sector is increasingly more important for the development of the energy sector. One important issue is to ensure that professionals are fully trained and strengthen their capacity (International Renewable Energy Agency, 2013). African Development Bank Group (2013), also identifies this as a high priority. Another is to ensure a stable energy supply, which can be improved if several kinds of energy sources are domestically produced, such as biofuels, new and renewable energies, electricity and petroleum (African Development Bank Group, 2013). Currently, the private sector is already involved in the development of the energy sector. Up to 39.2% of the locations of energy supply are located in the region around the capital Kigali, pointing to a trend of clustering of the energy establishments as a result of urbanization (Rwanda Development Board, 2012).

2.2.2 Skills gap

In many African countries such as Rwanda, it is not uncommon to see that the quality of education is not the same as in other OECD countries (Rwanda Development Board, 2012). When it comes to the energy sector in Rwanda, it is possible to see that a lack of training during education creates this skills gap. This implies that due to the lack of qualified jobs that suit the degree of the graduates, these graduates who become skilled workers could choose to leave the country (Meyer, 2001). Next, two different kinds of skills gaps in the context of the energy sector in Rwanda will be addressed.

Mismatch of demand & supply

On the basis of a skills survey in the energy sector, done by the Rwanda Development Board (2012), officials observed a skills mismatch within the energy sector of Rwanda. This mismatch resembles the difference between the demand and supply of employing graduates applicable to work within the energy sector. The conclusion was based on whether the employees considered their jobs suitable enough for their qualifications to which 78.1% of the participants highly agreed/agreed upon, while 21.5% did not. Looking at the overall gap in the energy establishments of the private sector, the gap consisted of 408 people in the short run. “Liberal professionals accounted for 40.9%, technicians 34.8%, artisans accounted for 11.3%, managers 6.9% and the scientific professionals, mainly engineers, accounted for 6.1% of the total skills gaps” (Rwanda Development Board, 2012, p.10).

More students graduate within the energy sector than technicians and artisans and since the private sector focuses on employing the latter, rather than professionals to work in the energy sector, it creates a mismatch between the supply and demand of skills in the private sector (Rwanda Development Board, 2012). This can be underpinned by the annual ratio of graduation of professionals versus technicians and artisans of 3:1 (Rwanda Development Board, 2012). A similar conclusion is drawn by the Entrepreneurship & Leadership Foundation (2015), that a ratio of one engineer to six technicians and sixteen artisans/craftsmen are required. It therefore recommends that merely increasing the number of technicians could be enough to meet the need of human capital within the energy sector. In other words, there is a higher need for technicians and artisans than for professionals, whose skills might get wasted. Therefore, the urgency of bridging this gap is high, in order to make the sector effective and efficient (Rwanda Development Board, 2012). However, the final ratio depends on the predominant generation technology, the level of automation implemented and the practiced level of mechanization, which

will be crucial for job creation (Rwanda Development Board, 2012). Because of that, university graduates cannot get enough qualified jobs that meet their educational standard, one has to look at the underlying reason for it, which has a lot to do with the lack of training and education standard (Rwanda Development Board, 2012).

Lack of training and education standard

The second determinant of the skills gap, in the energy sector of Rwanda, is the lack of the quality education and insufficient training, which prevents laborers of reaching international standards. Currently, best Rwandan practices in energy sector training do not compete with international best practices standards. As a result, there is a lack of highly qualified workers, which are needed to develop innovative strategies for the challenges within the energy sector. As a consequence, foreigners are employed to work on innovative solutions, as to develop the energy sector. (Rwanda Development Board, 2012)

In the continent of Africa there is a lack of basic equipment and specialist training (Muula, 2005) and room for improvement is present in multiple areas in Rwanda, in particular at the universities and other training institutions (Rwanda Development Board, 2012). According to international benchmarks, professionals and technicians in the energy sector, require an equipment-student ratio of 1:2 up to 1:4 to cover for the need of standard training equipment and machines. Such levels allow for an adequate competence-based technical training, as there is a proper division between theory and practice. During energy programs hosted by universities and the IPRC in Rwanda, basic training equipment was available, although it fell short to the international student ratio standard. In Rwanda, the ratio of equipment to students is somewhere around 1:25 to 1:30 and in some cases even larger, which is far below the sufficient level. This leads to students not receiving enough effective hands-on experience, as a lack of standard training equipment is crucial for post-graduate outcomes. (Rwanda Development Board, 2012)

Another area of improvement comes from the consequences of a high student enrolment rate over too few teachers, which creates a low staff to student ratio of 1:25 to 1:30 instead of an internationally recommended ratio of 1:10 for technical education. Furthermore, several official reports (Rwanda Development Board, 2012; Entrepreneurship & Leadership Foundation, 2015) show that no more than 40 percent of the technical teachers in Rwanda are qualified enough to teach at professional levels, which for instance can be during training sessions (Rwanda Development Board, 2012). Another potential point of improvement for technical teachers is to

have experienced industrial exposure, as to be able to give practical skills in a professional way. All the aforementioned factors hamper the standard of education and negatively affect the quality of graduates, in the energy sector of Rwanda (Rwanda Development Board, 2012; Entrepreneurship & Leadership Foundation, 2015).

A final issue is that in-company training is quite uncommon. A survey consisting of 89% of the establishments within the energy sector of Rwanda indicates that there are very few opportunities for students to get an internship. (Rwanda Development Board, 2012)

Competence from abroad

In an attempt to counter the losses the skills gap creates, many African governments have tried to find a solution to these problems, by relying on technical expertise from abroad. In many cases, professionals are hired by aid agencies and the skilled workers mainly consist of Europeans and Americans. Often, these solutions are successful, although there is a risk of getting stuck in a vicious circle as one continuously depends on technical experts who can after ending their respective projects. (Chetsanga, 2003)

3. METHODOLOGY

In this chapter an introduction and discussion is presented of the approach of this thesis. A presentation is given of the methods used to collect the data, as well as a discussion on potential limitations and other issues.

3.1 Research design and strategy

As previously stated, the research question of this study is to investigate the following: “*How is the energy sector in Rwanda affected by brain drain?*” In order to answer the research question some literature review has been previously given, case study and comparative analysis.

Brain drain is a well-researched topic globally, as well as for the continent of Africa (Kline, 2003; Muula, Mfutso-Bengo, Makoza, Chatipwa, 2003; Stilwell, Diallo, Zurn, Vujicic, Adams, Dal Poz, 2004). However, most of the conducted research has had a strong focus on the health care industries and the flight of human capital within that specific sector. Thus, our literature review has mainly been based on articles and literature describing the phenomenon of brain drain as phenomena, its cultural contexts as well as the industry settings. As to extend on previous literature, the current study will now continue describing the basic conditions and development plans- and strategies in Rwanda, the phenomenon brain drain with its pros and cons, how brain drain has previously been overcome, the skills gap and how the energy sector is currently operating in Rwanda. Central documents that touches upon skills gap and the energy sector in particular, have been an important ground for our research, together with other books and articles within the field for this study.

3.1.1 Case study

A case study is convenient for our research purpose, as it is suitable for studies of explanatory, descriptive and exploratory form (Blumberg, Cooper, Schindler, 2014). Case studies focus on a contemporary phenomenon and emphasize it in its real-life context. In addition, these studies are based on a replication logic for which one can expect that the same phenomenon can occur under similar conditions and as a result detect patterns and potential explanations (Blumberg, Cooper, Schindler, 2014). Case studies are not generalizable to the population of the sample, but to a

theoretical proposition (Blumberg, Cooper, Schindler, 2014). Our case study consists of multiple sources of evidence, which have been analyzed and compared. Furthermore, the study is of an explanatory kind, as it tries to explain what causes the phenomena of brain drain, how to overcome it and how brain drain affects the energy sector in Rwanda. In other words, it seeks to give a detailed understanding of the phenomenon (Bryman & Bell, 2015).

The data of this research consists of a collection of qualitative data, conducted through semi-structured interviews with key persons in Rwanda and Sweden. Interviews with representatives have been carried out, who are experts or have experience in the energy sector as well as on the subject of brain drain and workforce migration. Ola Ekman, Anders Knutsson and their contacts in Rwanda have acted as intermediaries for reaching suitable respondents. As an example of their reliability on the subject, Knutsson has previously been an intern at *NCST* in Rwanda, writing a report about the energy sector.

3.2 Semi-structured interviews (interview guide and schedule)

As previously mentioned, the main source of the empirical findings consists of semi-structured interviews, due to its suitable nature our study. The benefits of choosing a semi-structured interview-approach, is that it enables the respondents to interpret the given questions and endows them with more freedom providing answers. Furthermore, it also gives the opportunity to alter the structure of the questions and to come up with follow-up questions, adjusted to the situation. This way it is easier to get the most out of each interview, with respect to the situation and circumstances (Blumberg, Cooper, Schindler, 2014).

The questions differed depending on whether the respondent was a student or an expert. The common characteristic of all respondents is the interviews' topic "brain drain and the energy industry". The respondents have had the opportunity to answer the questions using their own interpretation, which enabled an acquisition of answers, which are as truthful as possible. An interview guide was prepared in advance to cover the main areas of the study, but also contained guiding questions to explain or clarify the bearing of the questions. When designing a so-called interview guide, it is of great importance to include the key issues, as well as any other information that the interviewer needs to keep in mind during the interview. According Drever (1995), the purpose of such a study is to help the interviewer, during the interview and stay within the lines. During the preparation for the interviews, the questions were designed with the

research purpose and question in mind. The questions were sent a week in advance to the respondents, to ensure they had time to prepare.

Our aim was to start the interviews with the best possible atmosphere such a good atmosphere as possible, with the belief that the respondents would like to share their experiences as much as possible. Therefore, the interviews began with our appreciation for their participation, a brief introduction about ourselves and the purpose of this study. This has led to the respondents feeling more comfortable and speak more freely, but also to get a better understanding of the topic and thus to provide better answers for the study, as well as leading to the questions being more indicative (Blumberg, Cooper, Schindler, 2014). To begin with, all of the respondents were asked whether they wanted to be anonymous or not. Then the interview continued with posed questions about their background and their relation to the given research subject as to get the respondents to start talking, give longer answers and enable the possibility to identify the respondent's character (Drever, 1995). Lastly, we proceeded with more specific questions that could be related to our research questions.

The questions do not necessarily have to be posed in the exact same manner as in the interview guide. When deemed necessary, the questions were slightly altered, parts were added, or deleted altogether. However, caution must be maintained against posing questions that are too different or differently executed. To interpret the topic from different respondents' perspectives, the questions were asked in a coherent manner to ensure the truthfulness of the empirical data (Bryman & Bell, 2015). Since the experience, motivation and reasoning may differ between respondents, scholars believe that the semi-structured interviews are a good way to narrow the empirical material because they provide a good opportunity to collect information based on respondents' different conditions (Drever, 1995).

3.2.1 Selection of respondents

During our entire research process it has been important to get a holistic perspective, as it gives a better understanding of the topic and its problematic as we are looking at the correlation between two main areas, namely brain drain and the energy sector. All respondents have been chosen according to purposive sampling (Bryman & Bell, 2015). Therefore, our choice of respondents was based on characteristics that consist of different areas of expertise from the energy sector, government and workforce migration. Therefore, we have interviewed representatives from the

National Commission of Science and Technology (NCST) in Rwanda, the *Swedish International Development and Cooperation Agency (Sida)* in Sweden, the *Ministry for foreign affairs (UD)* in Sweden and *AOT Consulting* in Uganda. By interviewing these individuals, a better understanding of the current challenges of the energy sector itself as well as about the skills gap and workforce migration was reached.

In addition to this, students have also been interviewed, who have or will graduate with a degree in either engineering or as technicians, from *Carnegie-Mellon University* in Kigali, Rwanda. These respondents complement the professionals well and create a better holistic picture of the situation and its different perspectives.

Name	Organization	Nationality	Length of interview	Type of interview
Nelson Tashobya	AOT Consulting	Ugandan	1 hour	Skype
Maria Stridsman	Sida	Swedish	1 hour	Telephone
Gaspard Twagirayezu	National Commission of Science and Technology	Rwandan	50 minutes	Skype
Måns Fellesson	Ministry for foreign affairs (UD)	Swedish	1 hour	Telephone
Student A	Carnegie Mellon University Kigali	Rwandan	45 minutes	Skype
Student B	Carnegie Mellon University Kigali	Ugandan	35 minutes	Skype
Student C	Carnegie Mellon University Kigali	Rwandan	40 minutes	Skype

Table 4. *Presentation of the respondents*

3.2.2 Data analysis (quality of interviews)

During the data analysis, the concept of grounded theory has been used. Grounded theory consists of two main features: firstly a theory is developed out of the collected data and secondly the process is iterative, which means that the analysis has been done parallel to the collection of the data and systematically involves it. (Blumberg, Cooper, Schindler, 2014)

All interviews were spread out over a span of a month, were recorded and notes were taken. This has helped us to remain focused during the interviews. After each interview, a discussion was held whether similar opinions were held about the empirics, how it related to the literature review and to other interviews already conducted. In addition to this, the recordings were used and the material transcribed as soon as possible, as it was easier to recall the details and information of the interviews. This has helped in the process of coding and facilitated making connections between the findings and theories (Blumberg, Cooper, Schindler, 2014). Since some of the interviews were held in Swedish and some in English, there might be a potential loss of information during the transcribing due to language reasons (Saunders, Lewis & Thornhill, 2009). The structure of the analysis as well as conclusions were also discussed, in order to answer the research questions as accurately as possible, in other words, the iterative part of the process (Blumberg, Cooper, Schindler, 2014). Furthermore, while in the process of conducting the analysis, attention was paid to the recordings multiple times.

After a draft of our empirical findings was finished, it was sent out to the respondents to get their feedback and approval. In some cases, where it was deemed necessary to complement the collected empirical data, follow-up questions were emailed. This has given us the possibility to understand and interpret the existing data better and also make our analysis and conclusions more comprehensive.

3.3 Quality of research

3.3.1 Reliability

According to Bryman & Bell (2015), the findings of a study need to be repeatable to have reliability, which can be divided into external reliability and internal reliability. External reliability refers to “the degree to which a study can be replicated” (Bryman & Bell, 2015, pp. 395). When conducting a qualitative research, a critique against the level of replication is discussed. Since one part of our study is of the qualitative kind, it will be harder to replicate as the basic conditions like environment and setting would probably vary from time to time.

In order to increase the reliability, an attempt was made to follow a clear structure throughout the interviews and the creation and provision of an interview guideline was helpful. A potential flaw regarding reliability could be that the respondents in Rwanda have not expressed their true beliefs or opinions, because of the risk of being overheard or bugged. The political climate in Rwanda is tense and authorial and could be a potential reason for this (Sida, a., 2014).

Internal reliability on the other hand refers to the case that the people conducting the research interpret the findings in a similar way from what was seen and heard before (Bryman & Bell, 2015). To avoid potential misunderstandings and thus increase the internal reliability, each interview was recorded to make sure it was possible to look back if necessary and hence decrease the possibility of biased conclusions. More importantly, all received answers were discussed as to make sure these answers were interpreted in a similar way. Since all parts have been carefully discussed, agreed upon and written together, this also contributes to the reliability of the study.

3.3.2 Validity

Another important criterion for a study concerns the validity. Validity refers to what extent you measure what you want to measure. Also, validity can be divided into two groups: internal validity and external validity. Internal validity has to do with the extent of the “good match between researchers observations and the theoretical ideas they develop” (Bryman & Bell, 2015, pp. 395). Since a qualitative research strategy depends a lot on how the researchers interpret the received material, the risk of different interpretations can occur, since the interviewers are subjective (Bryman & Bell, 2015; Silverman, 2011). One way of decreasing the risk of biased

interpretations was done by sending the empirical findings to the respondents and make sure that they agreed upon the interpretations.

External validity on the other hand refers to the extent it is possible to make any generalizations from the findings (Bryman & Bell, 2015). In an attempt to increase the external validity of this study, a self-imposed limit was introduced to only incorporate the energy sector and engineers, scientists and technicians in order to make it easier to make generalizations.

Since our research question is “*How is the energy sector in Rwanda affected by brain drain?*”, a qualitative study was deemed more suitable as the research is of an explanatory kind. Our study focuses more on words than on numbers and therefore a choice was made for a more epistemological rather than an interpretation oriented one, which is more suitable for summarizing a quantitative study (Bryman & Bell, 2015). As to increase the narrative and explanatory nature of the answers, a quantitative measurement would not have helped as much. (Sverke, 2003, 2004). Also, our study focuses more on getting a social understanding of the actual problem, where the respondents' view of this reality is crucial. This method provides a great freedom for the respondents and also has given us room to speculate, analyze and make conclusions more freely. In addition, Bryman (2002) states that when using individual data, gaps can be created, which however can be corrected for, when, comparing and using all available data. This enables the creation of full assessments that go beyond the data collected (Bryman, 2002). It is not our aim to acquire less profound facts from several respondents without an overall framework in which it works (Holme, 1997). Criticism that can be directed towards the selection of a qualitative method also includes the likelihood that the result is just a coincidence in and with a smaller selection than with a quantitative method. The precision of the estimate increases intuitively with a larger sample of respondents (Sverke, 2003, 2004).

Conducting semi-structured interviews is a suitable choice for this paper, as it is our belief it optimizes the value of the interviews, rather than using structured interviews. Choosing a structured interview where all questions will be verbatim to all respondents, limit the respondents' answers, which would have had a negative, as it could imply a rigid and artificial atmosphere of respondents. It also means that if the respondent would have not understood a question, it would not have been possible to rephrase or clarify it, but rather to ask the question again, which can lead to a lack of important information. (Bryman, 2002)

During the research process, many challenges were faced during the gathering of data and implied adaptations to the situations at hand with multiple corresponding adjustments. However, a lot of effort was done in order to ensure reliability and validity during the given circumstances and situations. Even though the contact net we originally had seemed promising, we did not get the responses we expected. Due to cultural differences in hierarchy and different ways of communication, getting in contact with the right people and schedule interviews required extensive time and effort, for example sending several reminders to the respondents. Because of this, it was required to revalue the options of possible respondents as to make it fit the purpose of our study.

Originally, our plan was to conduct a survey and distribute it to students at the University of Rwanda in order to get the perspective of native students. However, difficulties arose getting access to the involved university and later, because of specific policies, this strategy had to be abandoned entirely. This has also lead to the limitation that the sample size of the students could have been higher. Instead, it was possible to get in touch with the *Carnegie-Mellon University*, which is significantly smaller in terms of number of students. However, from the given student contacts received, a response rate of 30% has been achieved, which is regarded as sufficient for the current study. Ten email-addresses were offered by the school's principal, Bruce Krogh, which according to him were the only suitable respondents for our research.

4. EMPIRICAL FINDINGS

In this chapter the empirics of the research are presented, all derived from the undertaken semi-structured interviews with key persons in different areas: governmental, institutional as well as employees. Our empirical findings are structured in the same way as the analysis in the following chapter.

4.1 AOT Consulting (U) Ltd

4.1.1 Company and respondent background

From *AOT Consulting* an interview was conducted with Nelson Tashobya. Tashobya, who is originally from Uganda, works as an energy consultant. *AOT Consulting's* core business is focused on energy access, energy efficiency, renewable energy and climate change adaptation and mitigation. Furthermore, Tashobya has an academic background in electrical engineering and telecommunication engineering. After his studies, he started *AOT Consulting* together with some colleagues. Tashobya is primarily based in Uganda but aims for the entire East African region. Currently, Tashobya is doing an energy market study in Rwanda in cooperation with *Sida, the Swedish International Development Cooperation Agency*, mapping out opportunities and helping *Sida* meet their strategy objectives for the period 2015-2019.

4.1.2 Interview findings

According to Tashobya, the Rwandan grid does not reach most of the population, with the energy produced there being the most expensive in the region. Electricity remains very expensive for most Rwandans and 85% of Rwandans still use biomass to meet their primary energy demands. The national electrification rate is only about 23%, with most of which in urban areas, leaving the rural areas with a very low electrification rate. According to Rwanda's Vision for 2020 and Economic Development and Poverty Reduction Strategy 2013-2018 (EDPRS 2), Rwanda has set ambitious goals to attain 48% on-grid and 22% off-grid electrification rates. So in total, the increase would be from about 23% energy access to 70% energy access by the end of 2017/18.

Furthermore, Rwanda aims to boost its energy production from 185 MW to 563 MW by 2017/2018. These aims are supposed to be realized through solar power, peat, hydropower and potentially geothermal energy. To achieve the ambitious electrification targets, the Rwandan government and the private sector have a pipeline of energy development projects in methane-,

solar- and hydropower. In May 2015, President Paul Kagame launched a 25MW KivuWatt methane power plant on lake Kivu. There are plans to develop this plant to 100MW in the future. While the electrification plans may seem ambitious, the Rwandan government is steadily working on strategies to ensure that the targets are met.

Furthermore, Tashobya says that one of the biggest challenges for the energy sector is that the grid is very old and “can only take so much renewable energy”. At the moment, the government of Rwanda is not signing new Power Purchase Agreements; there is no capacity to produce more renewable energy power in the short term. However, there are plans to upgrade the grid urgently, in order to follow the development. Other challenges include the skills gap, limited capacity and parts of the workforce for some renewable energy technologies, have to be imported from the West. Tashobya believes that one of the reasons why the skills gap exists is because of the education system in Rwanda, which has yet to match with the industry’s skills needs. The educational level is not enough to provide students with the knowledge they need. “They deliver what they are expected to do, but they are limited in the scope of what they can do, due to lack of specialization skills.” However, an agency has been appointed by the Rwandan government to look at the skills’ need in the country, the WDA (Workforce Development Agency). Once they have been identified, institutions are advised to create appropriate courses to fill the skills gaps.

Another challenge, according to Tashobya, is lack of sufficient funding for the energy sector. Commercial banks are hesitant to lend money because they still perceive energy and renewable energy as a high-risk investment. These banks have safer options to invest in such as agriculture and real estate. This has to change, as private energy investors and entrepreneurs need financial support. Furthermore, the interest rates that the banks use are prohibitive.

Tashobya does not want to confirm if there is a brain drain or not in Rwanda. “I can tell you that there is for sure a skills gap, but it is a bit of a stretch to link it to brain-drain.” A reason for this uncertainty could be a lack of data. “To be able to see this trend, you need to have data on who is Rwandan by origin, where they have gone and what skills they possess, etcetera and as far as I know, I do not know if that type of data exists.”

When using non-local knowledge in implementation of new technology, it is important to adapt to local dynamics. If this is not done properly, the project will be slowed down, be unsustainable or out rightly fail. Apart from this, it is also expensive to bring in experts or foreign consultants, a

cost many entrepreneurs cannot afford. In order to solve the challenges that the industry is facing, in particular the skills gap, Tashobya advises better knowledge transfer. It is not only the education that has to improve but also the knowledge transfer from other neighboring countries. Maybe their way of implementing technologies or strategies are directly applicable, but at least somewhat adaptable. In addition to this, there should be more support for research, in order to tap from proven knowledge, of which more grant funding would be an example of this. This should also provide input to the curriculum. Another issue is that policy support has to get better. Sida is currently doing this in other sectors and it could be useful to see how it could be adapted to the energy sector. Furthermore, better tariffs for energy production is necessary for the development.

Tashobya concludes by saying that developing the energy sector would have a positive impact on the economy, as it would increase employment and overall growth. About 80% of the population is still working in the agricultural sector and with better energy access, industrialization could take place. Correspondingly, Rwanda's Vision 2020 has poverty reduction as one of its goals. Increased energy access could be one of the drivers for this development. It would lead to better health care, schooling facilities and a better standard of life.

4.2 Swedish International Development and Cooperation Agency (Sida)

4.2.1 Company and respondent background

From *Sida - the Swedish International Development and Cooperation Agency*, an interview was conducted with Maria Stridsman. Stridsman has been working for *Sida* for 24 years and has a long experience from Africa in particular. She is currently stationed in Kenya, working with the international project *Power Africa* and the Swedish investments in renewables energies. Stridsman works with all 10 countries and embassies in Africa, Rwanda included, where *Sida* has projects running. The Swedish government aids in creating strategies for the countries in which they wish to pursue projects and then appoints *Sida* to realize them.

4.2.2 Interview findings

The Swedish strategy for Rwanda involves improving the competitive situation, level of employment, environment and climate as focus tasks. Energy is not specifically identified as a focus task in the Swedish strategy, although it creates a bottleneck, which hinders the accomplishments of many of the goals. In Rwanda, renewable energy is not part of the Swedish government's strategy, however, it is part of the strategy Rwanda's Vision 2020 (African Development Bank Group, 2013).

Stridsman says that in Rwanda, energy is more of an enabler to reach the other goals, according to the Swedish strategy, whereas in Tanzania for instance, there is an entire program working with energy development. The energy sector is not growing at the same speed as other industries, which hinders radical change in for instance agriculture and industrialization. To overcome this bottleneck, the energy sector and infrastructure should preferably grow at a faster pace to have a sustainable and stable growth.

One of the main challenges for the energy sector is a lack of knowledge around renewable energy among ministries, banks and financial institutes. This leads to risk-averse banks and financial institutions, which cannot perform proper estimates or evaluations of companies, seeking to establish renewable energy projects in Rwanda. Uneducated ministries on this particular subject also lead to unclear feed-in-tariffs, for which is paid per KW. If a private investor wants to set up an agreement stretching over 20 years, it has to be clear what the feed-in- tariff is, but as it is today, this is not the case. The consequence of this is that many private investors do not dare to make the investment, since these are large capital investments. In Kenya the government has

agreements for 25 years, with clear feed-in tariffs and so far, no payments have been cancelled. Clear frameworks for tariffs are essential for getting more private investors.

Stridsman further says that most of the population is still using biomass as a source of energy, which is relatively cheap. Even if renewable sources would be cheaper in the long run, the first investment, for example a solar cell lamp, is still too high for the average Rwandan. Innovative solutions to solve this problem have been developed in other African countries. In Kenya, companies let people use their cellphones to pay, with “pay as you go”, which is more of a daily cost of paying for the energy use. By doing this, people are not required to pay large initial costs in the beginning of the investment, which enables these companies to reach out to a wider population. This service is spreading and a company called Mobisol is expanding their market into Rwanda. (Mobisol, 2016)

Whether there is a brain drain or not in Rwanda is something Stridsman is reluctant to confirm. “I would rather say that there is a lack of skills in general, rather than a brain drain, at least in that particular industry”. She also points out that there are particular sources, such as hydropower, in which competence exists because it has been used for years. In newer forms of sources however, it is less existent. There are few education possibilities about energy in Rwanda, which could be a reason why brain drain has not yet been seen in the energy sector. Within health care for instance, which is a more traditional profession, there are more educational options, which might also explain why a brain drain has been identified in that sector.

A reason for brain drain could potentially be that you are seeking a better standard of life, according to Stridsman. Rwanda is growing but the main part of the population is still poor. Furthermore, Stridsman states that the political situation in Africa and Rwanda is unstable and could be a potential reason for brain drain.

Stridsman believes that in order to overcome the problems with the skills gap in the energy sector it is of importance that institutions and organizations such as *Sida* continues to support the ministries, especially in their competence. It does not necessarily imply to just give money, but also supporting banks by sharing risks to be able to finance investments. Supporting microfinance institutions is also a part of this, so that for instance farmers for instance can get loans to make an investment for renewable energy.

A problem for the energy industry with the present skills gap is that one has to take in foreign consultants. “A problem with this is that it becomes more expensive and takes longer”. Since there already is a lack of capital in the country, this is problematic. Of course it also depends on which degree of education and competence one possesses, not if you are from Rwanda or an expat. Furthermore, bringing in expats does not have to be a bad thing. It could be beneficial, if the countries can learn from each other and hence speed up the process. The East African Power Pool is seeking to develop the regional energy trade, which can speed up the process of increasing energy access to the population, as the countries themselves do not necessarily have to produce all energy.

Better involvement with the private sector and education is important to create the appropriate competence. As an example of a public-private development project, Stridsman uses an example from Ethiopia. Volvo Trucks needed technicians in Ethiopia, but as there was a lack of technicians they made the decision to start a higher vocational education programme instead of educating 5-6 persons every year internally. *Volvo* contributed with 50%, *Sida* 40% and Ethiopia 10%, therefore sharing the financial burden but also making sure that the skills and competence of the students matched the requirements. “The closer you cooperate with the private sector, the more likely a demand for these skills”. The most important contribution from the private sector was not funding, it was to develop a curriculum that responded to the needs of the labor market, find relevant places for internship for the students, improve teacher training and introduce a more result oriented way of working.

To conclude, Stridsman states that this is a long development process for the country, even if it is developing fast. Whether the current political situation or a more democratic framework will work better is yet to be seen.

4.3 National Commission of science and Technology (NCST)

4.3.1 Company and respondent background

The next interview was conducted with Gaspard Twagirayezu from *NCST*, who works as a knowledge transfer analyst and has worked for the commission for 1, 5 years. Before working at the *NCST*, Twagirayezu finished a combined degree in electrical engineering and engineering management in Oklahoma City in the United States of America. Apart from studying, he has also worked with *NASA DEVELOP*, a recent graduate program, looking at the energy sector. *The National Commission of Science and Technology* works as an advisory board for the government in different sectors within science and technology. They have mandated to advise the government and coordinate policies. The commission is relatively new, only existing for 3.5 years and currently consisting of approximately 13 people, which will however grow in the future.

4.3.2 Interview findings

The Rwandan energy sector is mainly run on hydropower. In addition to this, Rwanda has thermal energy sources and a solar plant. The *Ministry of Infrastructure* has a specific division for energy and has created an Energy Sector Strategy Plan, which is a four-year plan stretching from 2014-2018. As previously stated, an example of this plan is that the government wants to produce 563 MW and increase the amount of households that are connected to the grid, which is 48% on-grid and 22% off-grid. (Republic of Rwanda, 2015) Rwanda Energy Group distributes energy in Rwanda and consists of 2 arms, which work closely together: EUCL (Energy Utilities) and EDCL (Energy Development).

According to Twagirayezu, one of the biggest challenges for Rwanda is that most people are not on the grid. Hydropower is the biggest source of energy but there are not enough generators to produce sufficient amounts. Secondly, costs are a big issue in many ways. It is costly to build up an infrastructure in order to increase energy access, as well as limited purchasing power of the people to buy electricity. This is why it is important to attract more private investors, to be able to upgrade the grid and increase the generation of electricity. Another way of increasing the amount of available energy could be to import energy from other countries.

Twagirayezu confirms the idea that there is a skills gap, but would not call it a brain drain. “Before we have a brain drain, we need to have brains to drain”. There is a knowledge problem and a skills gap but a lack of jobs is not the main issue, according to Twagirayezu since there are

not a sufficient amount of local energy professionals in the first place. He believes it is more of a universal problem, “you want to go where you can find the best opportunities.”

The lack of specialization is a problem in certain sectors, such as the energy sector and the consultants or workforce have to be brought in from abroad. When doing this, it is important to make sure that they do not just build or contribute what they are supposed to do and then just leave. To accomplish this, foreign professionals should work closely with local engineers and professionals to ensure a proper tacit and explicit knowledge transfer. It is important to make the local professionals understand and share the knowledge, in order to increase local knowledge levels and knowledge transfer.

It is also important to consider where students want to go to and where they could be sent to selectively, so as to increase their knowledge base and subsequently enable them to share their attained knowledge. If students or graduates were to work or study abroad, Rwanda can benefit from this as well. A way of closing the gap could be to adjust education to what skills are needed in the industry, according to Twagirayezu. By providing education and training, people can share experiences and get more hands-on practice.

Lastly, in order to have more industries and industrialization, there has to be better energy access, since it is currently not sufficient. Furthermore, the costs have to drop so that more people can afford the electricity and enjoy the benefits that come with it, which will also enable growth in overall economic output.

4.4 Ministry of foreign affairs

4.4.1 Company and respondent background

To gain an additional perspective on the context of the brain drain in Africa, Måns Felleson has been interviewed, who has returned to work at the *Ministry for Foreign Affairs*, after having worked for four years at the *Nordic Africa Institute*. He now works at the Global Agenda Department and is responsible for how the 2030 Agenda will be financed, which includes how to “end poverty and hunger, realize the human rights of all, achieve gender equality and the empowerment of all women and girls, and ensure the lasting protection of the planet and its natural resources” (Government Offices of Sweden, 2016). During his time at the *Nordic Africa Institute*, a research team was under his supervision that dealt with migration issues in Africa and his own projects focused on the mobility of researchers, provided with aid from Sweden. Felleson has mainly worked on migration issues related to the university in general, but also has had research responsibilities for Rwanda, when working at *Sida*, resulting in having attained a good overview on the context of the current subject and country.

4.4.2 Interview findings

Although Felleson says that brain drain in Rwanda can fairly certainly be confirmed, he believes that one of the main difficulties when researching the issue is to determine whether and when a person is classified to have been brain drained or not and to what extent. He continues, that in an African context, there is not enough data available. Much is estimated from the statistics from who are abroad, for what reason, how long they are away or if they ever come back. This implies, that it becomes very difficult to follow up and come up with precise figures on the subject. However, it is his belief that even though acquiring the statistics is difficult, it is possible to conclude that it is possible to acknowledge the problems that brain drain can generate.

In terms of brain drain, Felleson looks at the issue in a long-term perspective. On the one hand, he states that people in general strive to get a return on their invested education and consequently some go abroad to seek these opportunities. However, some of those who go away come back after a certain amount of time with new experiences, new forms of training programs, etcetera that have generated new skills, knowledge and a network of contacts, to which Felleson refers to as the concepts of brain gain and brain circulation. On the other hand he states that one needs to look at the opposite as well. During the years of absence, the country of origin also misses out on years of productive work from this person. He consequently posed the question: “What is worth

the most, to remain or to go away?” and answered that the outcome is disputable, because there are many different variables to take into account. He also states that there is a possibility of a double brain drain of highly competent people, leaving the country.

As a more extensive example, Felleson states that if one goes to the USA to work for McDonald's or some other low-qualified job in the developed world, one can earn relatively more there than what the skilled laborer would receive at a more qualified job at home. Consequently, this can cause a qualified worker to not use their education either at home or abroad, whose skills deteriorate over time. In any case, Felleson argues that an important aspect in general is that if other countries know that there are competent people residing in Rwanda, who boost developing innovations for further economic growth, it will provide an incentive for those other countries to provide more aid.

Felleson reveals that the level of education in Africa is generally very low. He further explains that countries claim that they are generating a highly educated workforce, but there usually is lack of interaction between the universities and the community's needs. He gives an example of how for instance many people are educated to become social scientists, even though there are not enough positions for them to fulfill, merely because it is cheaper than educating people to become doctors, engineers, etcetera. This leads to difficulties creating and maintaining a proper quality educational system.

It is therefore important to consider what to invest in, especially given the magnitude of these investments, when educating a well-trained, specialized workforce. One inhibiting factor is that when demand of specialized personnel cannot be found at home, it is often easier to take in the specialization from abroad. A subsequent problem with doing this is that one hires them for certain projects after which the specialized personnel leaves again. This leads to the country having a new technology for which there is not skilled workers to maintain it. This leads to a negative spiral of dependency, which Felleson notes is a classical mistake of foreign aid. Therefore, it is important to build capacity and have competent people who can take care of new technology, in order to become self-sufficient without bringing in people from abroad. Furthermore, he concludes that innovation is often context-based, and that anyone who is originally from Rwanda should know more about what is needed than any foreigner.

Fellesson also states that it is generally important to train a certain amount of people, but in Africa the issue of a constructive quality is another matter. A high standard of education is of great importance in order to get closer to a solution. This requires for instance more qualified teachers, which applies to the entire system. It is not solely important at the university level, that a high standard is important, but it also has to extend to the levels down the chain as to prevent the creation of a gap. It is therefore necessary to have a holistic perspective, where it is acknowledged that every level depends on the others, with Fellesson exemplifying by that you cannot have research without broadband.

Since Fellesson has worked a great deal with neighboring countries of Rwanda, he elaborated a bit on the situations and issues there. For instance, in Ethiopia, the diaspora is very large, since many doctors leave for the United States, which therefore indicates a clear case of brain drain. In Tanzania and Mozambique, however, this is not the case to such a great extent as in Ethiopia. Fellesson has no clear-cut explanation for this occurrence, only that there are several contributing factors behind it. However, it might be that Mozambique does not get many offers from the West, as they did not broadly master the English language. Moreover, many people who stay, might do so out of a sense of moral obligation as the state has improved funding education after the Civil War.

Finally, Fellesson state that political factors and instability might be the cause for leaving Rwanda, as well as to the ability to get better deals abroad. He continues that due to the nature of the current authoritarian regime, there is a lack of available statistics and that it is very time-consuming to get access to information, which leads to the postponement of research on for instance research mobility in Rwanda.

Because of this, you can also get some biased response when talking with people from Rwanda. However, he felt that more candid answers were given by Rwandan researchers, who reside or have resided in Sweden. One of the so-called pull factors that incentivizes people, especially researchers to leave their country of origin, is the possibility of having better endowments in which to carry out their research in terms of both pay and access to equipment. In their native countries, these people do not receive the same opportunities to achieve their aspirations.

4.5 Master students at Carnegie Mellon University (CMU)

4.5.1 Company and respondent background

Carnegie Mellon University (CMU) is a world leader in engineering education and research and expanded to the continent of Africa in 2012, by establishing the CMU Information and Communication Technology (ICT) Center of Excellence (CoE) in Kigali. Moreover, this undertaking is in partnership with the Government of Rwanda (*Carnegie Mellon University*, 2016a), where *Carnegie Mellon University* sees this as an opportunity to be pioneers in Africa, when it comes to innovations that can change the world (*Carnegie Mellon University*, 2016b). In order to see the point of view of future graduates, three first and second year students were interviewed at the Master of Science in Electrical Engineering and Computer Engineering (ECE) program. The program is supposed to have a very technically focused curriculum, by providing the students with skills in energy systems, mobile computing and telecommunications (*Carnegie Mellon University*, 2016b). The responding students are all male students between the ages of 25 and 29 and will be referred to as Student A, B and C.

4.5.2 Interview findings

What all three students agreed upon was that the political environment in Rwanda can be challenging. Student A described it as; “Africa is Africa, it is not stable, it can be one thing today and another tomorrow”, which was not that different from what Student B referred to by saying “In Africa you never know, it is unpredictable”. Student C also mentioned that the uncertainty of corruption is one of the factors that hinder people to apply there, even though Rwanda is doing a good job fighting it. In other words the corruption is relatively low by African standards, according to Student C.

One instance where both Student A and B agreed upon, was that Rwanda is attractive in a sense of entrepreneurship and that as a result many people come to work there. Since many industries are still in their infancy stage, companies can penetrate these markets without competition. They further elaborated that Rwanda is growing very fast and there are many things to improve, which creates huge opportunities. According to Student B, another reason to stay in Rwanda was that the people love their country and want to make an impact from the start - “People need a sense of belonging”.

There are a variety of reasons for leaving Rwanda, but what is most evident is that the salary and the opportunity to pursue a career are the main drivers to seek jobs abroad. Student A described the possibility of people graduating with a master's degree who struggle to get qualified jobs and when they do, it is often not well paid. Student C exemplified the difference in salary between the locals and expats, by stating how one of the telephone companies in Rwanda reduced the number of expats, in order to create more jobs in favor of locals. He was referring to the fact that one expat costs as much or more than five locals, while being required to the same amount and level of work. Student B however, did not think that finding a job within the energy sector would be hard when holding a master's degree, but imagined it to be harder as an undergraduate. Student C similarly implied that finding a job within the energy sector as an engineer tends to be easier in comparison to other industries, since the government is putting a lot of money and effort in for instance the ICT-development of the country. With that in mind, Student C will consider going abroad to start his career in case he cannot get a qualified job, even though having a strong desire to stay in Rwanda. If necessary, Student B is also open to go anywhere within or outside the continent to be able to pursue a career. Interesting tasks, appreciation, a challenging and exciting job and doing something different from the traditional way are the characteristics of a job most important to him. He stated this by explaining to be "seeking a challenge. In the tech sector this gap has partially been overcome" and therefore does not know yet whether to stay or not.

With respect to international experience, all of the students have gone abroad, either for work, attending an internship or for their studies. Student A explained that the school requires you to get a paid internship, that is part of the education, which is however not common in Rwanda. When Student A went studying in the US during his bachelor's degree, he got in contact with the main sponsor of the American school, for whom he is working now in Rwanda. He further elaborated how they have career fairs at their university, yet no energy companies are present, only IT related companies. Student B is originally from the neighboring country Uganda and came to Rwanda only for his master's degree. After his graduation he wants to develop his three startups stationed in both Rwanda and Uganda, including renewable energy, handling of biomass waste and management.

Student B explains that it is common to go to work in neighboring countries and that he has Rwandan friends who have done internships in Tanzania, that later on opened a branch in Rwanda as well and now they are back. Right now, Student B works as a teaching assistant at the university, where his current tasks do not relate too much to his field of study. He explained that

he has not really been exposed to the work market yet and that being a teaching assistant at *Carnegie Mellon University* in cognition and data science does not require him to really teach, therefore he is now considering a PhD. Student C has had an internship in Uganda, as he wanted to specialize in mass media, which was not as developed in Rwanda then. He also stated that very few internships are paid and that many students are applying for these internships. After graduation, he wants to stay in Rwanda to develop telecommunications, but with the IT-market sometimes being saturated, he might be forced to go abroad.

Student C adds, that another solution is to create seminars, boot camps and workshops, where graduates can meet companies and can create something and get funds from institutions. In other words, not only by looking for jobs, but also entrepreneurial options.

5. ANALYSIS

In this section we will discuss our empirical findings, link it to the theoretical framework and connect the dots of the research. After completion of all interviews we have seen a pattern in the answers, which leads us to some conclusions.

In order to analyze the outcome of this research, we have carefully looked at the linkages between theory and empirical findings to see what assumptions can be strengthened, what is missing in existing research and what can be added to future research. The different parameters will further be explained in detail and answer the research questions stated in the beginning of the study at hand, of what is causing brain drain and how to overcome it.

<i>Correlation between theory and empirical findings</i>			
	Theory	Empirical findings	
Lack of data	Yes	Yes	✓
Regional integration	Yes	Yes	✓
Linkage university with industry	Yes	Yes	✓
Importance of innovation	Yes	Yes	✓
Reliance on policies & tariffs	No	Yes	✗
Infrastructure	Yes	Yes	✓
Lack of brains	Yes	Yes	✓
Skills gap	Yes	Yes	✓
Competence from abroad	Yes	Yes	✓
Brain gain	Yes	Yes	✗

Table 5. *Correlation between theory and empirical findings*

5.1 Brain drain

5.1.1 Causes of brain drain

Push and pull factors

When analyzing the reasons for leaving Rwanda, the students' responses are largely consistent with the six gradients of Dovlo (2003). Together the students more or less, touch upon all of the six most common gradients, developed by Dovlo (2003), but what can be seen as the most important factors are the opportunity to pursue a career and to have a satisfactory job (Muula, 2005; Krugman and Obstfeld, 1991, Filler et al, 1996; Jovanovich, 1997; Tassinopoulos & Werner, 1998), which Felleson also said could be important indicators for researchers whom he has studied before.

Geographical movements

When we asked the participating students at *Carnegie Mellon University* where they are working or going to work after their training in electrical engineering, it is quite easy to see that the responses indicate that it is not very easy for them to generally find jobs in their field in Rwanda. They stated how open they are to moving to neighboring countries or even outside the continent, if they need to in order to be able to make a career. This is consistent with the framework of Chetsanga (2003), describing the different types of brain drain, depending on where they end up. All students can, according to themselves, fall within the scope of primary and secondary external brain drain. However, according to our findings, one of the students falls into the category of internal brain drain, as he had duties that were administrative and did not have anything to do with his education according to himself.

Lack of data

Due to the nature of our research, we found it relevant to ask the participants if there is a confirmed brain drain in the energy sector in Rwanda. As stated by several scholars (Carrington & Detragiache, 1998, 1999; Meyer, 1999; Beine, Docquier & Rapoport, 2003; Zlotnik, 1998), both Tashobya and Felleson agreed that the phenomenon is hard to measure because of the lack of data. Because of such poor statistics, it is not possible to give exact numbers on who has gone where, why, or whether the person has in mind if he aims to come back to his/her country of origin. Multiple scholars (Carrington & Detragiache, 1998, 1999; Meyer, 2001; Beine, Docquier & Rapoport, 2003; Zlotnik, 1998) confirm that data is difficult to assess, since a systematic data

collection system that shows the migration flows by country of origin and education level is required. According to Zlotnik (1998), the countries either lack the system or do not process and publish the data emanating from it. Therefore, we are assuming that it is not yet possible to confirm a brain drain in exact numerical values, since one then has to rely on data from each country worldwide about the country of origin, as well as the education level of all its immigrants. It is currently too hard and complex to measure. Fellesson, who has worked with researcher mobility of African researchers, also brought up the issue of lack of available data as one of the reasons why Rwanda is not yet studied in his research. As he stated, along with the other respondents, Rwanda has a regime with limited freedom of press (Sida, a., 2014). Consequently, Rwanda is reluctant to give access to information, which is not uncommon within the context of Africa in general nor Rwanda specifically (Sida, b., 2014). Considering this, our findings show that when it comes to brain drain, only estimations can be done, due to the aforementioned lack of data (Carrington & Detragiache, 1998).

5.1.2 Overcoming brain drain

The main strategy in overcoming brain drain is to focus on research and training in specific sectors, based on national priorities and orientations (Saravia & Miranda, 2004). According to several organizations (Republic of Rwanda, 2012; National Commission of Science and Technology, 2016), but also our respondents Twagirayezu, Tashobya and Stridsman, the energy sector is one of the most important sectors to focus on, as it does affect many other areas as well. Therefore, the following actions should be made, according to Saravia & Miranda (2004), in order to overcome brain drain:

- Implement educational strategies that highlight the national priorities through targeted national programs, as well as training abroad.
- Invest in infrastructure for research and development and create opportunities that enhance the growth of the public sector and the private sector for research, technological development and innovation.
- Create strong leadership that will enable unified collaboration both internally and externally, of scientific and technological capacity.

Conditions for knowledge creation

Factors such as political decisions, financing, infrastructure, technical support and the scientific community are often inadequate in developing countries, which compared to the developed

countries, hinder the capacity to do research (Meyer and Brown, 1999). Felleson explained that the conditions for conducting research can be so different due to endowments such as pay and access to equipment, which researchers consequently choose to go abroad. This could be overcome by improving the conditions for knowledge creation in a favorable environment for research and development (Meyer & Brown, 1999; Saravia & Miranda, 2004). Carrington & Detragiache (1999) state that estimations indicate that about one third of all professionals in research and development, live and work in a few developed countries, which in our opinion also indicates how important proximity to these factors are.

Building capacity for research and development

Developing countries can also prevent brain drain by building research and development capabilities, as well as investing in education and research and development (Saravia & Miranda, 2004). Linking the university to the industry could create a capacity for research and development, by learning what is important for the energy sector in particular and develop expertise in order to close the skills gaps. Stridsman argued that it is more likely that the demand for these skills increase if they have been developed through tight collaborations during the time of study.

Building opportunities for national development

Building opportunities for national development can be illustrated by China becoming a leader in biological research and biotechnology (Saravia & Miranda, 2004; Dodani and LaPorte, 2005). Rwanda could do the same by for instance becoming the leader in the energy sector in Eastern Africa. By collaborating with neighboring countries, Tashobya means that Rwanda could obtain advantages by a knowledge transfer. Furthermore, Stridsman and Tashobya referred to The East African Power Pool that is partly seeking to do this, by establishing better regional energy trade (East African Power Pool, 2016; International Renewable Energy Agency, 2013). Stridsman explained that by increasing the regional energy trade, the entire region could use and allocate resources more efficiently, and as for the example regarding China, such an initiative could lead to attraction of both international collaborations in joint ventures as well as professionals from Rwanda and abroad (Saravia & Miranda, 2004; Dodani and LaPorte, 2005).

Remittances from citizens living abroad

In the 1990s, the growth of remittances over a five year period led to a growth rate, that was equal to 20% per year worldwide (Orozco, 2002). Ratha (2003) argues that remittances from

citizens living abroad are an important aspect to take into consideration, when looking at the movement of skilled workers in developing countries, as they in the long run can be used to develop the social and economic development of their home country and thus overcome brain drain. These benefits of this can be regarded as quite similar to the one that Felleson states about executives and university graduates leaving the country for a while and returning with new skills that in the long run will help develop the economy of the home country, a so called brain gain.

5.2 The energy sector

5.2.1 Characteristics of the energy sector in Rwanda

The importance of innovation for the energy sector

In Rwanda, the energy infrastructure only reaches about 20% of the population (Republic of Rwanda, 2015), which creates a bottleneck for further growth of the entire country. Stridsman describes the energy sector as a primary factor (National Capacity Building Secretariat, 2016; Republic of Rwanda, 2012), for further development in all other sectors and in the overall development of the country. Tashobya also agrees on this and refers to the fact that the energy does not reach most of the population in Rwanda with the energy being produced as the most expensive in the region. About 80% of the population still works in the agricultural sector and 85% still uses biomass as their main energy source, according to Tashobya. Since biomass is a relatively cheap source of energy, the alternative cost of investing in a solar cell lamp is too costly for many people, as stated by Stridsman. In a long term perspective the solar cell lamp will pay off, but the investment still has to be made.

With an increased inflow of private investors and establishments of companies, the electrification of the country would be triggered by the development of the energy sector, spreading to development of the entire country (International Renewable Energy Agency, 2013). We further believe that it would provide a better climate for entrepreneurs, whom would benefit and increase innovation, which in turn leads to higher knowledge levels as well as increased quality of education overall. Tashobya further claims that tapping from proven knowledge would boost innovation and knowledge in the sector, to generate further growth, which is supported by Saravia & Miranda (2004)

Stridsman referred to an example, which justifies our thoughts on this. The company *Mobisol* launched an innovative solution by letting people use their smartphones with a “pay as you go” – service for electricity (Mobisol, 2016). This decreases the cost of the primary investments, which enables more people to use and get access to electricity. Not only does this increase the accessibility of energy, it also is the essential part to spur a positive spiral. Increased energy access would have social and economic benefits of which the entire population can benefit. Stridsman, Tashobya and Twagirayezu refer to the *East African Power Pool* as part of such a solution. These types of increased regional grids would lower the costs as it benefits from economies of scale (International Renewable Energy Agency, 2013). However, even though these innovative solutions are spreading to Rwanda, it is necessary to extend and upgrade the grid in order to get the electrification of the country started.



Figure 1. The importance of innovation for energy sector

In Rwanda’s vision for 2020, very ambitious goals have been set, aiming for enabling access of energy to 48% of the population on-grid and 22% off-grid. So in total, the increase would be energy access from 20% to 70% energy access (Republic of Rwanda, 2015). For this to become reality, we believe that the energy sector is depending a lot on innovation and are consequently in need for specialized and skilled personnel to make this happen.

Reliance on policies and tariffs and better education

Both Stridsman and Tashobya say that the banks and financial institutes are still reluctant to lend money, as they perceive energy and renewable energy in particular, as a high-risk investment compared to safer options such as real estate and agriculture. One reason for this is that they do not possess sufficient knowledge in order to conduct proper evaluations on companies seeking to establish businesses in Rwanda. Furthermore, Tashobya says that the interest rates used by the banks are prohibitive. In addition to this, ministries are also subject to a lack of knowledge on the subject, which is a potential reason for why the feed-in-tariffs are unclear. As the Rwanda Development Board (2012) mentions in the skills gap report, there is a lack of quality education

within the energy sector, which reaches up to international standards that is required for further development. This specifically applies to professionals working in the industry itself. However, if the quality in the sector overall is lower than international standards, this in turns reflects negatively on other sectors, as for example in this case of banks and financial institutions.

For private investors, both of these issues are a problem since they both lead to a lack of financial support and unclear estimates of income. Overall, we believe it might cause private investors to choose other countries over Rwanda as it is perceived as a safer option and would mean a secondary brain drain if executives and university graduates chose to go there for that reason (Chetsanga, 2003). Stridsman mentions Kenya as a neighboring country, which has agreements stretching over 25 years and clear feed-in tariffs. If private investors have to cancel plans on establishments in Rwanda because of unclear tariffs and policies, the ministries should work on frameworks that could better support entrepreneurship (International Renewable Energy Agency, 2013). This would imply clear terms and conditions in the contracts, as well as clear feed-in tariffs, in order to ensure the investor of a reliable contract. Furthermore, regulations for banks and financial institutions should be regulated to create competitive advantages. Investments in energy are often costly, which is why these policies are crucial for investors. Policies and regulations could potentially improve further development and industrialization in the country, as the sector is dependent on private investors. For this reason, the importance of private investors is also stated in theory as a critical point to achieve these goals (International Renewable Energy Agency, 2013; African Development Bank Group, 2013).

The importance of infrastructure for the energy sector

The infrastructure in Rwanda is, according to the respondents, limited and only reaches about 20% of the population (Republic of Rwanda, 2015). As both Tashobya and Twagirayezu explain, the issue is that most people are not on the grid and the grid itself is old. The Rwandan government is currently not signing any new power purchase agreements because of this reason and the plan is to upgrade the grid soon, according to Tashobya. In addition to this, costs are an issue, since building up an infrastructure across the country is capital intense and thus costly. Private investors are needed to upgrade the grid in order to extend the energy access to the people of Rwanda (International Renewable Energy Agency, 2013; African Development Bank Group (2013).

Yet, by increasing energy access, it does not necessarily mean that the people of Rwanda have the purchasing power to actually buy it, since most of the population is still poor (Sida, 2014b). One way of bringing down these costs, according to Twagirayezu, is to import energy from neighboring countries, something Stridsman also mentions and speak of the *East African Power Pool* (East African Power Pool, 2016).

If this were to become reality, energy becoming cheaper would mainly lead to the following two results: increased energy access to the population, which makes people enjoy the corresponding benefits as well as positively influence the industrialization of the country. This is supported by theory, which states that regional grid cooperation could benefit from economies of scale with accompanied lower costs (International Renewable Energy Agency, 2013).

However, as no new power purchase agreements can be signed due to limitations of the grid, it is our belief that the possibility of private investors to choosing a neighboring country increases. With the *East African Power Pool*, Rwanda could still enjoy the benefits of an increased energy access, but from a perspective of brain drain, it could potentially generate a secondary brain drain (Chetsanga, 2003). A secondary brain drain does not necessarily have to be a bad thing, as individuals leave, accompanied by their knowledge, to a neighboring country to work, but also bring back new knowledge when they return to Rwanda at a later stage. After being abroad and learning about techniques that might not yet be used or widely known and spread in Rwanda will provide them with specialized knowledge, which is highly requested, according to all respondents. Regardless, we believe that even though regional grid integration could be beneficial for Rwanda, it is important to upgrade the grid and increase the domestic energy production as well.

5.2.2 Skills gap

Gap in supply-demand and education standard and training

The level of education in Africa is unsurprisingly generally very low and a contributing factor causing the skills gap in Rwanda. Fellesson revealed that African countries often focus on producing the wrong kind of skills, which Tashobya also claimed to be true. Instead of investing in education, in fields such as doctors and engineers, many social scientists are being trained, because it is cheaper. In other words, there is a very poor correlation between what the university produces and what the society needs. Moreover, he believes that one often seeks to generate

laborers, but the reality is different. The focus is on educating as many people as possible and less focus is given to maintain a high standard of quality.

A skills gap report (Rwanda Development Board, 2012) showed that the standard for training in competency-based education in the energy sector is too low in Rwanda compared to international standards. Tashobya notes that students deliver what is expected from them and from the limited training they have received. Either way, he further says that in order to decrease the skills gap, the *WDA* will look into this issue and identifies what is needed to create the corresponding education and knowledge.

What has become clear from comparing predictions of the interviewed experts within energy and brain drain as well as existing reports, is that a solution to the skills gap in the energy sector of Rwanda is crucial for the continuous development of the country.

Competence from abroad

Because of a shortage of specialized skills in the energy sector of Rwanda, the economy has to take in the expertise from abroad to fill the skills gap according to Tashobya, Stridsman, Felleson and Twagirayezu, which also is in accordance with what Chetsanga (2003) argued about. All experts further explained that this would be very costly as it results in a kind of dependence spiral that will be difficult to get out of. Stridsman added that with hiring skilled workers from abroad becomes even more expensive and takes more time. Since there is already a shortage of capital, Stridsman continued, this would dig an even deeper hole in the economy. This dependence of foreign workers is in the long run not sustainable for Rwanda or other African countries, facing the same issues (International organization for migration, 2016).

Twagirayezu and Felleson pushed for the importance of making the local professionals understand and share their knowledge as to boost knowledge transfer. When doing this, it is of importance to make sure that they do not just build or contribute what they are supposed to and then just leave, as stated by Twagirayezu. Felleson highlighted that there is a need to build capacity and have competent people who can take care of this in order to thus become self-sufficient without bringing in people from abroad. Felleson further came to the same conclusion as Chetsanga (2003): the risk is that you end up in a so-called aid trap, where you rely on technical expertise, for which foreign personnel is only brought in for certain projects, who leave after completion without necessarily having transferred the know-how about the nature and

maintenance of new technologies, which the local experts do not have the skills to maintain. Moreover, Tashobya highlights that when using non-local knowledge while implementation of new technology, it is important to adapt to local dynamics. If this is not done properly, the project may be slowed down, be unsustainable or even fail. Furthermore, Fellesson argued that innovation is often contextually based, and that anyone who is originally from Rwanda, should know more about what is needed than an expat.

Brain gain

What has come to our attention is that the respondents tended to look at the problem more as a skills gap rather than a brain drain. Moreover, Twagirayezu brought up the importance to look at where the students want to go and where they could be sent selectively, so that they can learn different skills abroad and come back to share and implement their knowledge. If students or graduates were to work and/or study abroad, Rwanda can benefit from this as well. Also Fellesson also brought up the benefits of going abroad by stating that those who go away, may actually come back after a few years with new experiences, training programs, etcetera, that have generated new skills, knowledge and a network of contacts. The two of them referred in other words to the concept of brain gain.

6. CONCLUSIONS

The purpose of this study is to investigate how the energy sector in Rwanda is affected by brain drain. In order to fulfill this purpose, a case study has been performed, where students from the Master of Science in Electrical Engineering and Computer Engineering (ECE) program at the Carnegie Mellon University in Kigali, Rwanda and experts within the areas of brain drain and the energy sector in Africa or Rwanda founded the basis for the empirical findings. To understand how the participants perceived the connection between brain drain and the energy sector of Rwanda from all angles, semi-structured interviews were conducted. Two sub-questions were developed and corresponding responses will lead us to the answer of the main research question.

SQ1: What is causing brain drain?

On the one hand, there are factors in the sending countries, which make it unattractive for skilled workers to work in the country of origin. On the other hand, there are factors in the receiving countries, which make it attractive for skilled workers to work abroad. According to both existing literature and our empirical findings, we can conclude that there are six main reasons that are founding the basis for what is causing brain drain. Differences between sending and receiving countries regarding income, job satisfaction, career opportunities, governance, protection/risks and social security are the main gradients that are potentially causing brain drain.

Due to the fact that Rwanda has a regime, which is strained, controlled and an accompanied limited freedom of press and speech, there is a lack of data. Moreover, there is a shortage of systems to collect statistics of comparable data regarding migration flows containing information about country of origin and level of education of the immigrants. Therefore, it is very hard to make a clear statement by numbers, whether or not and to what extent the energy sector in Rwanda is affected by brain drain. Therefore, only estimations of numbers can be done regarding brain drain.

SQ2: How can brain drain be overcome?

In order to overcome brain drain, the core is to focus should be primarily on research and training in specific sectors, based on national priorities and orientations. One of Rwanda's strategies

regarding this topic is the development of the energy sector. For the development to succeed there are some main actions that are necessary to achieve. Firstly, implementation of educational strategies that highlights these priorities through targeted national programs, as well as training abroad. Secondly, investing in infrastructure for research and development and creating opportunities that enhance the growth of the public sector and the private sector for research, technological development and innovation. Thirdly, create capable leadership that will enable unified collaboration both internally and externally, of scientific and technological capacity.

RQ: How is the energy sector in Rwanda affected by brain drain?

During the study of the phenomenon of brain drain another issue has arisen, which has become even more important to highlight regarding the effect on the energy sector of Rwanda. Since there are not enough skilled workers within the energy sector, to leave the country to classify the problems as a brain drain, it is rather a matter of a skills gap. There is not a sufficient amount of qualified workers to handle highly technical tasks that the energy sector requires in order to come up with innovations for further development. Overall, one can say that the skills gap is based on a consistent lack of education from the bottom-up. Due to the fact that the university students do not get enough training or specialized skills during their studies, they cannot reach up to the same standard as international standards.

Because of the shortage of specialized skills in the energy sector of Rwanda, the economy relies on expertise from abroad to fill the skills gap. This is both very costly and time consuming, but what is even more problematic is the risk of getting trapped in a spiral of dependency that will be difficult to get out of. This dependence on foreign workers is in the long run not sustainable for Rwanda and they need to find a way to close the skills gap. Furthermore, there is the risk that when the skilled foreign workforce ends their contract, one is standing there with no competence to maintain what has been developed.

To conclude, the energy sector of Rwanda is not affected by a brain drain due to a skills gap. However, theory confirms that brain drain is a problem among highly skilled workers in less developed countries and as the sector develops, it is a risk and actions to overcome/prevent this might be necessary.

6.1 Recommendations

Suggestively, as our findings shows, our recommendations are rather to take actions against a skills gap and as the sector develops, take actions to overcome/prevent brain drain.

First of all, increasing the quality of education to comparable levels, as the international standards would decrease the skills gap as well as the extensive need for bringing in knowledge from abroad. This can be done by teaching in smaller classes, usage of better equipment as well as increasing the competence among teachers, which can then provide more specialized training. Moreover, it is very important to look at the demand of required skills and knowledge in the country and thereby adapt education in order to close the skills gap. Besides better education and training at the universities, in-company training is also important to counter the skills gap and develop the required skills for the energy sector of Rwanda. Furthermore, clear tariffs and regulations would provide incentives for companies to expand into Rwanda and thus create more jobs and attract more capital.

6.2 Suggestions for further research

The study has been focusing on Rwanda itself and no other countries, due to time countries. However, it would be interesting to investigate and benchmark this case to other East African countries and see what the differences might be. By doing so, better conclusions could be made on how cooperation and partnerships could prevent and solve brain drain. Suggestively, a field study in Rwanda would ease the data collection, as we believe the physical proximity highly affects the outcome and with better access to data more robust results can be expected.

One of the main findings of the research is that there is no brain drain of the energy sector in Rwanda, due to the skills gap. Therefore, it would be of importance to further research how the skills gap can be reduced and how to increase the quality of the education.

Brain drain does not necessarily have to be a bad thing, there can also be positive effects stemming from it. As a suggestion, it would therefore be interesting to investigate how brain gain and its positive effects could affect the development in the energy sector of Rwanda.

In addition, several respondents suggested that tariffs and regulations were unclear and might work counterproductively while trying to attract capital and companies to Rwanda. Therefore, an

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interesting perspective would be to investigate the effects of regulations and tariffs, before and after implementation, on the growth and development in the energy sector of Rwanda.

Similarly, it would be interesting to add the perspective of the importance of research and development in the energy sector of Rwanda and how it would affect the continuous growth over time.

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8. APPENDIX

8.1 Interview guide - Nelson Tashobya, AOT Consulting

Can you tell us a little about your current position and your previous work experience within the field?

Tell us briefly about the organization you are working for and what you do there?

What did you do before working at your current position?

How does the energy sector look in Rwanda now?

How developed is the infrastructure of the energy supply?

What kinds of energy are used?

What are the biggest current challenges for Rwanda in the energy sector?

Is there enough skilled workers to develop the energy sector further?

Does the government support the development?

What is important for the development of the energy sector?

To what extent do you think brain drain is a challenge for the energy sector?

In the energy sector, how does using non-local knowledge effect the implementation of new technology in terms of knowledge about local needs and culture?

How would you estimate the proficiency within the energy sector for employees overall?

How qualified are the tasks in relation to their degree or proficiency?

How do the possibilities for personal professional development look?

What could in your opinion other countries do to take action to help developing the energy sector in Rwanda?

What could be economic, social and environmental benefits of developing the energy sector in Rwanda?

8.2 Interview guide - Maria Stridsman, Sida

Can you tell us a little about your current position and your previous work experience within the field?

Tell us briefly about the organization you are working for and what you do there?

What did you do before working at Sida?

What do you believe is causing brain drain in Rwanda specifically?

What causes could be related to the country of origin (Rwanda)?

What causes can be related to receiving countries?

Apart from the often referred to as common reasons for brain drain (lack of jobs, etc.) are there any specific reasons why brain drain is large in Rwanda?

Due to its size?

Due to the location of the country?

Due to other factors?

Where do skilled workers go to seek employment? (overseas, within continent, within country or in other fields of work)

Why?

How could brain drain in your opinion be overcome?

What the country of origin (Rwanda) do?

What could other countries do?

Do you now how other countries or more specifically, African countries have done to overcome brain drain?

Could similar strategies be used in Rwanda? Why/why not?

8.3 Interview guide - Gaspard Twagirayezu, National Commission of Science and Technology

Can you tell us a little about your current position and your previous work experience within the field?

What do you do now?

What did you do before working at NCST?

Tell us briefly about the organisation you are working for.

How does the energy sector look in Rwanda now?

How developed is the infrastructure of the energy supply?

What kinds of energy is used?

What are the biggest current challenges for Rwanda in the energy sector?

Is there enough skilled workers to develop the energy sector further?

Does the government support the development?

What is important for the development of the energy sector?

To what extent do you think brain drain is a challenge for the energy sector?

In the energy sector, how does using non-local knowledge effect the implementation of new technology in terms of knowledge about local needs and culture?

How would you estimate the proficiency within the energy sector for employees overall?

How qualified are the tasks in relation to their degree or proficiency?

How do the possibilities for personal professional development look?

What could in your opinion other countries do to take action to help developing the energy sector in Rwanda?

What could be economic, social and environmental benefits of developing the energy sector in Rwanda?

8.4 Interview guide - Måns Fellesson, Ministry of Foreign Affairs

Can you tell us a little about your current position and your previous work experience within the field?

What do you do now?

What did you do before working at the Swedish Ministry for Foreign Affairs?

Tell us briefly about the organization you are working for.

What do you believe is causing brain drain in Rwanda specifically?

What causes could be related to the country of origin (Rwanda)?

What causes can be related to receiving countries?

Apart from the often referred to as common reasons for brain drain (lack of jobs, etc.) are there any specific reasons why brain drain is large in Rwanda?

Due to its size?

Due to the location of the country?

Due to other factors?

Where do skilled workers go to seek employment? (Overseas, within continent, within country or in other fields of work)

Why?

How could brain drain in your opinion be overcome?

What the country of origin (Rwanda) does?

What could other countries do?

To what extent do you think brain drain is a challenge for the energy sector?

Do you know how other countries or more specifically, African countries have done to overcome brain drain?

Could similar strategies be used in Rwanda? Why/why not?

8.5 Interview guide - Students at Carnegie Mellon University in Kigali, Rwanda

Tell us briefly about yourself. Who are you?

Degree/year?

Age?

Gender?

What is your highest accomplished degree?

Have you spent any time abroad? (studying, doing research or working)

What could be reasons for you to leave Rwanda for a job abroad? (salary, unemployment etc.)

What reasons would make you stay in Rwanda?

Where do you believe you will work after graduation? (overseas, within continent, within country or in other fields of work)

During your time at the university, have you had any contact with companies?

Internship

Ex-job

Working part time

How qualified tasks do you estimate that you will get at your first job related to your degree?

What do you believe is causing brain drain in Rwanda specifically?

What causes could be related to the country of origin (Rwanda)?

What causes can be related to receiving countries?

Apart from the often referred to as common reasons for brain drain (lack of jobs, etc.) are there any specific reasons why brain drain is large in Rwanda?

Due to its size?

Due to the location of the country?

Due to other factors?

How could brain drain in your opinion be overcome?

What the country of origin (Rwanda) does?

What could other countries do?