



**College of Science and Technology**

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## **Research Dissertation Title**

**“CHALLENGES FOR LOCAL FINANCIER IN  
RWANDA TO INVEST IN RENEWABLE ENERGY  
SOURCES AND ITS MITIGATION.”**

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A Dissertation submitted in partial fulfilment of the requirements for the degree of  
MASTER OF SCIENCE IN ENERGY ECONOMICS in the College of Science and  
Technology

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## DECLARATION


The study project reported is the results of my efforts and had never submitted in any other college or university for the same award.

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## **ABSTRACT**

Electricity access and use are known worldwide to be the key booster for reliable development. To fail in the integration of the sound energy sector is to fail at all in development. The challenge of the local financier in Rwanda to invest in renewable energy is a great topic that the researcher should develop and help to deliver the outcome that is helpful to the society. The Rwandan energy sector is keeping developing and the government of Rwanda with the partnership of the development institutions as well as development of different programs, Rwanda has made the remarkable development energy sources. Even though the development there is still a gap in the energy sector due to the challenges that arise in the financial sector in investing in renewable energy. Results of the study showed that some of the challenges are small product size, the real risk in investment, lack of skills evaluation, lack of internal reward/ incentives, limited ability to pay back, remote customers those were the challenges and some of the mitigations are: insurance, infrastructure and adequate quality control are some mitigations strategies. Generally, the energy sector in Rwanda has remarkable development but there is still some gap to address. That is why the policymakers should design the policies that favor the financial institution as the attraction methods to support 100% access to electricity as the government of Rwanda targets and encourage the local financiers to support the renewable energy projects.

## **KEY WORDS**

**Local Financier:** is defined as local person or entity that provide money as a gift, loan money to the applicant/business and expects to be paid back the amount of loan with or without interest or expects any percentage from the profit from the business in exchange for a loan or expertise.

**Energy:** Energy is ability to do work or produce heat.

**Renewable Energy:** It is energy that is produced by natural resources such as wind, sunlight, rain.

**Sources:** is defined as anything or place from which something comes, arises or obtained.

## LIST OF SYMBOLS AND ACRONYMS

- MW: **M**egawatt
- REG: **R**wanda **E**nergy **G**roup
- RURA: **R**wanda **U**tilities and **R**egulation **A**uthority
- BRD: **D**evelopment **B**ank of **R**wanda
- FONEWA: Financing Rwanda's Green Growth and Climate Resilient Development
- IPPs: **I**ndependent **P**ower **P**roducers
- SHS: **S**olar **H**ome **S**ystem
- USD: **U**nited State **D**ollar
- GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
- JICA: **J**apanes **C**ooperation **A**gency
- Endev: **E**nergising **D**evelopment
- RBF: **R**esult **B**ased **F**inancing
- PV: **P**hoto**v**oltaic
- DC: Direct Current
- PEPFAR: President Emergency Plan for AIDs Relief
- DRE: **D**irect **R**enewable **E**nergy
- IT: Information Technology
- GoR: **G**overnment of **R**wanda
- EWSA: **E**nergy **W**ater and **S**anitaion **A**uthority
- NPL: **N**on **P**erfoming **L**oan
- BDF: **B**usiness **D**evelopment **F**und
- BPR: **B**anque **P**opulaire du **R**wanda
- GT Bank: **G**uaranty **T**rust **B**ank
- CBA: **C**ommercial **B**ank of **A**frica
- PDO: Petroleum Development Oman
- PIE: **P**roject **I**mplementing **E**ntity
- MDGs: **M**illenium **D**evelopment **G**oals
- OSCs: Oilfield Service Companies

- SACCOs: **S**aving and **C**redit **C**ooperatives
- HPPs: **H**ydro**p**ower **P**lants
- EAC: **E**ast **A**frican **C**ommunity
- DRC: **D**emocratic **R**epublic of **C**ongo
- COD: **C**ommercial **O**peration **D**ates
- GHI: **G**lobal **H**orizontal **I**rradiation
- LCOE: **L**ivelised **C**ost of **E**lectricity
- HH: **H**ouse**h**olds
- C&I: **C**ommercial and **I**ndustry
- OPEC: **O**rganisation of the **P**etroleum **E**xportation **C**ompanies
- RAB: Rwanda Agriculture Board
- SIR : Savings to Investment Ratio
- USAID: **U**nited **S**tates **A**gency for **I**nternational **D**evelopment
- SWH: **S**olar **W**ater **H**eather
- PUE: **P**roduction **U**se of **E**nergy
- ICS: **I**mproved **C**ooks **S**toves
- ECM: **E**ntreprise de **C**onstruction **M**ixte
- PDO:**P**roject **D**evelopment **O**bjective

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May God bless you!

## **DEDICATION**

To almighty God Jehovah, to my husband and my son, brothers and sisters, friends and lecturers at University of Rwanda, College of Science and Technology this work is dedicated.

## **CHAP 1. BACKGROUND OF THE STUDY**

### **1.1. Introduction**

Despite the COVID-19 pandemic that slowed down the growth of renewable energy market, it is globally still important. According to the businesswire.com, the market of renewable energy is divided into four types of the energy sources, which are: hydro electrical power source, solar power source, geothermal power source and wind power source. In 2020, the global energy market had generated the revenues of \$ 692.8bn with 8.9% of the Compound Annual Growth Rate (CAGR) in 2016 to 2020 and about 52% were dominated by hydro electrical power(Wood, 2021). This tremendous increase is continually expected until 2026 at compound annual growth rate of 8.3% (Globenewswire, 2021).

At the African level, conferring to the IRENA Africa impact report 2020, the population of in Africa is large and still growing with the grow of GDP up to 3.4% in 2017 and it was projected to be 4% in 2018 and 2019 which dramatically increased the energy demand within coming decades(IRENA, 2020). And sustainable energy is among the main keys of Africa's Agenda 2063 and Sustainable Development Goals (SDG7) "which is Affordable and clean energy". This will continually increase the demand for energy.

Government of Rwanda has set a target to install OFF and ON grid electricity so that in 2024, one hundred percent of its habitants will be connected. In this policy, some grants were given and some investors have started to invest in Renewable energy. They are many commercial segments in renewable energy such as Mini-grids, solar home systems, clean cooking, and solar irrigation. A total capacity of 228.223 MW will be installed. Now, REG with corroboration with some stakeholders are starting the process of launching the bid for constructing the sites as in table 2.(REG, 2019)

Rwandan governmental research outcomes in the domain of energy economic Energy sector strategic Plan 2018/2019-2023/2024 has inspired the present research proposal: Rwanda Utility Agency (RURA) with its stakeholder's collaboration have developed policies and guide lines related to energy production some of them are in place and some others will be implemented in the near future. (MININFRA, 2018)Third Rwanda Energy Sector Development Policy Financing published by the World Bank in 2019 is one of documents that have been reviewed to more understand the research gaps related to the present 1 research. The policy shows that Rwanda's energy sector has emerged as a success story in Africa. Rwanda's progress in electrification during 2010–2016 ranked 11th globally and 3rd in Africa. Among the 20 least-

electrified countries, none made more progress than Rwanda during that period. Investments in grid extension have increased grid connections from 6 percent in 2009 to 56% percent at the end of February 2019. Off-grid access has more than doubled since 2016 and is estimated at 14 percent at the end of February 2019 (World Bank, 2019).

Many Independents Power Producers (IPP) have started to invest in hydropower and renewable energy where on other side some local financier such as corporates and retail banks and microfinance institutions began timid lending due the different challenges in energy sector.

For small IPPs, some local financier such as BRD via FONERWA provided credited line(green fund) 5.7Billion of loan at 11.5% per annum to transform private sector projects with clear impact in achieving national priorities in clean energy and environmental sustainability, including projects such as hydropower generation, solar and biogas.(Get.invest, 2021)

For SHS (Solar Home Systems) URWEGO Opportunities Bank supported by Endev RBF and GIZ financed 2.2 Million for retail solar systems to Solar Home Systems companies. Also, SACCO funded by World BANK and BRD gave a loan of 4million USD to finance final beneficiaries such as a household, enterprises and OSCs for the Small Household Solar acquisition (Get.invest, 2021)

However, much sponsorship is from donors. Another research source that inspired the present proposal is Target market analysis of the solar energy market in Rwanda developed by Paul Kirai and his co-authors in 2009 showed market segments of solar in Rwanda and different key players. The other source of research is the Grid code of 2013 developed by Rwanda utilities regulatory authority, (RURA). The *Grid Code* covers a range of technical, operational, commercial and governance issues (RURA, 2013). These documents and others which are not listed in this proposal have good research outcomes, yet they did not examine why local financiers are less involved in financing renewable energy sources in Rwanda. This is considered as a research gap that the present study has been exploring and mitigate.

## **1.2. Problem Statement**

Despite the market opportunities that are existing in the renewable energy sector there are still a gap in finance between the energy demand and the supply. Private investors are still needed to occupy the sector by making new and expanding the investment in renewable. Local financiers who are able to finance the renewable energy projects are the targeted important partners to support the renewable energy projects.

The research will portrait the picture of the situation of the investment in renewable energy in Rwanda as well as the main challenges that brings the gap in the system for both investors and the local financiers then suggest the remedies.

### **1.3. Research objectives**

In this research, there are both main and specific objectives. These are highlighted below:

#### **1.3.1. Main objective**

The main objective of the present research is to investigate challenges of local financier in Rwanda to invest in renewable energy sources and its mitigation.

#### **1.3.2. Specific objectives**

To achieve successfully to the main objective of the present study, the following specifics objectives will be based on:

- To explore the potential renewable energy sources commercial fundable.
- To assess challenges of local financier to invest in Renewable energy sources in Rwanda
- To assess challenges for investor to get renewable energy project loan

### **1.4. Research questions**

In respect to the research objectives, the following research questions will be considered:

- What are potential renewable energy sources commercial lending institutions in Rwanda?
- What are challenges of local financier to invest in Renewable energy sources in Rwanda?
- What are challenges for investors to get renewable energy projects loan?

### **1.5. Scope of the study**

Due to the limited time and the availability of promising renewables sources in Rwanda, the present study will focus on market segments related to hydro and solar energies business. Corporate and retail banks working in Rwanda, regulator RURA and main dealer REG will be interviewed as well as investing companies.

### **1.6. Expected Outcomes and Significance of the Study**

Expected outcomes and significance of the present study are presented in the following paragraphs. Both the expected outcomes and significance of the research reflect their importance on all stakeholders.

#### **1.6.1. Expected Outcome of the Study**

Firstly, the overall expected outcome of this study is the increase of number of local financiers to invest in renewable energy sources. Secondly, the successfulness of the present study will

present an efficient business model to all energy developers. Finally, the success of the present research will contribute to the high rate of power production from renewable energy sources.

### **1.6.2 Significance of the study**

The research in the present study will show how some economic theories will be applied and exploited by local financiers and energy developers. The thesis will be used as an academic resource for other scholars, financiers and investors in the domain of energy economics.

### **1.6.3 Thesis outline**

This section presents the structure of the thesis.

Chapter 1: This chapter gives an introduction of the thesis and it discusses the problem statement and objectives of the study.

Chapter 2: This chapter reviews related work to the present research, Rwanda energy situation and potential local financier.

Chapter3: Gives the methodology used to conduct successfully the work.

Chapter 4: This chapter contain data analysis.

Chapter 5: Conclusion and recommendation



## **CHAPTER 2. LITERATURE REVIEW, RWANDA ENERGY SITUATION AND POTENTIAL LOCAL FINANCIERS**

This chapter covers literature review related this work, discusses the Rwanda energy situation and some potential local financiers who can help the government of Rwanda to develop energy sector.

### **2.1 Literature review**

According to International Renewable Energy Agency (IRENA), Renewable energy projects, especially in developing countries, face multiple challenges from the institutional, policy and regulatory level to the market and project level, which can hinder the development and uptake of renewable energy. The latter include lack of market transparency, lack of financing and experience in project development, and lack of relevant information on regulations, markets and resource availability. This has led to a lack of bankable projects, making it difficult for investors to identify attractive projects, and therefore reducing available capital for those that are ready to be financed. For targeting specifically project-level barriers, IRENA tools aim to create a pipeline of investment mature projects by actively supporting early-stage project development and bridging the funding gap by assisting project developers access appropriate funding opportunities.(IRENA, 2016).

Barriers to renewable Energy Financing are Lack of long-term financing, lack of project financing, high and uncertain project development costs, lack of equity finance and small scale of project.(energypedia, 2021).There are also risks of Renewable projects which are high costs of resource assessments, high exposure to regulatory risks, high financial cost relative to other technologies, high operational risk, uncertainties over resource adequacy and uncertainties over carbon financing. The specific answers to observed barriers through Solar Home Systems – Tanzania & Rwanda, Mobisol will try to close the financing gap by getting loans and financing as a big company and then collect the money from customers on long term in small rates by M-PESA.(energypedia, 2021)

According to Elbolmajid Erfani, identifies the challenges faced by investors to invest in Renewable Energy Projects based on their criteria and their risks as shown on the table 1,2,3 and table 4 below.

Among the considerable number of RE investment criteria, technical criteria can be considered as the major one and its assessment ought to start in the first steps of a RE project. Because of the importance of these criteria in the main purpose object of the investment, electricity production. The criteria in this category are annual exploitability, energy efficiency, level of construction and operational difficulty, the reliability of technology, and safety.(Erfan, 2019)

*Table 1.risk factors in renewable energy investment sector in technical criteria*

<b>Sub criteria</b>	<b>Risk factors</b>
Annual exploitability	1) Variation of availability of natural
	2) Incompleteness of basic studies at the beginning of project
Energy efficiency	3) Inadequate and incomplete design
	4) Insufficient technical background and experiences on a specific project type
	5) Incorrect selection of equipment, materials, and technology
Level of Construction and Difficulties	6) Unavailability of sufficient and skilled human
	7) Conflict between the teams involved in the project
	8) Contractor, subcontractor, and supplier incapability
	9) Delays in decision making
	10) Failure of plant or equipment during the installation
	11) Shortage of material and equipment
	12) Managerial risks
	13) Inadequate or undulating topography of project site

	14) Quality of Foundation of the wind machine tower
Reliability of Technology	15) Fluctuation of production rates
	16) Progressiveness of technology in future
	17) Connection to the electric Grid
	18) Difficult Transportation of blades, towers and turbines
	19) immaturity of technology and quality products
Safety	20) Unexpected accident and injuries
	21) Inadequate and strict safety regulation

Source: (Erfan, 2019)

It should be considered that the reason of any investment is profit, so factors related to economic criteria are the basis for all investments. The investors expend noticeable money and time on their projects, so the figures in this regard should be calculated with care, and this can be done by understanding different factors from this category. Criteria in this group are; investment cost, operation, maintenance cost, and consumption market(Erfan, 2019)

*Table 2.risk factors in renewable energy investment sector in economic criteria*

<b>Sub criteria</b>	<b>Risk factors</b>
Investment Cost	1) Price fluctuation in the international market
	2) Dependency on the international market for importing raw materials
	3) Increasing rate of inflation
	4) changing the bank interest rate
	5) changing currency exchange rate

	6) Insufficient funding and financing
	7) Changing orders and scope (contract risks)
	8) High pay back (High power generation cost)
Operation and maintenance Cost	9) Occurrence of serious problems for the essential part
	10) Lack of skilled person for employee during the operational phase
	11) Poor finance management
	12) Increase in realization time
	13) Natural disasters: unusual flooding, bad weather, and earthquake
	14) lack of appropriate maintenance
Consumption Market	15) Market changes
	16) Market competitiveness
	17) Change in energy price

Source: (Erfan, 2019)

Investors should also consider the amount of attention paid by governments to RE projects as it is critical for the acceptance of the projects by the public. The investors also look forward to developing an international social standard for their projects and the capital they invest. Criteria to be observed under the social category are social benefits and conformity with supportive policies of the government.(Erfan, 2019)

*Table 3.Risk factors in Renewable energy investment sector in Social and Government criteria*

<b>Sub criteria</b>	<b>Risk factors</b>
Social benefits	1) social and public acceptance
	2) Incomplete stakeholder identification
Conformity with supportive policies of the government	3) Political stability
	4) Change in state laws and regulation and policy

Source: (Erfan, 2019)

The current condition of environment makes it necessary for investors and authorities to consider environmental issues seriously. This has made environmental standards and rules of production stricter now compared to the ones in the past. The criteria are critical concerning customers' demand, sustainability, and potential future rules. The criteria in this category is effects on natural environment.(Erfan, 2019)

*Table 4.Risk factors in renewable energy investment sector in environmental criteria*

<b>Sub criteria</b>	<b>Risk factors</b>
Effects on natural environment	1) Insufficient environmental requirement and standards
	2) Inadequate environmental impact assessment
	3) Negative effect on environment [
	4) Damage of physiological and psychological health of human and ecology

Source: (Erfan, 2019)

This study identified 11 influencing factors classified under four main categories and 47 potential risks related to each criterion. The study used a systematic literature review besides expert interview. Understanding these potential risks can assist the investors to learn about the challenges they may face upon investments. (Erfan, 2019)

## **2.2 Rwanda Energy Situation**

Currently in Rwanda, access to electricity is about 66.8% of Rwandan households including 48.4% connected to the national grid and 18.4% accessing through off grid systems.(REG,

2021). In a bid to position Rwanda as a services hub for east and central Africa, the Rwandan government committed itself to a large number of power purchase agreements with independent power producers to increase generation capacity. With power production projected to exceed demand by approximately 200MW in 2024, the government is shifting its focus to increasing access, stimulating demand, and strengthening the transmission network. By 2024, Rwanda plans to supply electricity to 100 percent of the population (52 percent through an expanded electrical grid and 48 percent through off-grid technologies) (MININFRA, 2018). The government has also targeted improvements in the grid network, including reducing system losses and improving reliability, as well as connecting with neighboring countries and importing and exporting power across borders. Several U.S.-based or U.S.-owned micro-hydro, off-grid solar, and mini-grid firms are active here; there are many opportunities for firms providing innovative and affordable transmission and distribution systems and equipment (Nasho solar and RICA, Agahozo.). The electric motorcycle taxi(e-Moto)/AMPERSAND is expanding its electric motorcycle taxi business to take advantage of plentiful power to replace the estimated 100,000 gas-powered motorcycle taxis in Rwanda(Government, 2020).

Hydropower and thermal power continue to dominate with the highest shares of the installed generation capacity of 104.628 MW equivalent to 44.00% and 58.8MW equivalent to 25.00% respectively, while solar power contributes the least (5%)(REG, 2021) as per the Figure below:

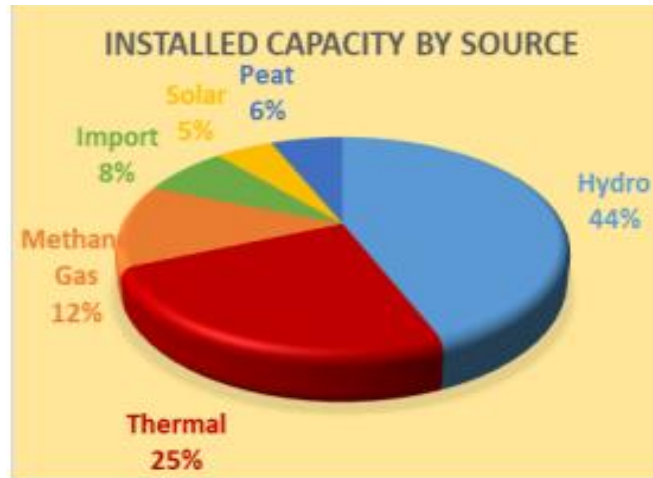


Figure 1. Installed Capacity by Source

Source: REG annual Report 2021

Technology Installed capacity (MW): Hydropower 104.628 44, Thermal Power 58.8 25, Solar Power 12.05 5, Methane Gas 29.79 12, Import & Shared 18.1 8, Peat Fired PP 15 6. Total 238.368 100MW

### 2.3 Potential local financiers for RE in Rwanda

In Rwanda the financial system is composed mainly of finance institutions , pensions schemes , insurers, foreign currency dealers and remittances. They are 11commercial banks, 3 microfinance , one development bank and one cooperative bank. These banks plays a role in Rwandan financial system of 67%. In Eastern African countries, the Rwandan banking sector shows a strong performance. This is due to the fact that Rwanda have succeeded in reducing the ration of non-performing loans (NPL) form 8,5% (2017) to 5,5% (2019), while in Kenya this indicator raised from 9,75% to 12,5% in the same period.The reasons for the low NPL ratio include a good economic performance, guarantees such as the BDF, high collateral requirements of the banks . The loans from banks have been increasing, however, the loan related to the renewable energy sources is still low comapared to other sectos. The percent goes high because of big infrastructure of water and national grid.. The following table shows the different loans given from 2017. The three largest commercial banks in descending order of market share are

Bank of Kigali, Banque Populaire du Rwanda (BPR), and I&M Bank. Other foreign banks present in Rwanda include Ecobank, GT Bank, Equity Bank, Kenya Commercial Bank, NCBA (formerly the Commercial Bank of Africa (CBA)), Access Bank, Bank of Africa, Cogebanque, Urwego, Development Bank of Rwanda, and microfinance banks AB Bank, Zigama, and Unguka

*Table 5. Loan in the past financial years*

Sector	2018/17	2019/18	Annual Increase	2020/19	Annual Increase
Manufacturing	64,923,639	128,975,305	99%	262,472,663	104%
<b>Water &amp; energy</b>	<b>11,567,678</b>	<b>61,110,937</b>	<b>528%</b>	<b>105,764,236</b>	<b>73%</b>
Transport & communication	3,945,980	145,226,682		244,869,432	69%

*Source: Annual reports BNR of all 3 financial years*

### 2.3.1 Commercial banks

In Rwanda there are some regulations that distinguish financial system. On major criteria is the capital of the financial institution. Table 1 shows the list of commercial bank in Rwanda.

*Table 6. Commercial banks in Rwanda*

Bank	Priority sectors	Customers
Bank of Kigali Ltd	All sectors	Retail customers and corporate customers
I&M Bank Plc	All sectors	Retail customers and corporate customers
COGEBANQUE Plc	All sectors	Retail customers and corporate customers
KCB Bank Rwanda Ltd	All sectors	Retail customers and corporate customers
Ecobank Rwanda Ltd	All sectors	Retail customers and corporate customers



Banque Populaire Du Rwanda Ltd	All sectors	Retail customers and corporate customers
Equity Bank Rwanda Plc	All sectors	Retail customers and corporate customers
Access Bank (Rwanda) Plc	All sectors	Retail customers and corporate customers
Bank of Africa Rwanda Plc	All sectors	Retail customers and corporate customers
Guarantee Trust Bank (Rwanda) Plc	All sectors	Retail customers and corporate customers
Commercial Bank of Africa (Rwanda) Plc	All sectors	Retail customers and corporate customers

Source:(BNR, 2021)

### 2.3.2 Microfinance

The microfinance institutions have been on the Rwandan market for a while. They have been helping farms and small and medium enterprises. The dominant microfinance institutions in Rwanda are shown in the following table.

*Table 7. Microfinance*

Microfinance	Priority sector	Customers
Unguka Bank Ltd	All sectors	Retail customers and corporate customers
Urwego Bank Plc	All sectors	Retail customers and corporate customers
AB Bank Rwanda Ltd	All sectors	Retail customers and corporate customers

Source:(BNR, 2021)

### 2.3.3 Development bank

There only one development bank in Rwanda, Banque Rwandaise de Development (Development Bank of Rwanda Plc) BRD. This bank collaborate with other banks . For energy, BRD developed a program with collaboration with the government of Rwanda, The Project

Development Objective (PDO) is to increase electricity access in Rwanda through offgrid technologies and facilitate private-sector participation in renewable off-grid electrification. The PDO will be achieved by providing a financial intermediary financing to the Government of Rwanda (GoR) as the borrower. GoR on-lends the funds to the BRD, which administers the facility. BRD is the Project Implementing Entity (PIE) and which functions as a wholesale institution for PFIs as well as lend directly to MGDs and locally registered OSCs. Targeted beneficiaries are Rwandan households and businesses which will gain access to offgrid electricity services through solar systems or mini-grids and whose use of electricity will replace consumption of diesel, kerosene, and dry cell batteries as well as other alternative fuels. The direct project beneficiaries include (i) participating SACCOs and banks, which will gain knowledge and experience in lending in a new sector; (ii) mini-grid developers who will gain access to finance to build mini-grids; and (iii) private companies engaged in off-grid electrification (mini-grid developers and potentially locally-registered off-grid solar companies), which will get access to financing for expanding their businesses in Rwanda as well as gain experience of working with local financial institutions. BRD will also benefit from capacity building in energy lending.

#### **2.3.4. Cooperatives**

There are many cooperatives in Rwanda, Zigama CSS and SACCO are the main cooperatives in Rwanda. SACCOS have been investing in DRE. SACCOS as well ZIGAMA with BRD corperation has invested in solar water heater and in clean cooking.(RDB, 2021)

#### **2.4. Potential market of DRE in Rwanda**

They are different markets segments of DRE in Rwanda, yet they differ from the size and the maturity (Get.invest, 2021). This study focused on the potential market segment of the following DRE products:

- Small IPP(<10 MW)
- Minigrids
- C&I ( commercial and industry application)
- PUE ( Productive Use of Energy)
- Domestic applications

### 2.4.1. Small IPP

Small IPPs related to DRE in Rwanda focuses mainly on , hydropower plants, solar power plant and biomass. The small IPPs is mature market since many investors do not need a subsidy schem. This study targets IPPs related to hydro and solar systems(REG, 2021).

*Table 8.Small IPPs*

<b>Price (RWF)/kWh</b>	<b>System</b>	<b>Deatails</b>
<b>96</b>	Solar	Solar system only
<b>103</b>	Solar	Solar PV system, with hybrid controller
<b>422</b>	Diesel	Diesel 100%
<b>255</b>	Grid Power	Non Residential,>100kwh/month
<b>227</b>	Grid Power	Non Residential,0-100kwh/month
<b>201</b>	Grid Power	Telecom Towers
<b>186</b>	Grid Power	Health facilities
<b>179</b>	Grid Power	Data center
<b>157</b>	Grid Power	Hotels
<b>134</b>	Grid Power	Small industries,<22 0000kwh/yr
<b>103</b>	Grid Power	Medium industries
<b>94</b>	Grid Power	Large industries
<b>127</b>	Hybrid-Grid(large industry) and diesel	Share of diesel power:10%
<b>110.4</b>	Hybrid-Grid(large industry) and diesel	Share of diesel power:5%

**Source:** (REG, 2021)

### 2.4.2. Mini-grids

Minigrid market in Rwanda is still new. RURA collaborating with REG have been developing some regulations to govern minigrid developpers. And these regulations are based on the following aspects:

- **Scope** : very small and small isolated grids and small power distribution
- **Registration:** for very small isolated grid and electricity licencing for small isolated grid and small power distribution

- **Time:** 15 years and any other terms must be requested and justification of deviation provided. Capped at 25 years
- **Term renewal:** 5 years but not automatic
- **Exclusivity:** Applicable to small isolated grids and small power distribution for areas in the licence but can be revoked under certain circumstances
- **Tarif setting:** to be established by RURA through a methodology
- **Technical requirements:** compliance required
- **Grid arrival:** There are 3 options, relocate the assets, sell the assets to the Rwandan Energy group or become a small power producer or distributor of electricity purchased from the main grid.

Yet, they are few which started to exploit both solar and hydro for some small villages. The following tables show different companies with their respective installed capacity and number of households (HH) connected.

*Table 9. Energy Companies with their customers and installed capacity*

Technology	Company	Customers	Capacity(Kw)
<b>Hydro</b>	ECOS	258	11
	NYANKOROGOMA	143	13
	HOBUKA	265	34
	COFORWA	415	60
	MUKUNGU	96	21
<b>Solar</b>	NESELTEC	95	30
	RENERG	132	30
	MESHPOWER	2384	6
	ABSOLUTE ENERGY	587	50
	ARC POWER	1187	20
	EQUATORIAL POWER	1007	120

**Source:** (REG, 2021)

The government of Rwanda is targeting to electrify 348,708 HH by 2024. Referring to the political target of electrifying 395,000 HH through minigrids, the market volume is estimated at 150 Mio. € by considering investment costs per kW of 4300 000 RWF. (REG, 2019)

### **2.4.3. Commercial and Industry application (C&I)**

Commercial and Industry application (C&I) is the captive power system on the premises of a single commercial or industrial energy consumer, mainly for self-consumption. Sometimes, surplus power is injected into the national grid, but for the case of Rwanda is not applicable since there is no net metering concept. The concept is not applicable for two main reason: The first reason, REG argues that distributed generation from small solar PV installations would compromise the stability of its power system. The second reason is that C&I customers (including industries, hotels, institutions, etc.) account for 70% of REG's sales, the introduction of a net metering regulation will certainly have a negative impact on REG's revenue (RURA , 2020)and this cannot be ignored when setting and operationalizing net metering regulation. However, this depends on the configuration of a C&I configuration. If it is not ON-grid the net metering is not required. This becomes a big concern , once the system is grid connected. Figure 4.2 shows the SORWATHE with a PV installation used as a C&I system. Whereas figure 4.3 shows 20 kWp C&I installation at KIGALI GENOCIDE MEMORIAL. As other solar PV systems, the investment cost per kWp for C&I system varies between 900 000 to 100000 RWF (Get.invest, 2021). The potential investors in C&I are hotels, schools , hospitals , telcom towers and son on. Considering only telcom towers in Rwanda, there are 948 base stations (Get.invest, 2021). Knowing that a base station require installed capacitor between 20 and 27 kWp, the potential market is 25.9 billion of RWF.



*Figure 2. 50 kWp Installation at SORWATHE*

Source: (Crossboundary, 2019)



Figure 3.20 kWp Installation at KIGALI GENOCIDE MEMORIAL

Source: (Crossboundary, 2019)

#### **2.4.4. Productive Use of Energy (PUE)**

Productive uses of energy (PUE) is defined as activities “that involve the utilization of energy: both electric, and non-electric energy in the forms of heat, or mechanical energy - for activities that enhance income and welfare. In rural contexts, these activities are typically in the sectors of agriculture, rural enterprise, health and education (MINAGRI, 2013). In Rwanda, the PUE is mainly applied on agricultural sector. The local financiers are not yet involved in the market, however, some subsidies and donations have been experienced in Rwanda (MINAGRI, 2013). The market is still not mature, but the government has been encouraging investors to be involved in such market segment. Only one company, Ignite has been on the Rwanda market since 2017. Ignite has so far Sales of 400 W Ennos pumps (for 1 acre) and it is aiming at selling 300 units and 500 units for 2021 and 2022 respectively.

*Table 10. PUE for Agriculture in Rwanda*

<b>Project</b>	<b>Activity</b>	<b>Source of Funds</b>
<b>SIR project</b>	100 installed solar pumps	OPEC , RAB and URWEGO bank
<b>Hinga weze</b>	7-10 sites irrigated, each has 10 ha	USAID
<b>NGOMA</b>	1500 farmers got solar pumps	FONERWA
<b>NASHO</b>	2000 farmers got solar centralized pumping systems	Government

Source: (PowerAfrica, 2019)

#### **2.4.5. Domestic applications**

The DRE for domestic applications is mainly composed by three market segments: Solar home systems (SHS), solar water heater (SWH) and Clean cooking. The present study discusses each segment in details showing its potential market in Rwanda.

##### **2.4.5.1. SHS in Rwanda**

SHS are playing a key role in the provision of affordable and environmental-friendly energy services in many rural areas of Rwanda where grid extension and mini-grids are not yet economically viable. Since the approval of Rwanda’s Rural Electrification Strategy (RES) in June 2016 and some support programmes, which implied subsidies to SHS companies (e.g. through the ENDEV programme) there has been a huge growth of annual sales: In 2016/17 the same amount of SHS were sold, as in all previous years; and in 2017/18 the sales grew by 80%, as shown in Table 11. Currently , data related to this business is not available, an adequate study might be conducted for figure it out.

*Table 11. Installed SHS from 2016 to 2020*

<b>Installed SHS</b>	<b>Year</b>
<b>48922</b>	2016-2017
<b>87796</b>	2017-2018
<b>82415</b>	2018-2019
<b>51860</b>	2019-2020

Source: (PowerAfrica, 2019)

#### **2.4.5.2. SWH**

Of late, the solar water heater is gaining publicity with people understanding the benefits of installing a solar water heater at home. A solar water heater uses solar energy for heating water and does not use electricity at any point for the subject purpose. This implies that your annual electricity bill will reduce substantially, as it does not include the electricity consumed for heating of water. Solar energy is renewable, non-polluting, nature-friendly, and cost-effective. The power production costs incurred by the government also comes down with more people turning to solar energy and solar-powered systems. Therefore, the state and central governments offer subsidies and rebates for installing solar power systems. Earlier the consumers were apprehensive of the usability and complications with respect to solar power systems. Leading to a reduction in sales of subject systems. The government of Rwanda has been encouraging investors to develop this market. Therefore, from 2011 to 2018 , **Solar Rwanda Programme** gave subsidies of 20% (250 out of 1200 USD) and loans of 600-800 USD (through some local 3 banks) (BRD, 2021). Now, the subsidy is no longer in the place. Yet, the market for SWH is still valid. Hotels nad middle class are potential market. Considering the price of one SWH, an estimation of the potential market can be done. A SWH of 200 liters cost 1200000 RWF, once almost 900 hotels and middle class and upper classes in Rwanda are considered, an estimation of 450 billion RWF can be obtained.

#### **2.4.5.3. Clean cooking**

The quantity of sustainable woody biomass in Rwanda is only 3.3 million tons whereas its consumption is over 4 million tons. To achieve a sustainable balance between the supply and demand, Rwanda has developed a strategy seeking to **intensify the dissemination of Improved Cook Stoves (ICS), promote efficiency in charcoal making and use alternative fuel such as LPG and electricity**. The government of Rwanda targets to have 500 000 HH with improved cook stove by 2026 (African development Bank Group, 2019). This reveals the market size of improved cooking stoves.



## CHAP 3. METHODOLOGY

This chapter contained the methods, technics and different procedures that were used during data collection, processing, analyzing and data presentation. All the procedures will be done in courtesy of delivering the results that are supporting the objective of the study. Figure 1 shows main steps that have been used to obtain the results. First step is documentation, second is data collection and then data analysis and discussions.

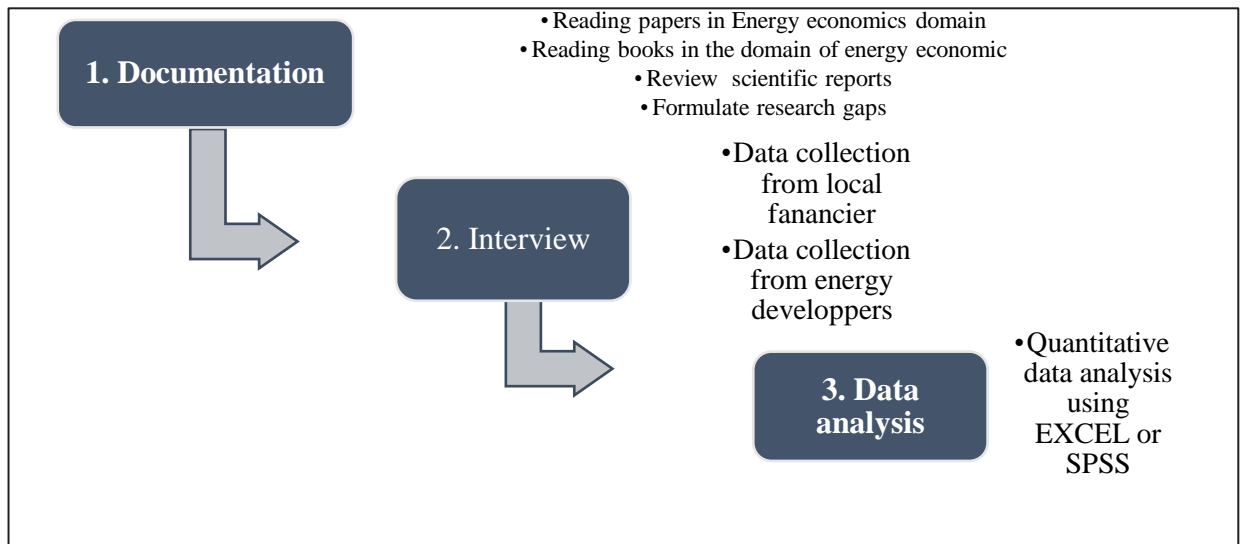


Figure 4. Methodology Steps

Source: Researcher

### 3.1.Documentation

To achieve suscefully the objectives of the study a review of some documents related to renewable energy sources in Rwanda have been consulted. A review of the potential financiers in Rwnada have been conducted. Many report of of National Bank have been reviewed in order to have the clear view of the finance system in Rwanda.

Due to the lack of full data about the financial and energy sectors in general in Rwanda, the few data obtained were presented and employed in this research for the purpose of drawing the conclusion about the main objective of accessing the challenges of financiers to invest in renewable energy in Rwanda .

### **3.2. Sample size specification**

Judgement nonprobability sampling technique was used to select 33 respondents from energy providers institution and companies as well as the financial institutions. two persons from the top-level staff of institution who involve in the decision making were asked to fill the questionnaire to make sure that the information provided are reliable and helpful to the study.

### **3.3 Data collection**

During the process of collecting primary data for analysis, questionnaire was designed and used in order to capture the required data from respondents for further analysis. Potential local financiers and energy private developers, and REG were given the questionnaire that is found in the appendix. The questionnaire targets to figure out the level of loan given to develop the renewable energy sources, and the challenges of the local financiers encountered while assessing the renewable sources projects. In addition, challenges that borrowers have faced during the process of demanding the loan up to the end process were enquired.

### **3.4 Data analysis**

The researcher conducted descriptive analysis of data and both Excel and SPSS softwares were employed in order to analyze data and give a good representation in tables and charts.

- i. Descriptive statistics:** This type of analysis used to understand the perception of both the energy providers and local financiers through out their responses.
- ii. Table and Chart:** The easiest and quickest way to look into your data is by using (frequency) tables and bar charts. This only goes for nominal and sometimes ordinal data.

## CHAP 4: DATA ANALYSIS

### 4.1 Challenges for Local Financier to invest in Renewable Energy Sources in Rwanda

In table 12, 63.6% were agreed that the energy company has small production size. 57.6% agreed that the energy companies have the real risks. 51.5% said that there is absence of sound operational data. 51.5% of the respondents said that there is limited access to reliable technical information. 63.6% agreed that there is lack of skills to evaluate/negotiate projects. 54.5% responded that there is increase in transaction cost with initial investments. In addition, 36.4% said that there is lack of internal reward. 42.4% responded that the renewable energy company is small size. 48.5% said that there is a challenge of little of production of equipment and component then 51.5% has reported that there are challenges in loan payment.

*Table 12. General Challenges for the financier and investors*

General Challenges		Percent (%)
The energy company has a small product size	Yes	63.6
	No	36.4
The energy company have real or perceived risk.	Yes	57.6
	No	42.4
Absence of sound operational data.	Yes	51.5
	No	48.5
Limited access to reliable technical information	Yes	51.5
	No	48.5
There is lack of skills to evaluate/negotiate projects	Yes	63.6
	No	36.4
Increased transaction costs with initial investments	Yes	54.5
	No	45.5
Lack of internal rewards or incentives	Yes	36.4
	No	63.6
Many renewable energies companies are small	Yes	42.4
	No	57.6

Little production of equipment and components	Yes	48.5
	No	51.5
Challenges in loan repayment	Yes	51.5
	No	48.5

Source: Primary data.

### **Challenges that may arise especially for the Local financier**

In table 13 below, 72.7% said that remote customers is the challenge, 60.6% of the respondents said that limited and fluctuating demand for the energy services is the challenge, 54.5% of the respondents said that payment risks is the challenge, 66.7% reported that limited ability to pay is the challenge, 57.6% Shortage of local actors capable of carrying projects financially, 54.5% said that inadequate financial mechanisms is the challenge.

*Table 13. The Challenges that may arise for the local financier*

<b>Challenges for the local financier</b>		<b>Percent %</b>
Remote customers	yes	72.7
	No	27.3
limited and fluctuating demand for energy services	yes	60.6
	No	39.4
Payment risk	yes	54.5
	No	45.5
Limited ability to pay	yes	66.7
	No	33.3
Shortage of local actors capable of carrying projects financially	yes	57.6
	No	42.4
Inadequate financing mechanisms	Yes	54.5
	No	45.5

Source: Primary data

## 4.2 Challenges that may arise for the regulator

The table 14 below is presenting that 66.7% agreed that inadequate quality control is the challenge that may arise for the regulators. 63.6% said that lack of mechanisms to monitor standard might be a challenge. 57.6% reported that burdensome permitting process is among the challenges and 54.5 said that lack of specific legal framework is a challenge.

*Table 14. The challenges that may arise for the Regulators*

Challenges for the Regulators		Percent %
Inadequate quality control	yes	66.7
	no	51.5
Lack of mechanisms to monitor standards	yes	63.6
	no	39.4
Burdensome permitting processes	yes	57.6
	no	54.5
Lack of specific legal framework	yes	54.5
	no	45.5

Source: Primary data

## 4.3 Mitigation of the challenges

In the table 15 below the 60.6% respondents said that to provide project insurance would be a mitigation, 54.5% said that reducing the tax for the materials, 57.6 were said that to provide the infrastructure for the energy companies would be the mitigation strategy. 51.5% reported that having the adequate financing mechanisms is a mitigation. 51.5% said that to have adequate quality control would serve as the mitigation strategy. 57.6% said that having the internal rewards or incentives would serve as a mitigation. 54.6% said that having the access to modern technology would be a mitigation. 60.6% of the respondents said that providing the skills to evaluate or negotiate the projects would serve better. 57.6% reported that having the abundant reliable technical information would be mitigation.

*Table 15. The Proposed mitigation*

Proposed mitigation		Percent %
To provide project Insurance	yes	60.6
	No	39.4
Reducing tax for the materials	yes	54.5
	No	45.5
Providing the infrastructure	yes	57.6
	No	42.4
Adequate financing mechanisms	yes	51.5
	No	48.5
Adequate quality control	yes	51.5
	No	48.5
Internal rewards or incentives	yes	57.6
	No	42.4
Access to the modern technology	yes	54.5
	No	45.5
Providing skills to evaluate/negotiate projects	yes	60.6
	No	39.4
Abundant access to reliable technical information	yes	57.6
	No	42.4

Source: Primary data

## **CHAP 5. SUMMARY, CONCLUSION, RECOMMENDATION AND FURTHER RESEARCH AREAS**

### **5.1. Summary and discussion of findings**

The results of the study were obtained by analyzing the data from the field, and collected through questionnaire. The respondent were 33 from the financial institutions, renewable energy developers and the regulators from the government agencies. The researcher had chosen to ask one board member in high level, those who participate in decision making in the institution to ensure the reliability of the responses.

The results told us that 63.6% of respondent agree that the energy company has small production size, 63.6% agreed that there is lack of skills to evaluate/negotiate projects, whereas small proportion 36.4% said that there is lack of internal reward, 42.4% confirmed that the renewable energy company is small size. 48.5% said that there is a challenge of little of production of equipment. 72.7% reported that remote customers is the challenge, 60.6% of the respondents reported that limited and fluctuating demand for the energy services is the challenge, 54.5% of the respondents said that payment risks is the challenge, 66.7% reported that limited ability to pay is the challenge. 66.7% agreed that inadequate quality control is the challenge that may arise for the regulators. 63.6% said that lack of mechanisms to monitor standard might be a challenge. Even though the challenges for the local financiers and the regulators there are the proposed mitigations where 60.6% respondents reported that to provide project insurance would be a mitigation, 60.6% of the respondents reported that providing the skills to evaluate would be highly appreciated.

### **5.2. Discussion and Conclusion**

The results identified the main challenges that the local financiers meet within the journey of providing the capital for the investors as well as the challenges for themselves to invest in renewable energy in Rwanda whereas the small production for the investing companies, incapable workers, and limited capacity of the client to pay back were reported as the main challenges. Despite the challenges there are the proposed remedies including providing the insurance for the projects aimed to provide the energy for the society, and to provide the skills for investors workers to manage and/or evaluate would be an added value and the strongly help to mitigate the challenges that are existing in the renewable energy sector.

In line with the results from the other authors including (IRENA, 2016),(Erfan, 2019) and others they have shown the challenges for investing in renewable energy sectors in general. But Local Financier in Rwanda has still the potential energy market but with some operational, technical challenges that would be addressed to create good working environment and serving long range of the population in order to reach the national target of providing the electricity at hundred percent in Rwanda by 2024.

The purpose of this research was to assess the challenges for the local financiers in Rwanda to invest in renewable energy and the mitigations. Different literatures displayed with the facts that there are the challenges that hinder the local financiers to invest in renewable energy in Rwanda. Qualitative data were collected about challenges that local financiers, policymakers and investors meet and how to mitigate them, confirmed that there were the challenges for all three sectors (financiers, policymakers and the investors)(UCHER, 2021). The results also shown that, most of the local financiers fear the fluctuation in energy demand and remote customers while the challenge for the policymakers were mostly inadequate quality control and lack of legal framework even though there are the challenges there are also the mitigations for all sectors that's good news for the society.

### **5.3. Recommendation**

Based on the research findings from the primay data that were collected for the purpose of assessing the challenges of local financiers in Rwanda to invest in renewable energy and its mitigation, the reseacher would like first to recommend the furth researchers to conduct studies with higher sample size to prove the impact of local financiers investment in renewable energy in Rwanda, second, the local financiers to look far from the challenges because even if there are the chalenges but there are sitill the opportunities; the more the number of the population in need continue to rize the more the opportunity for the investors, third, the researcher would like to recommend the investors who have engaged in renewable energy to join the local financiers to get loan for the expansion of their activity and lastly the government should provide the requirements including the infrastructures, legar framework, good working environment so as to easy the investment in renewablle energy in Rwanda.

### **5.4. Areas for further research**



This study has been conducted for the case of Rwanda in 2021, it was assessing the current situation about the challenges of local financier in Rwanda to invest in renewable energy and its mitigation. Those opened up the mind sets about the situation and create the curiosity for further research to be conducted in the following areas but not limited to:

- i. The challenges of the renewable source development in Rwanda.
- ii. The more the situation developed then the same research should be conducted to assess the new challenges and new ways of mitigating them.
- iii. Renewable energy should be studied a high extent so that its importance be remarked in society and their impact on the socio-economic development so that all the stakeholders understand the opportunity that is found in that area.
- iv. Further research should be conducted in the same areas but taking care of rural areas for achieving durable the development.

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## **APPENDIX I: CONSENT LETTER**

**University of Rwanda      August 16, 2021**

**College of Science and Technology**

**Dear all**

**REF: CONSENT LETTER**

I am **Marie Ange Mukantwari** a master's student at University of Rwanda, College of Science and Technology in Energy Economics Program. I am currently conducting a research for the Masters of Science in Energy Economics degree. The research objective is to assess **Challenges for local financier in Rwanda to invest in Renewable Energy Sources and its Mitigation**. I kindly request you to participate in this study by honestly and accurately responding to all items in data collection materials. The information you provide will be used for the purposes of the research and will be held in strict confidence. You may ask the researcher to inform you about the findings of the study.

Thank you very much for participating in this study.

Yours faithfully,

**Marie Ange Mukantwari**  
**MSc Student at University of Rwanda**

A handwritten signature in black ink, appearing to read 'Marie Ange Mukantwari', with a stylized flourish at the end.

## APPENDIX II: QUESTIONNAIRE FOR RESPONDENTS

The research instrument has been formulated to collect data for the purpose of the research meant to create a greater understanding **on challenges of local financier in Rwanda to invest in renewable energy sources and its mitigation**. Kindly note that your response to these questions will be confidential and shall be used for the purpose of this research only.

Thank you for your participation.

### SECTION A: Demographic characteristics of respondents

#### 1. Category of respondents (tick with $\surd$ )

- a) EPD(Energy Private Developers) (How many developpers in the association ?)
- b) Corporate Banks
- c) Retail banks
- d) RURA
- e) REG

#### 2. Age of respondents (tick with $\surd$ )

- a) 20- 25 years
- b) 25-30 years
- c) 30-40 years
- d) 40-50 years
- e) > 50 years

#### 3. Gender of the participants (tick with $\surd$ )

- Male
- Female

#### 4. Marital status of respondents (tick with $\surd$ )

- Single
- Married
- Widowed
- Divorced

#### 5. Education level of respondents (tick with $\surd$ )

- Masters and above
- Bachelor
- Secondary

**6. Working experience (tick with √)**

- Less than 3 years
- 3-5 years
- 5-7 years
- More than  7 years

**Section B: Involvement of different parties**

**B.1. Banks**

**1. Have you ever given a loan to any energy companies?**

Yes

No

**2. If Yes, which Energy companies did you give a loan?**

- .....
- .....
- .....
- .....
- .....

**3. If Yes to question 1, when did you provide that loan?**

...../...../.....

**B.2. EPD (Energy Private Developers)**

**1. Is there any bank which support or finance your project?**

Yes

No

**2. If Yes, name them.**

— .....  
 — .....  
 — .....  
 — .....  
 — .....

**3. If Yes on question 1, how much were you financed?**

.....

**4. When did you receive that financial support?**

...../...../.....

**5. Any grace of period? If yes, what are the effects?**

.....  
 .....  
 .....

**Section B: Challenges of local financier in Rwanda to invest in renewable energy sources**

Indicate your level of agreement with the following statements relating to the assessment of the challenges of local financier in Rwanda to invest in Renewable energy sources.

**Answer questions by filling columns by No or Yes.**

**First column for Yes and the second by No, where it is the best answer.**

<b>STATEMENTS ABOUT CHALLENGES</b>		
<b>I. General challenges</b>	<b>Yes</b>	<b>No</b>
1. The energy company has a small product size.		
2. The energy company have real or perceived risk.		

3. Absence of sound operational data.		
4. Limited access to reliable technical information.		
5. There is lack of skills to evaluate/negotiate projects.		
6. Increased transaction costs with initial investments.		
7. Lack of internal rewards or incentives.		
8. Many renewable energies companies are small.		
9. Little production of equipment and components		
10. Challenges in loan repayment? If Yes, why? a. b. c. d.		
<b>II. Investors-Banks</b>	<b>Yes</b>	<b>No</b>
1. Shortage of local actors capable of carrying projects financially		
2. Inadequate financing mechanisms		
3. Low public awareness about the efficacy and potency of RETs		
4. Challenges in loan recovery, if Yes, how: a. b. c. d.		
<b>III. Regulatory challenges</b>	<b>Yes</b>	<b>No</b>
1. Inadequate quality control		
2. Lack of mechanisms to monitor standards		



3. Burdensome permitting processes		
4. Lack of specific legal framework		

**Section C: Mitigation**

**What do you think can be done to overcome those challenges?**

1. ....  
.....
2. ....  
.....
3. ....  
.....
4. ....  
.....
5. ....  
.....

**Thank you for your Participation**