Renewable Energy Development

“An Analysis of Investment Models”

Case of Zimbabwe

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DECLARATION

I, Erica Makoni do hereby declare that this research project is my original work. It has never been presented or published anywhere or in any institution for the award of any type of degree or academic award. Reference was however made to material already published by other people. This is indicated under the reference section.

ABSTRACT

Zimbabwe is endowed with a vast renewable energy resource base that is currently under-utilized presenting a big scope for investment opportunities. Faced with a growing population and an increase in energy demand, it is crucial that the country integrates renewables in the total energy supply mix for sustainable development. Zimbabwe has experienced fluctuations in its policy formulation processes which affected renewable energy investment. The country is lagging behind in terms of Renewable Energy Technologies due to slow uptake of these technologies in the energy sector. The country has a national electrification rate of 42%, coupled with an average demand of 1700MW against actual generation averaging 1000MW. The energy deficit averaging 700MW is an indication that more effort needed to finance energy projects in Zimbabwe to meet demand as well as transition to clean energy. In that respect, the general objectives of this study were to investigate policy issues that act as barriers to unlock investment in Renewable Energy Technologies in Zimbabwe and to identify innovative models that can be used to fund renewable energy projects in Zimbabwe. Innovative financing models comprise mechanisms of raising funds in support of renewable energy development and this involves new approaches for pooling private and public revenue streams to scale up or develop renewable energy projects. The models also highlight new revenue streams and incentives earmarked to the sector's development. The population of this study was the top management of Ministry of Energy and Power Development, Ministry of Finance, Rural Electrification Agency and Independent Power Producers. A sample of 59 was reached by employing both stratified and systematic sampling. A semi structured questionnaire was used to collect primary data and analyzed by descriptive analysis. The LCOE model was developed to test the effects of government subsidy on the net value of Solar PV and Hydropower projects. The study established that inconsistency government policy has retarded investments in new renewable energy projects. The author recommended the introduction of time-bound subsidies whereby Output-based Aid is given to community projects or IPPs on providing evidence of installation of a renewable energy system. BOOT (Build, Own, Operate & Transfer mechanism) Models were also recommended for the development of mini grids; where private sector entities design, construct, operate and maintain the power plant for a predetermined time frame and transfer ownership to the community were recommended. During this period, they recover their investments from the project outputs.

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LIST OF ABBREVIATIONS

BOOT	Build Own Operate & Transfer
RE	Renewable Energy
RETs	Renewable Energy Technologies
ZERA	Zimbabwe Energy Regulatory Authority
REA	Rural Electrification Agency
IPP	Independent Power Producer
SSA	Sub-Saharan Africa
GDP	Gross Domestic Product
NDS1	National Development Strategy 1
SDGs	Sustainable Development Goals
FIT	Feed In Tariff
MoEPD	Ministry of Energy and Power Development
PPA	Power Purchase Agreement
FDI	Foreign Direct Investment
MDBs	Multilateral Development Banks
IFC	International Finance Corporation
MIGA	Multilateral Investment Guarantee Agency
IRR	Internal Rate of Return
CER	Capital Enrichment Ratio
LCOE	The Levelized cost of energy
WACC	Weighted Average Cost of Capital
NPV	Net Present value
NGOs	Non-Governmental Organisations
ZDBP	Zimbabwe Domestic Biogas Programme
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
EMA	Environmental Management Agency
NDC	Nationally Determined Contributions

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CHAPTER ONE: INTRODUCTION

1.0 Background

The world's energy access deficit is increasingly concentrated in Sub-Saharan Africa (SSA), where energy access rate surged from 34 percent in 2010 to 47 percent in 2018 (The World Bank, 2020). Sub-Saharan Africa urgently needs a clean energy revolution to counter energy poverty. The majority of the population in SSA without access to modern energy rely on traditional fuels for energy while those that have access often face high prices for supply that is poor quality and rely on under-developed systems that are not able to meet their needs. Access to modern energy is of paramount importance for socio-economic development. Beyond direct economic and social benefits, clean energy access will raise human security and build resilience in states and communities to help limit the risk of large-scale migration across the African continent (Rigaud et al., 2018). Zimbabwe is endowed with a vast renewable energy resource base that is currently under-utilized presenting a big scope for investment opportunities. Faced with a growing population and an increase in energy demand, it is crucial that the country integrates renewables in the total energy supply mix for sustainable development.

In 2019, electricity shortages resulted in poor performance in the industrial sector causing GDP contraction by 12.8% (African Development Bank, 2020). Facing huge power supply deficits that affect industrial activity, the country launched the National Renewables Energy Policy and the Biofuels Policy to foster renewable energy integration in the current energy supply thus promoting a diversified energy mix. Excluding large scale hydro-power generation systems, the share of renewables in the energy mix is expected to increase from 5% in year 2017 to 27% in year 2030 (National Renewable Energy Policy, 2019). Despite these national set targets, financial constraint remains one of the largest barriers to the development of Renewable Energy Technologies (RETs) in Zimbabwe. Financial (Capital) access constraints have impeded the deployment rate of Renewable Energy Technologies in the country. The world has been put into disarray by the global pandemic and the economic impact of COVID 19, which has caused disruptions and instability in financial markets globally; Zimbabwe not an exception; reducing investment attractiveness in the renewable energy sector. This challenge requires the development of robust and innovative investment financing models so as to enable delivery of renewable modern energy services, especially to the marginalized rural populace.

1.1 Motivation

It is worrisome to note that the lack of sufficient power is impeding Zimbabwe's economic progress despite that the country is endowed with a vast amount of renewable energy resource base that is currently under-utilized. This is evidenced by the fact that, in 2019, electricity shortages were cited as a major contributor to poor economic performance in the industrial sector causing the Gross Domestic Product (GDP) contraction of 12.8% (African Development Bank, 2020). Power supply deficits affect industrial activity, which in turn has heavy ripple effects on macro-economic variables such as unemployment, inflation, exports, forex reserves as well as decline in agricultural output, among others. Zimbabwe, as a country has a huge demand-supply gap which needs to be filled urgently. Despite the macro-economic negative effects of power energy shortages, clean energy is regarded as a basic necessity in human lives at micro level as well.

Nevertheless, the Government has had robust plans for the energy sector, particularly in the renewable energy sub-sector, which if well and timely implemented, Zimbabwe could have been out of energy problem. The Government has been consistent in dismally missing the electrification targets in 2019 and 2020. One of the major reasons cited was lack of funding which has triggered this study to investigate and research into the appropriate funding models that the country could adopt as far as the renewable energy sector in concerned. Faced with a growing population triggering an increase in energy demand, it is critical that the country integrates renewables in total energy supply mix for sustainable development and to do away with the climatic shocks. More so, for the attainment of the National Vision 2030 if becoming an upper middle-income economy, National Development Strategy 1 in 2025, as well as the Sustainable Development Goal (SDG) 7 of affordable and clean energy by 2030, it is then crucial for the Government of Zimbabwe to find appropriate funding options for the renewable energy sector in the country. Energy is one of the key economic growth enablers with high backward and forward economic linkages. It is also important to note that the dependency on hydro power amidst effects of climate change is exerting more burden on current electricity supply and that the reliance on power imports on the backdrop of regional shortages is also not sustainable, hence the need for the country to invest in other forms of renewable energy such as solar, wind and biogas, among others.

1.2 Research Objectives

The current study seeks to address the following objectives:

- To investigate policy issues that act as barriers to unlock investment in RETs in Zimbabwe.
- To identify investment models that can be used to fund renewable energy projects in Zimbabwe.

1.3 Study Research Questions

The current study seeks to answer the following research questions:

- Do the existing finance and energy policies act as cornerstones to unlock investments in RETs?
- Do investments in RETs contribute positively to Zimbabwe's economy?

1.4 Hypothesis Formulation and Development

The hypotheses are stated in null form.

- A robust and innovative finance model does not attract investment in RETs and grow the RETs market in Zimbabwe.
- Increased commitment to deal with policy issues in Zimbabwe is not a barrier to attract investment in RETs.

1.5 Relevance of Study

Renewables offer a sustainable solution in providing for the country's growing energy needs at a time when the world is battling with the negative impacts of CO_2 emissions resulting from the burning of fossil fuels for energy generation. As off-grid renewable energy solutions are key to ensure universal energy access and inclusive economic development, investment in these technologies needs to be scaled up. Despite the growth observed over time in off-grid renewable energy financing, investments in these solutions still represent a very small portion of the overall energy access financing landscape. Achieving universal access by 2030 requires an increase in annual investment in modern energy especially decentralized off-grid systems. This study will help to advise the policy makers on the financing model which could be used to fund projects in the renewable energy sector in Zimbabwe which can help improve economic growth.

1.6 Tentative Thesis Chapter Outline

Chapter 1 gives an outline of the research background, problem statement, research questions as well as the corresponding research objectives while Chapter 2 provides a comprehensive review of the literature on investment finance models appropriate in the renewable energy sector with a focus investment models used globally. The review presents levels of investment according to source of funds in different regions. It will also discuss the factors hampering investment finance in other regions and countries. Chapter 3 outlines the research methodology to be followed by the current research as well as the data collection and analysis procedure and Chapter 4 presents the results from the analysis as well as their interpretation. In Chapter 5, the author shall recommend the best suited investment finance models to the country of study and in so doing demonstrate how the proposed financing model can help grow the RETs market in Zimbabwe and achieve the government's goal of universal energy access by 2030.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter provides a comprehensive review of literature on renewable energy development in Zimbabwe and investment financing methods which can be used to fund the projects in the renewable energy sector. The review presents levels of investment according to source of funds. Factors hampering investment finance shall be discussed in detail in this chapter.

2.1 Current State of Zimbabwe's Energy Sector

Zimbabwe's electricity generation is dominated by renewable, hydroelectricity power at the Kariba Dam Hydroelectric Power Station which produces about 750 MW of the total supply of 1200MW.Over the years, Zimbabwe has experienced consecutive years of droughts which have adversely affected the country's electricity generation and supply which had negatively affected the prospects of the economy.

2.1.1 Power Supply Sources

Table 2.1:Power supply sources

Name of power plant	Owner	Capacity (MW)
Kariba Dam Hydroelectric Power Station	ZPC	750
Kariba South Extension (Hydro)	ZPC	300
Hwange Thermal Power Station	ZPC	920
DEMA diesel peaking plant	ZPC	100
Munyati (Coal)	ZPC	100
Bulawayo (Coal)	ZPC	90
Harare (Coal)	ZPC	80
Triangle (Bagasse)	Triangle Ltd	45
Hippo Valley Estates (Bagasse)	Hippo Valley Estates	33
Green Fuel (Bagasse)	Green Fuel	18
Small and Mini-hydro IPPs	Various IPPs	30

Source: Renewable Energy Policy,2019

Zimbabwe has an installed capacity of approx. 2,470MW, comprised of large hydro (approx. 45%) and fossil fuel powered stations (approx. 50%). The remaining 5% is derived from IPPs. Licensed IPP projects have the capacity to approximately generate a combined 130 MW of power, of which the bulk is derived from 3 independent power producers using biomass, and to a lesser extend from mini hydro projects. In recent times, various solar PV systems ranging in size from 400kW to 1MW has been installed mainly for self-consumption, especially in response to the extended power cuts being experienced in the country (National Renewable Energy Policy,2019).

Zimbabwe has a net deficit in power supply as the actual capacity available is much lower than the installed capacity. This is due to a combination of droughts causing low water levels in the Kariba dam, a shortage of coal, cost of fuel and power stations operating under capacity due to a lack of maintenance. Actual capacity sits around 1,300MW-1,500MW compared to an installed capacity of approx. 2,470MW. Solar power accounts for a rather small sector of independent energy production. Only 18% of households have solar panels, while the majority of the population uses wood fuel (Mzezewa, 2017). 66.8% of the population uses wood fuel, and only 32.8% of the population has access to modern fuel (kerosene, electricity, or gas), which implies that wood power is the main source of fuel for much of the population and nearly all of the rural population (Mzezewa, 2017). The over reliance on wood fuel has led to deforestation issues across Zimbabwe. To make matters even worse, Zimbabwe is contractually obligated to provide Namibia with 150 MW of energy, which has generated a need to import energy from neighbors Mozambique and South Africa.

The Government of Zimbabwe seeks to increase private sector participation in electricity generation by promoting Independent Power Producers as it seeks to diversify the energy mix through promotion of renewable energy sources, methane among others which will be prioritised. Key programmes and projects targeted for implementation between 2021 and 2025 include the following: Renewable Energy Policy; Clean Energy Access; Rural Electrification Programme underpinned by Expanded Rural Electrification and Electricity End-Use Infrastructure Development; and Institutional Capacity Building Programs (NDS1, 2020). The Zimbabwean government has had robust plans for the energy sector, but lacks proper implementation as a result of lack of access to funding. Table 2.2 shows the status of completed projects in 2019 and 2020.

Table 2.2:Ref Projects Performance for 2019 And 2020: Targets and Achievements

PROGRAMME	**OUTPUT**	**2019**		**2020**	
		Target	**Actual**	**Target**	**Actual**
Grid Electrification	**No of Institutions Electrified**	**519**	**142**	**364**	**155**
	Funding (ZWL)	*21 mln*	*28 mln*	*147.5 mln*	*196mln*
Solar Micro Grids for Public Institutions	**Solar systems Installed**	**40**	**0**	**20**	**0**
	Funding (ZWL)	*To be pre-financed by the winning bidder*	*Winning bidder failed to secure foreign currency*	*74 mln*	*Amount, could not be raised due to cash flow constraints.*
BIOGAS	**Biogas Digesters Constructed**	**10**	**5**	**12**	**5**
	Funding (ZWL)			*ZWL 6.4 mln (3 mln from levy and 3.4 mln from Treasury)*	*3.4 mln from Treasury was not received*

Source: Ministry of Energy and Power Development (2021)

Table 2.2 shows that the Government of Zimbabwe has been dismally missing its 2019 and 2020 electrification targets. In 2019 it set a target of electrifying 519 institutions but the met target was 27.4% by electrifying only 142 institutions. In 2020, the Government targeted to electrify 364 institutions and it only managed to electrify 155. In as far as renewable energy is concerned, the Government targeted to install 40 and 20 solar systems in 2019 and 2020 respectively but managed to install none in both years due to non-availability of funding. It was the Government’s target to construct 10 and 12 Biogas Digesters in 2019 and 2020 respectively but it only managed to construct 5 in 2019 and 5 in 2020 and the major reasons for such deficits is the lack of funding. This proves that financing has been a major hindrance in achieving renewable energy plans, hence the need for this research to propose the best financing model for renewable energy in Zimbabwe.

2.2 Renewable Energy in Zimbabwe

Zimbabwe has vast RE resources that are presently underutilized and presents a big scope for investment. The primary, renewable energy sources are solar, hydro, wind and biomass which includes bagasse (sugarcane based), sawmill waste, biogas and forestry waste (Renewable Energy Policy,2019).

2.2.1 Renewable Energy Potential in Zimbabwe

Solar

Solar potential of 16-20MJ/m^2/day in Zimbabwe is vastly unexploited and is present in several regions of the Country. In 2018, Zimbabwe had grid connected installed capacity of about five Mega Watts (5 MW) that is well short of the potential.

Small hydropower

Significant small hydropower potential is present in the Eastern Highlands region and perennial rivers. Estimated potential of small hydropower is 150 MW in the country.

Biomass

According to IRENA (2020), Zimbabwe has a total potential of 1000 MW from biomass in the form of bagasse, agricultural and municipal waste, forest residue and other forms. Forest residue from commercial forests has been estimated at 70,000 tons which has the potential to generate nearly 150 MW power.

Geothermal

Zimbabwe also has geothermal energy potential of around 50 MW that has not been harnessed and presents scope for future exploitation.

Wind

Wind speeds of three meters per second are not significant for power generation, but can be used for water pumping.

In an effort to resolve the energy problems, Zimbabwe has crafted a number of energy policies and as well as the national blueprint, National Development Strategy 1 (NDS1) which comprehensively has a plan for renewable energy. Under the National Development Strategy 1 (NDS1) period (2021 to 2025), priority will be on development of reliable, adequate and low-priced power (NDS 1, 2020). To ensure improved energy supply, the core objective of the NDS1 is to increase power supply from the current installed capacity to 3467MW by the year 2025 and construction of additional 280km of transmission and distribution network by 2025. This will ensure economic stability and growth, given the fundamental forward and backward linkages with the rest of the economy. Despite current modest interventions in the energy sector, the country continues to experience significant electricity shortages, mainly due to aged infrastructure dating back to 1950s that has lacked sustained maintenance and upgrading (NDS1, 2020).

2.2.2 Technology Specific Renewable Energy Targets

Technology specific targets in the Renewable energy sector are backed by a strong policy framework, regulations and institutional support to ensure that they are enforced. Targets have been set for Zimbabwe considering greenhouse gas (GHG) emission targets set in the NDC objectives, demand-supply projections, grid absorption capacity and ability of utilities to pay for such energy.

Table 2.3:Technology specific RE targets by the year 2030

Technology	Target (MW)
Small Hydro	150
Grid Solar	1,575
Wind	100
Bagasse and other RE	275
Total RE target	**2,100**

Technology	Number of Units
Solar Water Heaters	250,000

Technology	Number of Units
Domestic Biogas Digesters	8,000
Institutional Biogas Digesters	288

Source: Renewable Energy Policy, 2019

2.2.3 Promoting Off-grid Technologies in Zimbabwe

Off-grid systems and other clean energy solutions can provide access to electricity and clean energy sources in regions where traditional grid extension is not economically feasible. They provide affordable lighting, improve communications, improve the quality of healthcare facilities and educational institutions in addition to other businesses and institutions. There are several off-grid technologies that can improve energy access in remote areas of Zimbabwe such as mini grids, micro grids, solar home systems, small hydro and renewable energy based water pumps and systems.

2.2.3.1 Mini-grids and Micro-grids

In Zimbabwe, licensing fees are waived off for installation and operation of micro-grids and mini-grids with an installed capacity of less 1 MW. In order for the mini-grids and micro-grids to qualify as community projects, these projects shall provide electricity to nearby communities, community projects, health facilities and educational institutions. These projects require approval of at least 66% or two thirds majority of the local population before beginning work on the project. The tariff set for these programs considers the paying capacity of the consumers (Renewable Energy Policy,2019).

2.2.3.2 Small Scale Distributed Generation (SSDG)

High solar power potential, coupled with decreasing solar equipment costs, provides an opportunity for investments in Small-Scale Distributed Generation (SSDG) to mitigate unpredictable supply. SSDG provides higher reliability of supply due to generation taking place at the point of consumption. There has been an increase in number of SSDG projects in the Commercial and Industrial sector in Zimbabwe. Examples of solar powered SSDG projects that have been commissioned in Zimbabwe include:

- 466 kWp Econet Willowvale Switch
- 600 kWp Kefalos Foods
- 950 kWp Schweppes

2.3 Incentives for Promoting Investment in Renewable Energy

2.3.1 National Project Status and Tax Incentives to Renewable Energy Projects

Awarding National Project Status to Renewable Energy projects enables projects to be exempted from the customs and general excise regulations. This allows the developers to import certain Renewable Energy systems used in the generation plants at competitive rates. Tax Holidays as well as duty free status for solar projects apply for various renewable energy projects. In addition, accelerated and full tax deductible depreciation allowance is given for all solar equipment installed in a consuming or producing entity.

2.3.2 Prescribed Asset Status to Renewable Energy Projects

Prescribed Asset Status encourages investors or developers to have access to sufficient capital to fund Renewable Energy projects. It attracts capital from pension funds and insurance funds as under the investment guidelines, pension funds have to invest certain percentage of the capital in Prescribed Assets. Ministry responsible for Energy recommend Renewable Energy projects on case to case basis to the Ministry responsible for Finance for Prescribed Asset Status.

2.3.3 Viability Gap Funding for Off-grid Community Project in Rural Areas

To increase electricity access and develop off-grid community solutions, projects in rural areas are eligible for Viability Gap Funding from the Rural Electrification Fund for development of distribution network in the area.

2.3.4 Reduced Licensing Fees and Requirements for Developers of RE Projects

Renewable energy projects are provided with concessions in licensing fee and enjoy relaxations in other licensing requirements. Based on the values of the capacity factor and the ratio between the capacity factors of renewable energy technologies to that of conventional power plant, the licensing fees were reduced for developing Renewable Energy projects as shown in Table 2.3 below.

Table 2.4:Licensing Fees

Technology	Capacity Factor	Ratio	Licensing fee for Generation in USD		
			1-10 MW	Beyond 10 MW	
			Fixed	Fixed	Variable per 25 MW
Conventional power plant	0.8	1	10,000	20,000	10,000
Solar PV	0.23	0.2875	2,875	5,750	2,875
Biomass	0.6	0.75	7,500	15,000	7,500
Small hydro	0.55	0.6875	6,875	13,750	6,875
Geothermal	0.72	0.8961	9,000	18,000	9,000
Wind	0.3	0.375	3,750	7,500	3,750

Source: Renewable Energy Policy, 2019

2.4 Modern Energy Access and Development

Lack of access to reliable modern energy presents profound challenges for economic development in Sub-Saharan African (SSA) countries (Chijioke *et al*, 2016). As noted by various authors, tapping the vast renewable energy resources in the continent would greatly help to curb energy poverty and promote modern energy access and at the same time address other issues such combating climate change, improve healthcare and education which would ultimately result in poverty eradication. More so, studies conducted by Gujba *et al*. (2018) and Agbemabiese *et al*. (2016) strongly suggested that increasing renewable energy access can spearhead economic development of countries, hence they realize their true economic potential. As Zimbabwe is grappling with power shortages amidst the implementation of the National Development Strategy 1 in an effort to attain the National Vision 2030 of attaining a middle-income status by 2020, it has to invest in renewable energy for the vision to become a reality.

Despite the benefits of the investing in renewable energy sources, many African countries are still meeting a large proportion of their national energy demands from traditional biomass. Sustainable development and use of the continent's massive biomass, geothermal, hydropower, solar and wind power have the potential to rapidly change Africa's current realities. The growing importance of access to reliable, affordable and clean energy in the region has put investments in the energy sector as a priority in the agenda of many African governments, regional bodies and international funders.

2.5 Investment Models

Investment models have shifted from conventional government and foreign benefactor funding sources to private, generally local enterprises and banks. The key to unlocking funding that will galvanize business development is to attract more traditional investors, private equity institutions, commercial debt, and public-private partnerships that do not yet consider the region's energy infrastructure development to be a safe and stable investment (Financial Innovations Lab Report,2015). Traditionally, utilities and project developers have provided the majority of equity in large renewable projects through their balance sheet. In the past five years, other types of investors have increased their commitments to renewable electricity. Institutional investors have an important role in freeing up debt and equity capital in operating-stage renewable energy projects. Banks, private equity funds, project developers and utilities can then redeploy the proceeds into the development and construction of new projects. Innovative financing structures are now being used during construction and operational stages of renewable energy projects. Renewable energy innovative financing models comprise mechanisms of raising funds in support of renewable energy development and this involves new approaches for pooling private and public revenue streams to scale up or develop renewable energy projects. The model also highlights new revenue streams and incentives earmarked to the sector's development.

2.6 Sources of Financing and Technology Maturity

Figure 2.1 shows that early-stage technologies are often financed by government research and development programs, or in the Research and Development budgets of large companies. Investments at earlier stages of technology development carry greater risks and are thus less attractive for private investors. By investing in R&D of renewable energy, governments aim to boost private investments at the later stages of technology maturity. The private equity element, in particular, takes growing companies specializing in renewable energy into the next phase, which is scaling-up either of manufacturing or of service offerings, including project development. This stage also sees an important role for investors on public stock markets, providing new capital via share issues by specialist renewable energy companies. In the rollout phase, are the asset finance of utility-scale renewable energy projects such as wind farms, solar parks and biofuel plants, and the funding of small distributed generation plants (solar systems of less than 1MW in capacity). Asset finance, the largest element of the continuum by far, relies on-balancesheet capital from large developers such as utilities; and a mix of equity and debt from infrastructure investors and banks.

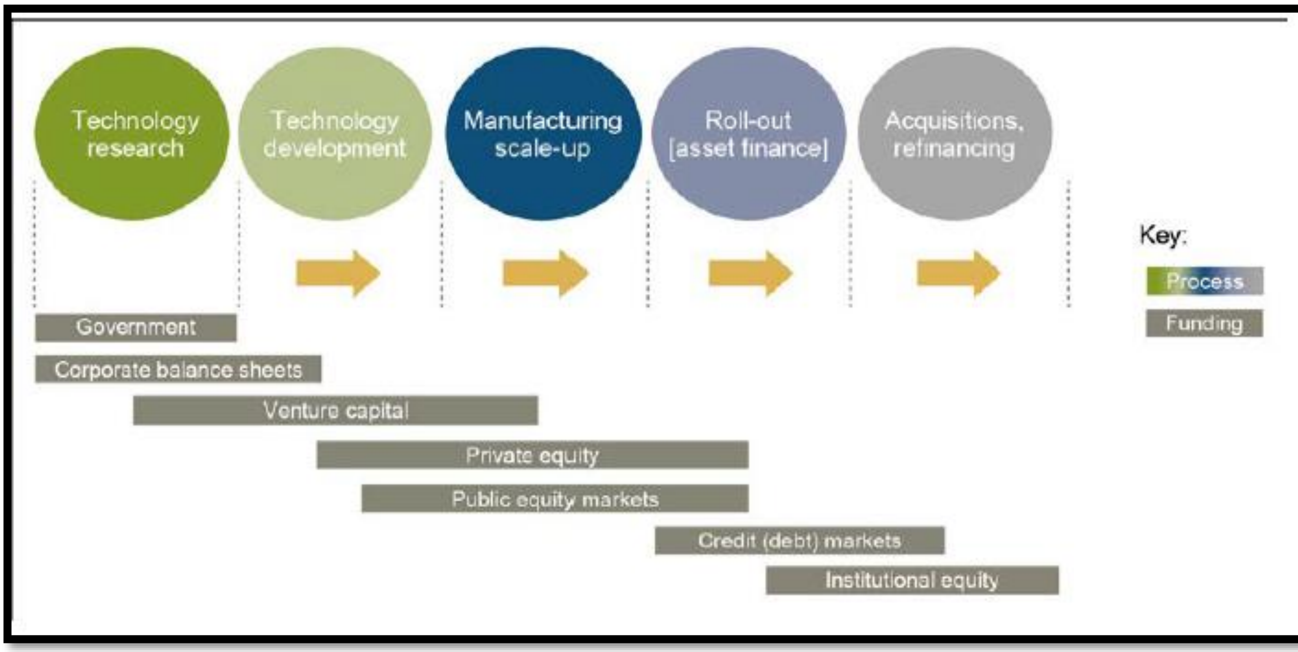

Figure 2.1:Sources of Financing and Technology Maturity

Source: Frankfurt School-UNEP Centre/BNEF, 2020

2.6.1 Capital Sources

There are various possible sources of funding for the renewable energy in literature. According to IRENA (2020), the private sector remains the main provider of capital for renewable energy projects, accounting for 86% of investments in the sector between 2013 and 2018 globally, while project developers provided 46% of private finance, followed by commercial financial institutions at 22%. Project-level equity was initially the most widely used financial instrument, linked to 35% of the investments in renewables from 2013 to 2016 (IRENA, 2020). Since 2017, it has been overtaken by project-level conventional debt, which reached 32% between 2017 and 2018. Public finance, representing 14% of total investments in renewables between 2013 and 2018, came mainly via development finance institutions. Public financing resources, although limited, can be crucial to reduce risks, overcome initial barriers, attract private investors and bring new markets to maturity (Chijioke *et al*, 2016).

2.6.2Renewable Energy Project Financing Plan

The financing plan sets out how the initial cost will be funded. Usually, senior debt lenders will provide only 70%–80% of the total cost and require the sponsor to bring the rest as equity, junior loans, subordinated debt and mezzanine finance (United Nations, ESCWA, 2016). RE project financing usually comes from three main sources namely equity, loans and grants.

1. Equity

Equity is the capital raised from shareholders. It carries the highest level of risk. Significant equity contributions are required from the sponsors in case of riskier projects. Sponsors should have a majority shareholding or adequate operational control. The expected return on equity is generally two or more times greater than return on debt. In return for the higher expected yield, equity investors bear the greatest risks and have rights to distributions from the project only after all other financial and tax obligations are met (United Nations, ESCWA, 2016).

2. Loan (debt)

A loan or debt is an amount of money provided by a third party to the project that must be repaid either during or at the end of its agreed term, plus interest over the period of the borrowing. Tax authorities treat interest payments as a cost and this means the project company can deduct interest when calculating its taxable income (United Nations, ESCWA, 2016). In contrast to equity investors, lenders who provide debt financing to a project do not own shares in the project. The major sources of debt financing are international and national commercial banks. Other sources of debt financing include multilateral development banks (MDBs) and the International Finance Corporation (IFC), debt/equity investment funds, equipment suppliers, and private investors. These banks can play a major role by syndicating the debt financing of a major project among several banks so as to minimize their own risk exposure on any given project. International funds dedicated to development projects will often create loans with generous repayment terms, low interest rates and flexible time frames. Such loans are called “soft-loans,” and precisely because of their lower interest rates and flexible terms, they are generally preferable to commercial loans (United Nations, ESCWA, 2016).

3. Grants & Guarantees

A grant is an amount of money provided by a third party to a project. Grants are usually provided to projects that are commercially not profitable and do not need to be repaid. Guarantees are offered by multilateral development banks and national development banks. For example, the Multilateral Investment Guarantee Agency (MIGA) is organized by the World Bank to help investors and lenders to deal with political risks by insuring eligible projects against losses relating to currency transfer restrictions, breach of contract, expropriation, war and civil disturbance, as such facilitating developing countries to attract and retain private investment.

The maximum feasible debt/equity ratio will need to be negotiated between lenders and equity holders. That depends on the expected cash flows i.e. whether there is sufficient cash in the early period of the loan to meet both debt service and expected dividends. The financing plan should identify each source of financing for the project, together with the amount of such financing and include all sources of funds allocated to the coverage of the project costs: loans, credits, equity contributions, grants and internally generated funds from the declared project entity. Revenues must cover first the operational costs of the project. They will also serve to repay the debt financiers, through principal and interest payments. After debt repayment, and if the financial ratios allow it, equity financiers will also be paid through dividend payments for the shareholders.

2.6.3 Financial Instruments

Several financial instruments can be used to finance RE projects, depending on their size, complexity, level of profitability, level of risk and type of technology implemented (United Nations, ESCWA, 2016).

1. Equity financing

Equity financing refers to the acquisition of funds by issuing shares of common or preferred stock in anticipation of income from dividends and capital gain as the value of stock rises. Equity financing can also come from professional venture capitalists (United Nations, ESCWA, 2016).

Venture capital is a specific segment of private equity investment, which entails investing in RE energy. Venture capital investors obtain equity shares in the RE project company and generally play a significant role in the management and technical aspects of the company. Private equity is essential for large-scale project developers because of the high amount of own capital required. Several public agencies and funds have developed finance mechanisms that provide equity investment opportunities for sustainable energy businesses and projects, often leveraging large amounts of investment from other private financing sources (United Nations, ESCWA, 2016).

2. Senior debt

Senior debt is the debt which must be serviced before any other debt or equity in the project. This is generally a precondition of loans by large local or international banks over the assets of the project (in project finance), which can include the contracts for sale of outputs from the project. It may also be secured over the assets of the project sponsor (United Nations, ESCWA, 2016).

3. Leasing

Leasing is a common way of dealing with the initial cost barrier. Leasing is a way of obtaining the right to use an asset (rather than the possession of this asset). In many markets, leasing finance can be used for small RE installations, even when the installation lacks collateral value (United Nations, ESCWA, 2016). Leasing companies are often bank subsidiaries having experience with vendor finance programs and other forms of equipment finance that are analogous to renewable energy.

4. Mezzanine Financing

Mezzanine financing is sometimes called subordinated debt financing. It is capital that sits midway in repayment priority between senior debt and equity and has features of both kinds of financing. Subordination refers to the order or priority of repayments (United Nations, ESCWA, 2016). Subordinated debt is structured so that it is repaid from project revenues after all operating costs and senior debt service has been paid. There are much fewer sources of subordinated debt than there are of senior debt or equity, so it is often considered to be specialty financing (United Nations, ESCWA, 2016). Subordinated debt financing is generally made available directly from insurance companies, subordinated debt funds, or commercial financing institutions (CFIs).

5. Project Financing

Project financing relies only on a project's cash-flow expectations and spreads the risk between the different actors. It is often based on a complex financial structure where project debt and equity are used to finance a project, rather than the balance sheets of project sponsors. Usually, a project financing structure involves a number of equity investors, as well as a syndicate of banks that provide loans to the operation (United Nations, ESCWA, 2016). The loans are most commonly non-recourse loans, which are secured by the project assets and paid entirely from project cash flow, rather than from the general assets or creditworthiness of the project sponsors. The ratio of debt to equity is much higher in project finance than in corporate financing, a project with 80% debt and 20% equity is common in project financing (Mohamadi, 2020).

6. Vendor financing

Vendor financing occurs when a financier provides a vendor with capital to enable an offer of financing for equipment. Under a vendor-financing scheme, there are two types of arrangements: one between vendor and financier and the other between vendor and customer. The former defines the terms that can be offered to the customer such as rates, length of term and necessary documentation (Mohamadi, 2020). The vendor/customer agreement defines the repayment terms of the loan. For RE equipment, these agreements can be structured such that the customer payments are lower than the value of energy savings associated with the new equipment. Leasing is the most common form of vendor financing.

7. Bonds

A bond issued through a project company is like a loan but is used in non-banking markets as a tradable debt instrument. The project company agrees to repay the bondholder the amount of the bond plus interest (coupon) at fixed installment dates (Mohamadi, 2020).

Globally, RE projects are financed mainly with project-level conventional debt, which peaked at US$119 billion in 2017 and accounted for 32% of the total investment between 2017 and 2018, on average (IRENA, 2020). Balance sheet financing, both equity and debt, also supported considerable investment, each contributing to 27% (or 54% combined) of total commitments between 2017 and 2018, on average (IRENA, 2020). Balance sheet financing was almost exclusively used to finance the development of solar PV and onshore wind, whereas project-level conventional debt was used for a wider range of technologies, including offshore wind. Green bonds have the potential to channel significant volumes of capital into renewable energy (Quaschning, 2016). Annual issuance of green bonds solely earmarked to renewable energy experienced a rapid increase in recent years, from US$2 billion in 2013 to US$38 billion in 2019. They are often used to re-finance existing assets and can attract institutional investors due to their large ticket sizes (IRENA, 2020).

2.6.4 Renewable Energy Policy Provisions to Finance the Development of Off-grid Technologies

The following initiatives are provided by the Zimbabwean government to attract private funds and finance the development of renewable energy projects:

1. **Grants:** The Government works with the NGOs and multi-lateral institutions to obtain grants that can be provided for development of micro-grid and mini-grid projects.
2. **Concessional Loans:** Off-grid projects employing renewable sources are eligible to get concessional loans from the dedicated Green Energy Fund.
3. **Grace Period in Loans:** Loans availed by the developers from the dedicated Green Energy Fund and REF for developing these projects are eligible for an initial extended grace period for repayment that will allow the developers to recover the operating expenses and other investments in the initial years before making the interest and principal payments of the loan.
4. **Subsidies:** The Government provides a certain defined amount of subsidy according to the type and size of the project in order to make the project financially sustainable in the initial years and attract funds from private investors.
5. **Budgetary Allocation:** Developing off-grid projects needs government support and a yearly allocation of the annual budget shall provide a boost to the developers.

2.7 Status of Global Investments in RETs

2.7.1 Impact of COVID 19 on RETs Investments

Following the outbreak of the coronavirus disease-2019 (Covid-19), renewable energy investments saw a 34% decline in the first half of 2020, compared with the same period in 2019 (IRENA,2020). Going forward, there is a risk that the impacts of the global crisis on both the energy and financial sectors may negatively affect renewable energy investment, hampering progress toward a global energy transition. In the financial sector, the economic impact of the global pandemic has caused disruptions and instability in financial markets where the investments in RETs should come from (Gross, Leach and Bauen, 2020). The global equity markets have also not been spared, which declined 30% in few weeks after the Covid-19 has been declared a pandemic in 2020 (WEF, 2020). This has led to major losses in balance sheets for many businesses investing in the renewable energy sector around the world. This has negatively their credit worthiness and their borrowing capacity which has a ripple effect on their investments.

2.7.2 Investment by Technology

According to IRENA (2020), between 2017 and 2018, solar PV and onshore wind consolidated their dominance in the renewable energy market, representing on average 77% of total finance commitments in the renewable energy sector.

2.7.3 Investment by Region

IRENA (2020) reported that he East Asia and Pacific region attracted, on average, 32% of global renewable energy financial commitments between 2017 and 2018, peaking at US$ 125 billion in 2017. This was mainly driven by increased spending on solar PV and onshore and offshore wind in China, which represented, on average, 93% of renewable energy investment in the region between 2013 and 2018. Building on the extensive project pipeline in Sub-Saharan Africa, there are over 90 renewable energy projects available on the Sustainable Energy Marketplace. There are 10 promising renewable energy projects (including wind, solar, bioenergy, hydropower projects) located in Cameroon, Cote D'Ivoire, Kenya, Mali, Senegal, Sierra Leone and Togo with a total capacity ranging from 6 MW to 70 MW (IRENA, 2019). The East African region, being led by Rwanda is leading the continent's charge to embrace renewable energy, including solar, geothermal and wind power (World Bank, 2020). Rwanda has an 8.5-MW solar farm in Agahozo that was commissioned in 2014 valued at $24 million which has 2,800 solar panels. The Authority of Heads of State and Government of the Economic Community of West African States (ECOWAS) adopted the ECOWAS Renewable Energy Policy (EREP) which aims to increase the share of renewable energy in the region's overall electricity mix to 35% in 2020 and 48% in 2030 (IRENA, 2016).

2.7.4 Public and Private Finance

Private finance provided an average of 86% of total investment for renewable energy projects between 2013 and 2018, equivalent to annual commitments of US$257 billion globally, while public finance reached an average of US$44 billion annually in the same period (IRENA, 2020). Throughout 2013-2018, project developers continued to be the main actors within private finance, providing an average of 56% of total private finance between 2017 and 2018, mainly through balance sheet finance, either through debt or equity. The private sector is the main provider of capital for renewables but public resources remain crucial to reduce risks for private investors and bring new markets to maturity (IRENA, 2020).

2.7.5 Investment by Source

Public and private actors normally have distinct roles and approaches in renewable energy finance. The private sector, for example, while providing the majority of finance tends to focus more on regions and technologies with favourable investment environments and public finance, in contrast, concentrates on areas that still require more work to reduce the cost of capital (for example, through risk mitigation instruments) and technology costs by demonstrating the business potential of hard-to-enter sectors and markets (IRENA, 2020).

2.7.6 Non-Governmental Organisations (NGOs)

Non-governmental organizations (NGOs) are primarily involved in experimental activities and the promotion and dissemination of renewable energy installations as part of community development efforts (through public information and the promotion of individual or collective equipment) in Mali (Chijioke *et al*, 2016). More so, professional associations are an effective network for disseminating information and building capacity for the renewable energy sector.

2.7.7 Development Partners

Development partners have an important role to play in promoting and disseminating renewable energy technologies. According to Quaschning (2016), there are three groups of development partners operating in Mali: (i) Multilateral development institutions supporting the Government in developing and implementing renewable energy projects and programs which are the World Bank Group, the United Nations Development Program and United Nations Environment Program, the African Development Bank and the European Union Delegation. (ii) Bilateral development partners operating within the framework of bilateral cooperation for financing projects and programs through public or private institutions. (iii) Organizations that work directly with beneficiary populations and seek funding for renewable energy projects and programs from development partners. Zimbabwe has limited opportunities to work with the development partners such as Britton Woods institutions due to the bad repayment reputation. However, there are opportunities to work with bilateral agreements, for example, with China.

In 2017-2018, annual renewable energy investment reached, on average, USD 337 billion. The finance and investment landscape for renewables is depicted in Figure 2.2 below.

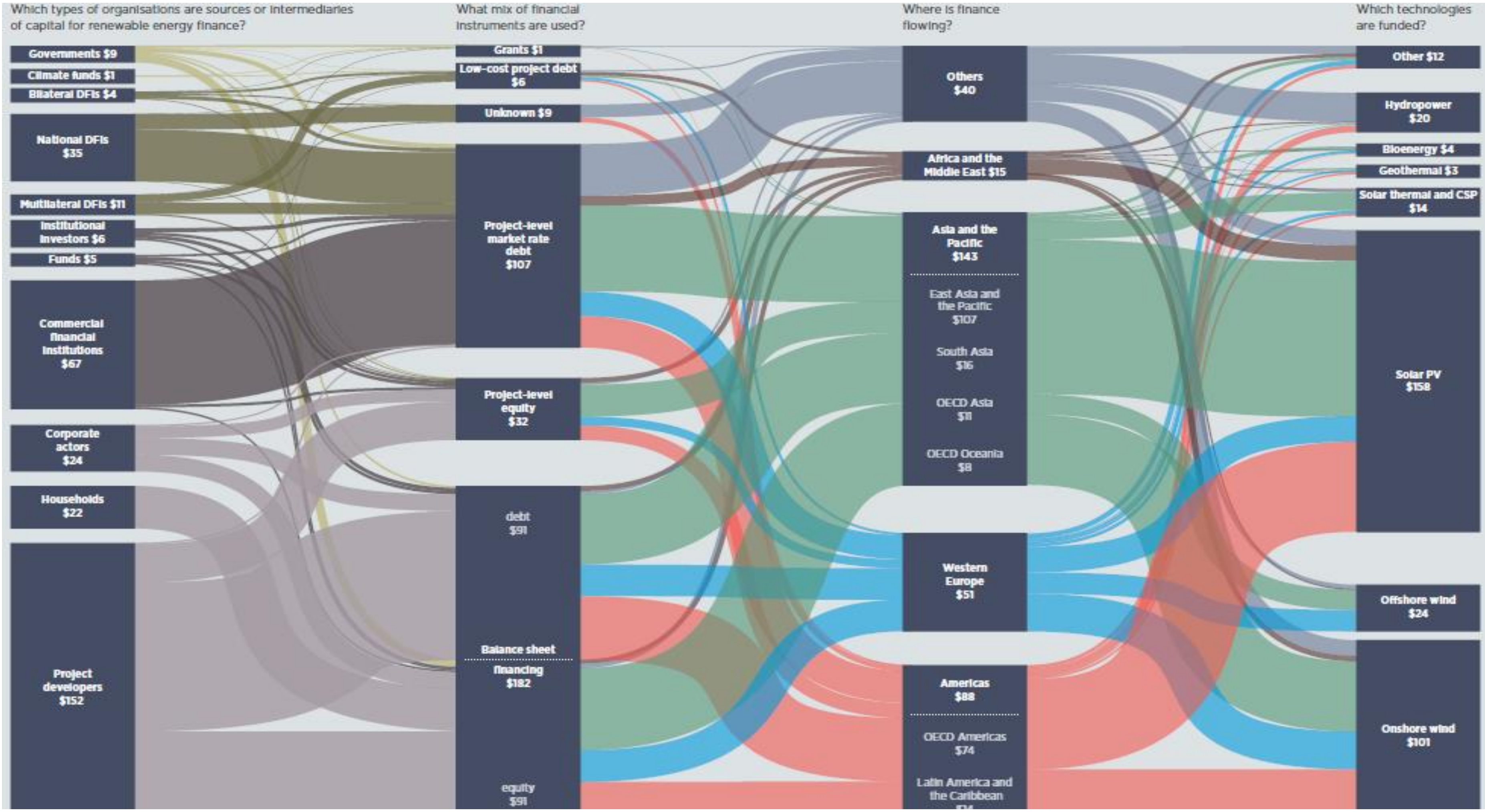

Figure 2. 2: Global landscape of renewable energy finance in 2017-2018

Source:(IRENA,2020)

2.8The Financial Gap in Zimbabwe

Due to uncertainties around the currency and exchange rate trajectories in Zimbabwe, the financial sector has no much appetite to lend. The country dollarized in 2009, de-dollarized in 2019 and now has returned to the use of a basket of currency. Whenever the country changes its currency regime as well as the foreign exchange regime, it results in loss of savings by depositors and loss depreciation of loans value. This, compounded with the inflation uncertainties, the financial sector has lost the appetite to lend. In addition, the Zimbabwe Government has not been receiving the loans from the Britton Woods institutions due to failure to repay its principal debt and interest payments. This means that the Government is crippled in borrowing from both domestically and internationally. Domestically, the Government can only borrow from the private sector through the issuance of treasury bills and bonds. This lack of access to credit facilities is a critical barrier to the dissemination of RETs. Limited access to financial resources (credit and loans from banks and other credit facilities) and high cost of finance (including higher interest rates) are preventing commercialization of RETS in Zimbabwe. The barriers to investment in Renewable Energy Technologies being faced in Zimbabwe are in tandem with those discussed in literature which include high initial capital cost, high investment costs, high transaction costs, lack of access to capital and lack of purchasing power (Panwar, Kaushik and Kothari, 2017).

2.8 Barriers to Renewable Energy Technologies Development

The African Development Bank (Lund, 2017) noted that that there exist numerous challenges that hamper RETs development and commercialization in Africa ranging from country specific issues, policy and regulatory, research and technological and most importantly, investment and financial barriers. In Africa, RETs have not yet attracted the level of investment or policy commitment they require and have not been widely disseminated in the region, and Zimbabwe is not an exception (Twidell and Weir, 2015). The amount of resources allocated to developing renewable energy technologies in African countries are negligible relative to the amount of resources allocated to the conventional energy sector. Figure 2.2 displays the interlinked relationships between barriers faced by RETs.

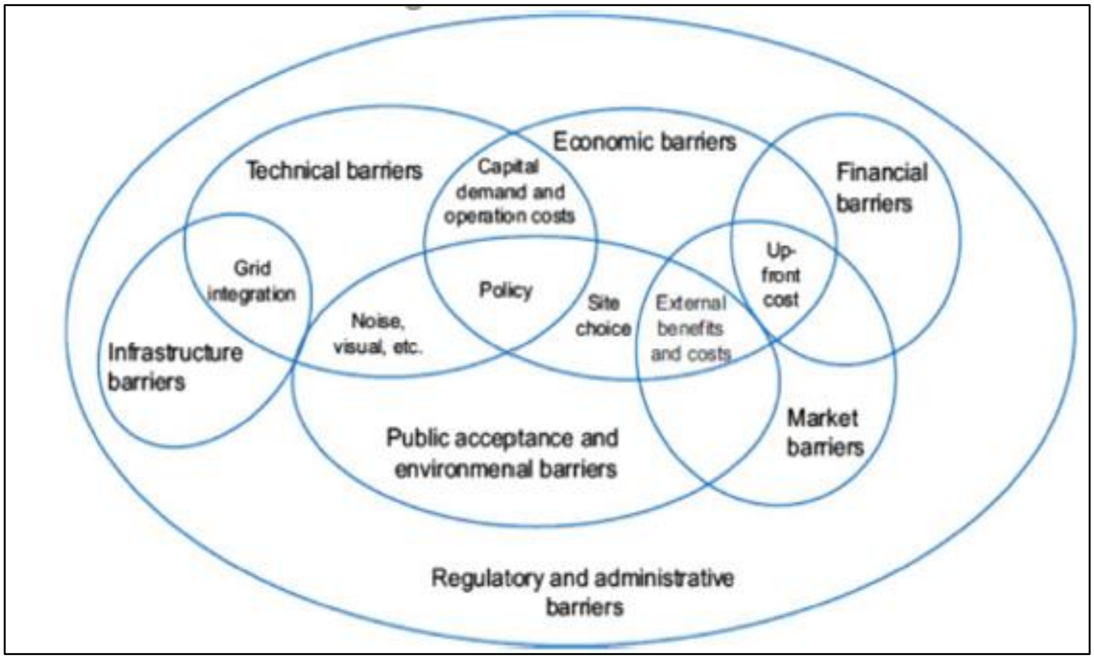

Figure 2.3:Barriers to Renewable Energy Technologies Development

S*ource*: Muller et al. (2011)

2.8.1 High Upfront Development Costs

Most RE projects' economics fail to compete with fossil fuels as the cost per unit of energy is typically greater than those for fossil fuels projects. According to the World Bank (2012) the high costs can be attributed to the fact that sites can be located away electricity grids, ensuing in long negotiations to get the grid extended. High cost of doing business is a huge barrier for the development of RETs in developing countries, Zimbabwe is not an exception (Harjanne and Korhonen, 2019). These include corruption costs and inputs for the projects which are not developed locally, but imported. These high development costs scare away investors as the payback period will be long, and the more the payback period, the higher the risks, especially in a volatile economy like Zimbabwe.

2.8.2 Distorted Energy Prices

Current energy prices do not reflect the environmental and social costs of production, thus causing

RE projects to be more expensive than conventional technologies. When costs include the social and environmental benefits, referred to as the “true costs”, renewable energy is economically and environmentally more attractive than traditional fossil fuels. Furthermore, fossil fuel projects such as coal powered power stations are often subsidized by the government, further giving fossil fuel projects market advantage over RETs. Energy prices do not reflect the true benefits of deploying renewable projects. In most countries, energy sectors are highly regulated by the Government especially on pricing. This therefore led the sector to be less attractive as the regulated prices may fail to consider the production cost, positive and negative externalities, hence less attractive to investors (Ellabban, Abu-Rub and Blaabjerg, 2014). In Zimbabwe, currently the energy sector is monopolised by the government which is the sole supplier of modern electricity.

2.8.3 Lack of Equity

Lenders to projects often require a higher portion of equity compared to the debt, with debt to equity ratios of 70:30 often preferred (Kaltschmitt, Streicher and Wiese, 2017). The lack of venture capital or start-up funding further impedes the development of renewable energy in that, project developers are unable to secure the equity financing required by lenders (Walker and Devine-Wright, 2018). This has been mentioned as a huge barrier to renewable energy investment as most of the companies have a capital structure with a huge proportion of debt financing.

2.8.4 Risk and Return

Most of the studies (Quaschning, 2016) on renewable energy investment in literature have identified higher risks associated with the investments as a huge barrier hampering investments in renewable energy, especially in developing countries. By its nature, as renewable energy is sourced from natural elements, renewable energy projects exhibit a higher level of risk and uncertainty. The natural elements which forms renewable energy include but not limited to wind, sun and hydro which are often difficult or impossible to control, making it even more difficult to predict cash flows thus increasing the costs even more (Walker, 2018). Renewable energy projects show diminished returns with the project only turning cash positive in the later years of the projects’ life cycle (Quaschning, 2016). Thus, investors are exposed to more risk in renewable energy projects but are often not compensated by any real form of acceptable internal rate of return (IRR), making investment in the sector even less attractive. The good example to qualify this is the case of hydroelectricity in Zimbabwe which constitute a huge proportion of electricity supply, it is being adversely affected by climate change, so this can apply to wind and solar generated electricity. By nature, investors are risk averse, hence not investing in the renewable energy projects.

2.8.5 High Transaction Costs

Due to high cost of doing business in developing countries, there are higher transaction costs. This coupled with very low incomes, businesses have to price less. Businesses aim to maximise the shareholder welfare through the profit maximisation. High transaction costs erode the profits of the businesses, hence disincentivising the investors to invest into the renewable energy sector, and the economy at large (Goswami and Kreith, 2017). This also is one of the factors scaring away investments in Zimbabwe, both domestic and Foreign Direct Investment (FDI).

2.8.6 Long Term Financing Requirement

Renewable energy projects cost more in the initial stages as they require high initial outlay and costs less once the plant is installed and operational (Moriarty and Honnery, 2016). This implies that these projects need long term funding. The long-time exposure is usually compensated for by higher interest rates and returns on equity, but such returns further make renewable energy projects unattractive, hence being shunned by the investors (Gielen *et al*., 2019). Investors prefer to match their long-term assets with long term liabilities, thus in-order to obtain long term financing. Renewable energy projects need investors that are looking for long term assets, often such investors are pension funds (Gielen *et al*., 2019). However, these pension funds limit their risk and are unwilling to invest in risky renewable energy projects. This leaves this critical sector with few funding options available.

In Zimbabwe the main barriers to the development of renewable energy projects are mainly:

1. Policy and regulatory barriers
2. Tariff and net metering barriers

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2.9 Government Policy and Investment

The benefits of policies aimed at promoting investment are widely recognized by investors and world economies in their trade engagement and daily processes (UNCTAD, 2015). They ensure the expansion of productive capacity, enterprise development, income growth, job creation and technology diffusion. According to Pradhan (2015) a sound investment policy is necessary for economic growth and development and such a policy should encompass promotion and entrenchment targeted at sectors where investors and trade ventures presence would be advantageous to the country's economic growth contribution effort. In the past, Zimbabwe has experienced changes in its investment policy formulation process and strategic trade and industrial policies have been mainly influenced by the changing political set-up of the country. However, Zimbabwe is faced with a number of challenges which include inconsistent economic policies, corruption and bad governance, public services deteriorations made the foreign investors to be discouraged since 2000s when things began to change negatively. This has resulted to Zimbabwe certainly lagging far behind in terms of domestic investment contribution to Gross fixed capital formation (GFCF) compared with other developing countries.

2.9.1 Feed-in-Tarrifs

A Feed in Tariff (FIT) is a policy mechanism designed to accelerate investment in renewable energy technologies. Their design aims to accelerate investment in these technologies by providing adequate compensation above the electricity market price and hence an incentive mechanism to boost renewable energy development and reduce uncertainties for investors. It achieves this by offering long-term contracts to renewable energy producers, based on the cost of generation of each technology. Rather than pay an equal amount for energy, lower cost technologies such as wind power, for instance, are awarded a lower price per-kWh price than technologies that cost higher, such as solar PV. Experiences from other countries in the world suggest that a well-designed Feed in Tariff can generate rapid growth for targeted renewable energy projects, by creating conditions that attract capital to those particular sectors (Eberhard Anton et al, 2016). Currently, Zimbabwe is lacking well defined feed-in-tariffs for Independent power producers as the Ministry of Energy and Power Development is trying to migrate to competitive bidding framework (MoEPD, 2021). A well-designed FIT policy leads to the deployment of renewable energy sources in the shortest time and at the lowest cost for the society. Australian Energy Council (2018) highlighted that FITs are a major driver of the development of most renewable energy markets especially by independent power producers. Currently, ZERA conducts Power Purchase Agreement (PPA) negotiations on a project-by-project basis, using the existing REFiT for guidance. Table 2.5 shows Zimbabwe's tariffs for renewable energy technologies for 2013, 2016 and 2018. The tariffs have been dropping due to technological improvements.

Table 2.5:Zimbabwe's Tariffs for Renewable Energy Technologies

Technology	*Generation capacity range*	*Tariff (US$/kWh)*		
		2013	*2016*	*2018*
Hydro	100 kW < x ≤ 1 MW	0.153	0.146	0.142
Biomass	100 kW < x ≤ 10 MW	0.137	0.123	0.098
Bagasse	100 kW < x ≤ 10 MW	0.111	0.102	0.079
Biogas	100 kW < x ≤ 10 MW	0.127	0.114	0.106
Solar PV	100 kW < x ≤ 1 MW	0.186	0.140	0.130
Wind	100 kW < x ≤ 5 MW	0.148	0.112	0.100

Source: Renewable Energy Policy,2019

The FiTs used during utility-supplier PPA negotiations of all RE technologies are much higher than the rates at which electricity is supplied to customers. Currently, there is little incentive to enter a PPA with ZETDC under these FiTs when the utility is in such financial distress. Similarly, with customer tariffs from ZETDC currently significantly below the level of the FiTs, ZETDC also has no incentive to enter a PPA.

2.9.2 Net Metering

Net metering is a policy that allows electricity customers with their own generation capacity to be financially compensated for the energy they produce. Net metering is widely regarded as having an important role in deployment of distributed generation, especially solar energy. State and local governments have authority to establish net metering policies, and some have done so for many years. In 2018, the net metering regulations were promulgated under Statutory Instrument 86 (SI86). However, the ceiling of 100kW may limit large investment in the Renewable energy market in the long-run. Net metering regulations, gazetted by the Government of Zimbabwe in early 2018 are meant to govern the net trading of electricity consumed from the utility and generated and fed back from small-scale, grid-tied renewable energy generators like solar PV on rooftops. In July 2019, ZERA announced the launch of these regulations, with application up to a threshold of 100 kW. For any plant above this threshold the tariff code will apply. The pricing for net metering dictates that for every kWh that the customer exports to the grid, they shall receive a credit of 0.9 kWh in the billing period. The Zimbabwe Energy Regulatory Authority (ZERA) has trained 270 Solar Equipment Technicians to ensure safe installation of solar equipment that meets specified standards across the country at household and industrial level. This should ensure Zimbabwe has sufficient capacity to develop further installations of SSDG beyond the 100 kW threshold.

2.9.3 Monetary Policy Inconsistency

Zimbabwe acquired its independence on 18 April 1980. Thereafter, its government introduced the currency known as the Zimbabwean dollar (ZW$) as an official currency, replacing the Rhodesian dollar in equivalence. At its inception, the Zimbabwean dollar had an exchange rate of one to 1.47 United States dollars (US$). However, according to Zimfact (2020), by July 2008 its value had dropped to ZW$10 billion to 0.33 US$. This was fuelled by the substantial increase in money supply of ZW$20.5 trillion." The increase led Zimbabwe to be the first hyperinflationary economy of the 21st century. This caused the abandonment of the ZW$ and the adoption of the US$ and other currency such as the Euro and the Rand. Exchange rate stability is one of the main factors that promote total investment, price stability and stable economic growth. Exchange rate movements have been a big concern for investors, analyst, managers and shareholders. The currency fluctuation in Zimbabwe since early 2000 has contributed to low investments in the country. Currency fluctuations pose a greater risk to investors both domestic and foreign investors. The impact of an exchange rate pass-through effect on prices further stimulated the hyperinflation in the period 2000 – 2008 (Zimfact, 2020). After experiencing episodes of hyperinflation depreciation of the Zimbabwean dollar, it became apparent that authorities had failed to bring about economic stability in Zimbabwe. The dollarization of the economy in 2009 brought some currency stability, until October 2020 when the RBZ separated the USD accounts and the RTGS accounts, bringing the new currency called RTGS$. This move left many investors in heavy exchange rate losses. The introduction of SI142 in 2019 which bans the use of foreign currency in Zimbabwe drove many investments into losses again, until SI 85 of 2020 which lifted the ban and put new measures. Currency volatility has been an issue for Zimbabwe over the last two decades which hinders new investments into the country.

2.9.4 Indigenisation and Economic Empowerment

The policy consists of the land reform programme and the Indigenisation and Economic Empowerment Act of 2008 (IEE Act) (Chowa, 2013). Thus, the indigenisation policy seeks to ensure that indigenous people own and utilize their resources, so as to broaden the base of Zimbabwe ‘s economy. The policy mainly targets residents from rural areas, and aims at the improvement of their socio-economic conditions through infrastructure development, small and medium enterprise development, local ownership of natural resources, as well as improving academic standards (Matunhu, 2012). Indigenisation programmes started scaring away potential foreign investors due to its complicated clauses 51/49 share ownership. Government of Zimbabwe turned the country into least favourable investment destination. Most foreign investors were not willing to invest in indigenisation contracts, where they will become minority shareholders and effectively have no power to secure property rights on their investments.

2.9.5 Bankability of Purchasing Power Agreements

A power purchase agreement (PPA) is a legal contract between an electricity generator and a power purchaser, lasting between five and 20 years. Such agreements play a key role in the financing of independently owned electricity-generating assets. The seller under the PPA is typically an IPP, an entity which generates and supplies power to the state utilities or directly to the end users. The IPP is not a state utility, but can be part of a Public Private Partnership entity, together with a state utility. The current regulations on Zimbabwe states that the IPPs can sign an agreement with off takers at an agreed cost reflective tariff, but however the challenge now is on currency convertibility. Some PPEs with foreign currency agreements are being paid local currency which in turn hinders them from paying their dividends or loans. These policy inconsistences affect investment in renewable energy in Zimbabwe.

2.10 Profitability Indicators of Renewable Energy Projects

To decide whether or not to invest in a Renewable energy project, an estimation of the economic value or profitability of the project is required, which is generally calculated through a financial model (United Nations, ESCWA, 2016). The financial indicators used most often to evaluate the profitability of RE projects from the point of view of the project developers are:

2.10.1 Net Present Value (NPV)

NPV is the difference between the present value of cash inflows and the present value of cash outflows. It is one of the most reliable measures used in capital budgeting because it accounts for the time value of money by using discounted cash flows in the calculation (United Nations, ESCWA, 2016).

$$\boxed{NPV = \sum_{t-1}^{T} \frac{C_t}{(1+r)^t} - C_0}$$ ……………. Equation (2.1

where:

C_t = net cash inflow during the period, t

C_o = total initial investment costs

r = discount rate

T = number of periods during which the project is expected to operate and generate cash inflows (in years for RE projects)

The first indication of the profitability of RE investment is that it shows a positive NPV. The condition NPV= 0 allows the limit of profitability of a project to be defined.

2.10.2 Internal Rate of Return (IRR)

The IRR is the interest rate that equates the equivalent worth of an alternative's cash *inflows* (revenue) to the equivalent worth of cash *outflows* (expenses). Hence it is the interest rate at which the discounted present worth of benefits equals the discounted present worth of costs. It is sometimes referred to as the *breakeven interest rate*. The internal rate of return (IRR) is the discount rate that makes the NPV equal to zero. From the definition of IRR, the project is profitable if its IRR is higher than the WACC. Otherwise, the project will generate a negative NPV and should therefore not be carried out because it would lead to economic losses for the investor (United Nations, ESCWA, 2016).

2.10.3 Capital Enrichment Ratio (CER)

CER or profitability index (PI), also known as profit investment ratio (PIR) and value investment ratio (VIR), is the ratio of pay-off to investment of a proposed project. It is a useful tool for ranking projects because it allows the developer to quantify the amount of value created per unit of investment (United Nations, ESCWA, 2016). CER is calculated by dividing the present value (PV) of the project's future cash flows by the initial investment:

$$\boxed{CER = \frac{\text{PV future CF}}{\text{Initial investment}}}$$

……………….. Equation 2.2

A CER greater than 1 indicates that profitability is positive, while a CER less than 1 indicates that the project will lose money:

2.10.4 Payback Period

Payback period is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment. The payback period gives an indication of the liquidity for the projects that would return money early. In addition, it can be a measure of risk inherent in a project since cash flows that occur later in a project's life are considered more uncertain (United Nations, ESCWA, 2016). The disadvantage of the payback period is that it ignores any benefits that occur after this period and therefore neither measures the project profitability nor takes into account the time value of money. The formula to calculate the payback period of a project depends on whether the cash flow per period from the project is constant or not. In the case where it is constant, the formula to calculate the payback period is:

$$\text{Payback period} = \frac{\text{Initial investment}}{\text{Cash inflow per period}}$$

……….. Equation 2.3

When cash inflows are uneven, we need to calculate the cumulative net cash flow for each period and then use the following formula for payback period

$$\text{Payback period} = A + \frac{B}{C}$$

…………….... Equation 2.4

where:

A = number of years after the initial investment at which the last negative value of cumulative cash flow occurs;

B = absolute value of the negative cumulative cash flow at the end of period A;

C = cash flow during the year A+1.

Two options are used for calculating the payback period: the simple payback period and the discounted payback period:

The **simple payback period:** cash inflows are expressed as a constant value (the time value of money is ignored);

The **discounted payback period:** cash inflows are discounted; the discounted cash inflow for each period is to be calculated using the formula:

$$\text{Discounted cash inflow} = \frac{\text{Actual cash inflow}}{(1+r)^n}$$ ….. Equation 2.5

where:

r = discount rate

n = period to which the cash inflow relates.

The project is considered profitable when the discounted payback period is less than the duration of the economic life of the project.

2.10.5 Levelized Cost of Energy (LCOE)

The Levelized cost of energy (LCOE) is the ratio of lifetime costs to lifetime energy generation, both of which are discounted back to a common year using a discount rate that reflects the average cost of capital (United Nations, ESCWA, 2016). It is given in unit of currency per unit of energy produced and it can be used to effectively compare different technologies, taking into account the project's lifetime costs; it is very helpful for decision-making, especially for utilities: The lower the LCOE, the higher the return for the investor. For project developers, it might be a good indicator to compare the competitiveness of the RE project with the existing infrastructure.

$$\text{LCOE} = \frac{\textit{Total Life Cycle Cost}}{\textit{Total Lifetime Energy Production}}$$ …………Equation 2.6

$$\text{LCOE} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)t}}$$ ……………………Equation 2.7

where:

I_t: Investment expenditures in the year t

M_t: O&M expenditures in the year t

F_t: Fuel expenditures in the year t

E_t: Electricity generation in the year t

r: Discount rate

n: Life of the system

2.10.6 Conditions for Profitability

Several financial indicators are useful for assessing the viability of the project, including IRR, NPV, CER and payback period(United Nations, ESCWA, 2016). The developer can use other indicators to confirm the profitability of the project and make the choice between the options of its realization but, in every case, the selection criteria should satisfy the following conditions:

- NPV > 0
- Discounted payback period < n (economic observation period)
- IRR of the project > WACC (weighted average cost of capital)
- CER > 1
- LCOE lower than other conventional technologies

These indicators have to be calculated for reference-case situations but also for the case when some key assumptions change.

2.11 Conclusion

The energy gap currently faced in Zimbabwe can be viewed as an opportunity for private sector investment through innovative sources of financing in Renewable Energy Technologies. The current chapter discussed the various RE Project financing sources and financial instruments. Factors which hamper investment in the renewable energy sector in developing countries with a focus on the country of study were also discussed. This will give appropriate insights into the development of the methodology section in the proceeding chapter.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the procedures used in conducting the study are presented. They include the study area characteristics, research design, target population, sample and sampling procedures, research instruments, validity and reliability of instruments, data collection and data analysis procedures.

3.2 Research Design

The research design and methodology structuring phase is a fundamental step in the development of a good scientific study (Oji, 2015). The research design has been mentioned by many empirical studies as the most important aspect in determining the research outcomes. Well-articulated research designs tend to minimise measurement errors that arise from specific methodologies. Žukauskas, Vveinhardt and Andriukaitienė (2017) pointed out that a well-articulated research design increases the reliability of the research findings. Scholars including Zegwaard, F, (2018) highlighted that selection of research methodologies should be based on appropriateness in order to gather sufficient evidence which addresses the research questions. Since the financing of Renewable Energy Projects in Zimbabwe is under researched it was found necessary to obtain and analyze qualitative data. A descriptive survey was used as the best research problem in the study. The approach entails observation of some subset of a population at a single point in time. In this study, the design enabled the researcher assess the energy financing situation and describe the population. Economically, data is collected easily in large population using surveys. This study's objectives were fulfilled best by using the descriptive survey.

3.3Sites of the Study

Ministry of Energy and Power Development - Ministry of Energy and Power Development has its key deliverable as energy supply and security for the whole country. The Ministry makes a commitment to provide a service to the specified quality standards and within stated time limits through policies and legal framework which guide the sector for the benefit of the nation.

Ministry of Finance and Economic Development- The Ministry of Finance and Economic Development is entrusted with the stewardship of national resources, their mobilization, allocation, management and accounting for economic growth and development through the provision of sound macro-economic policies**.**

Rural Electrification Agency - Zimbabwean Government gave high priority to rural infrastructure development programmes, which included the rural electrification programme. The policy framework was a deliberate intention to correct the imbalances between urban and rural electrification with the ultimate goal of socially and financially empowering the rural communities and enhancing their capabilities in their contribution towards economic development of the country.

Independent Power Producers - An independent power producer or non-utility generator is a company that is not a public utility but owns facilities to generate electric power for sale to utilities and end users.

3.4 Target Population

Martinez-Mesa at al (2014) defined population as a group of independent individuals which is restricted to a certain geographical region (country, city, neighborhood) or certain institutions (schools or hospitals). These individuals must have at least one common characteristic. The target population corresponds to a sub-portion of the population, about which the researcher intends to draw findings and conclusions. The target population is having the common characteristic which is in best interest of the study (Denquia, et al 2014). Lastly, study sample is comprised of that selected part of the target population for the study, which will be investigated and conclusions drawn about the target population, which will be trusted to reflect the overall situation (Martinez-Mesa at al, 2014)

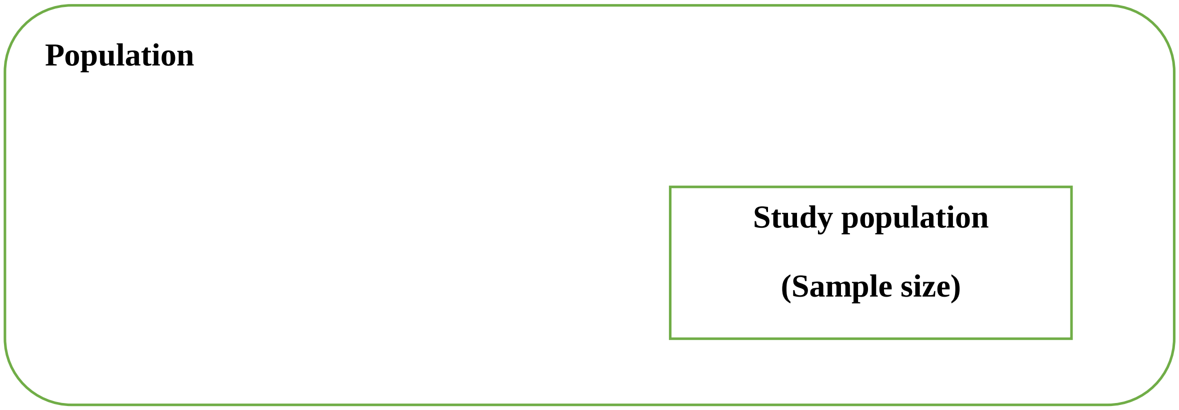

Figure 3.1:Pictorial Representation of Population Concepts.

Source: Author's own compilation

3.5 Sampling and Sample Size

Sampling is a process of taking a subset from chosen sampling frame or entire population (Taherdoost, 2016). Sampling can be used to make inference about a population or to make generalization in relation to existing theory. In essence, this depends on choice of sampling technique. In general, sampling techniques can be divided into two types; the Probability or random sampling and Non- probability or non- random sampling.

After selecting a good research topic and appropriate research design, obtaining a good and adequate sample is more important in order to create credible research results. Making sure that that there is enough data for the research is a precursor to credible findings and analysis. Qualitative researchers have not yet justified the adequate sample sizes of qualitative studies (Marshall *et al*, 2015).

3.6 Probability Sampling

Probability sampling means that every item in the population has an equal chance of being included in sample. One way to undertake random sampling would be if researcher was to construct a sampling frame first and then used a random number generation computer program to pick a sample from the sampling frame (Etikan and Bala, 2017). Probability or random sampling has the greatest freedom from bias but may represent the most costly sample in terms of time and energy for a given level of sampling error (Etikan, Musa and Alkassim, 2016). The probability sampling consists of simple random, Stratified random, Cluster sampling, Systematic sampling and Multi stage sampling.

To attain the objectives of the study sample, both stratified and systematic sampling were used. Separate strata were used to organize the frame into different categories where a number of distinct categories are embraced by the population. Separate stratums were used to select the sample where a stratified sample was produced. All the selected groups in the population were well represented using the stratified sampling design and efficiency was also improved through gaining control of the sample's composition.

The population of this study was top management of Ministry of Energy and Power Development, Ministry of Finance, IPPs and the Rural Electrification Agency. The choice for this category was motivated by the fact that they are the implementing agencies of Renewable Energy in Zimbabwe and have the knowledge of current financing models of renewable energy in Zimbabwe. The list of the top management was retrieved from 2021 Proposed Budget Estimates. Due to the overwhelming similarities of IPPs, only 8 of them will be used for the purpose of this report which were found by systematic sampling from the 25 licensed IPPs. The number 8 was reached using systematic sampling where the third IPP was drawn based on the either hydro, solar and biomass technologies. The study adopted the recommendations by Marshal et al (2015) that single case studies should generally contain 15 to 30 interviews.

Table 3.1:Target Population

Cadre	Population	Target Population
Ministry of energy and Power Development	91	6
Ministry of Finance and Economic Development	245	42
Rural Electrification Agency	40	3
Independ Power Producer	25	8
Total	**376**	**59**

3.7 Research Variables

Renewable Energy – Renewable energy has the potential to play a major role in reducing Africa's acute energy supply gap, thus increasing energy supply from renewable sources not only reduces the risks from rising and volatile prices for fossil fuels, but also brings climate change mitigation benefits (UNEP, 2011). One of the impediments to scaling up investments in renewable energy could be due to lack of sufficient financial capacity, hence, understanding the key financing models is critical.

Government Policies - The intervening variables were based on factors that would influence investment in renewable energy projects. These include the government policies on renewable energy development, availability of investment capital and the local fiscal and monetary policies that cause currency volatilities.

Equity Financing- Equity financing involves acquisition of funds by issuing shares of common or preferred stock. The essence of equity is that the borrower must repay the funds along with agreed-upon service charges such as interest and loan origination fees. If the money is not repaid as promised, the lender can start collection proceedings Equity financing are important especially as far as raising capital for growth, expansions or acquisitions is concerned.

Loan (Debt) Financing- Short-term debt forms the largest proportion of financing in the capital structure of small and medium enterprises in emerging and developed economies alike. This attribute is linked to lack of access to long-term debt and equity capital. This is because it can be easily accessed and useful during times of emergent working capital shortage. Given the aspirations of SDG 7, the debt financing is useful in renewable projects for Zimbabwe to have Clean Energy by 2030.

Government Grants - An award of financial assistance in the form of money by the government of Zimbabwe through the Ministry of Finance to an eligible Renewable Energy firm with no expectation that the funds will be paid back. The term does not include technical assistance which provides services instead of money, or other assistance in the form of revenue sharing, loans, loan guarantees, interest subsidies, insurance, or direct appropriations. Given the recent link of the government of Zimbabwe and Afrexim Bank, there is need to on the success of grants in renewable energy projects in Zimbabwe.

3.8 Data Collection Procedures

The semi structured questionnaire was administered by the researcher through direct interaction with the respondents, observing all Covid-19 Health protocols, to explain the motive of the study and for purposes of creating rapport that facilitated the carrying out of interviews with these respondents. The first was designed in such a way that they clearly addressed the objectives of the study. Respondents were visited during their free time, this was during break time and lunch hour so as not to interfere with their work schedule. The advantages of using questionnaires are: the person administering the instrument has an opportunity to establish rapport, explain the purpose of the study and explain the meaning of items that may not be clear. The questionnaires were self-constructed based on the study objectives and the questions.

3.9 Data Analysis Procedures

The questionnaires containing data from the respondents was first edited then coded to facilitate statistical analysis. According to Haradhan, M (2017), data must be cleaned, coded and properly analyzed in order to obtain a meaningful report. Data collected was analyzed by descriptive analysis. The descriptive statistical tool helps the researcher to describe the data and determine the extent to be used (Haradhan, 2017). Tables and charts were used to summarize responses for further analysis and facilitate comparison. Content analysis was used to analyse the qualitative data by grouping the data into common themes.

3.10 Data Management and Ethical Considerations

The researcher ensured that the respondents were aware of the purpose of the study, duration of the study and the advantages of the study. The respondents were assured of the privacy, confidentiality and anonymity of the collected data as they were not supposed to indicate their name, phone number or any form of identification. Respondents' confidentiality was also maintained as the data was not linked to individual respondents. All participants took part freely after understanding the purpose of the study and voluntary and informed consent was also encouraged. Finally, all the findings were presented for analysis accurately.

3.11 Energy Economics Financial Modelling

The researcher shall prepare standardised financial models in excel to show different relationships with regards to energy economics of different renewable energy technologies. Effects of investment incentives such as government subsidy on the Levelized Cost of Energy shall be discussed. Such information is important to investors to make sound investment decisions.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction

This chapter presents results of the study and discussions of the findings. The background information of the respondents is presented and the findings as per the objectives. Primary data was collected using structured questionnaires which were administered to the top management of Ministry of Energy and Power Development, Ministry of Finance and Economic Development, Rural Electrification Agency and Independent Power Producers. The discussions are presented in the sections addressing research hypotheses and study objectives and involved the use of descriptive including frequencies and percentages. The data were presented in tables, graphs and pie charts.

4.1.1 Response Rate

The total sample size used in this study was 59 top management of Ministry of Energy and Power Development, Ministry of Finance and Economic Development, Rural Electrification Agency and Independent Power Producers. A total of 59 Questionnaires were distributed and a total of 45 questionnaires were dully filled and returned translating to a response rate of 71.2%. Therefore, the instruments were regarded as responsive and formed the basis for data analysis.

Table 4.1: Response Rate

Response	Number	Percentage
Responded	42	71.2
Not responded	17	28.8
Total	**59**	**100**

Source: Survey Data, 2021

The procedures employed by the researcher contributed to a high response rate. Follow up calls were made to ensure the respondents did not forget to fill the questionnaire.

4.2 Section A: Sample Description and Characteristics

The socio-economic characteristics of the sample were examined to give an overview of the status of the respondents in the study area. These include age, gender, organisation and number of years worked in the organisation.

4.2.1 Gender

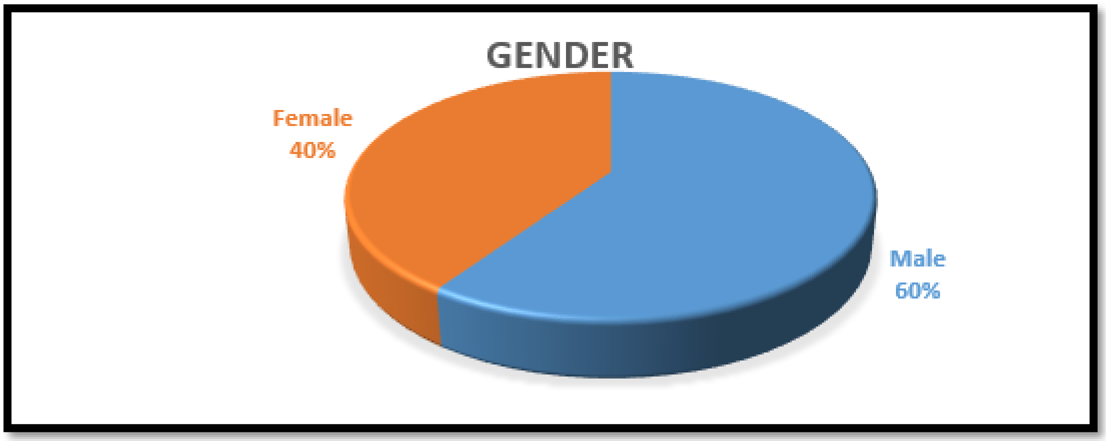

Figure 4.1:Gender of the respondents

Source: Survey data, 2021

Gender was important to understand because modern energy access and efficient use of energy affect women to a very large extent. From figure 4.1, 60% of the respondents were male and 40% female. Globally, the energy sector is also advocating to bring opportunities to achieve gender equality and inclusion. The results concur with the World Economic Forum (2020) stated that gender norms have contributed immensely in holding women back from pursuing professional careers in key sectors such as energy.

4.2.2 Age

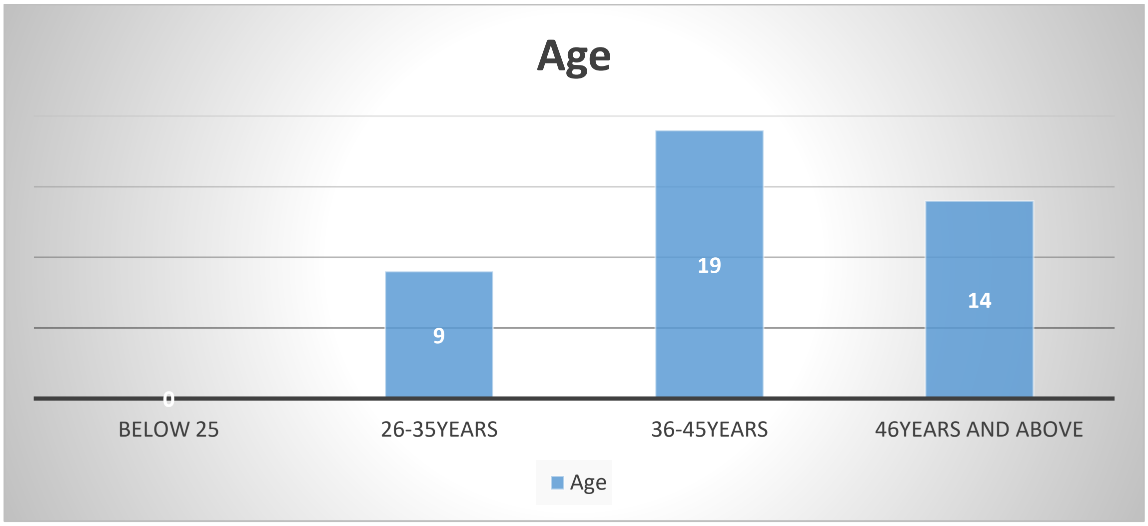

Figure 4.2:Age of the respondents

Source: Survey Data

Figure 4.2 shows that the majority of the respondents 19 (45%) were between 36-45years, followed by 14 (33%) were above 46 years and lastly 9 (21%) of the respondents1 were between 26-35 years. Maturity was recorded in the manner in which the respondents responded to the questionnaires according to their age brackets.

4.2.3 Organisation

Table 4. 2:Distribution of Respondents by Organization

Cadre	Target Population	Response	Percentage
Ministry of energy and Power Development	6	5	11.9
Ministry of Finance and Economic Development	42	27	64.3
Rural Electrification Agency	3	3	7.1
Independ Power Producers	8	7	16.7
Total	59	42	100

Source: Survey Data,2021

Table 4.2 shows that about 64.3% of the respondents were from the Ministry of Finance which is responsible for managing and mobilizing funds for public resources. Investment in renewable energy using national resources in Zimbabwe is approved by the Ministry of finance, hence making their significance in the study. About 12% of the respondents were from Ministry of Energy and Power Development whilst 16.7% were executives from the Independent power producers. The Rural Electrification Agency formed 7.1% of the study.

4.2.4 Working Experience

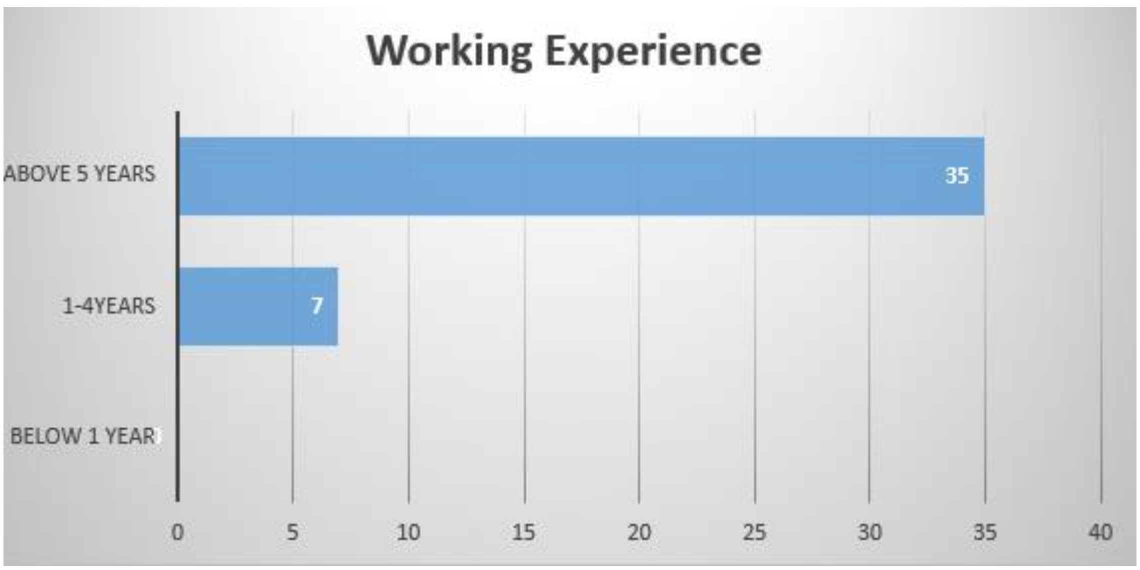

Figure 4.3:Working Experience of Respondents

Source: Survey Data

The study was composed of 83% respondents who had worked within their organisations for above 5 years and only 17% had worked between 1-4years within their organisations. This show that the study results were from employees with experience and had been exposed to various fiscal years.

4.2.5 Department

Table 4.3:Respondents' Respective Departments

Department	Freq	%
Fiscal Policy Advisory Services	2	4.8
International Cooperation Department	3	7.1
Finance Department	9	21.4
Debt Management Office	3	7.1
Budgets	10	23.8
Investment Analysis	6	14.3
Operations Management	4	9.5
Revenue And Tax Policy	2	4.8
Renewable Energy	3	7.1
Total	42	100

Source: Survey data, 2021

Table 4.3 presents the distribution of respondents by with respect to the departments they operate from. It shows that 23.8% of the respondents are in departments which deals with budgets. The budget is an important instrument in financing organisational activities and operations. Finance department had 21.4% followed by the Investment departments had 14.3%. the study managed to get about 7.1% of the respondents from the renewable energy department in the Ministry of Energy and Power Development. The study managed to get responses from every department which has a significance impact on renewable energy financing.

4.3 Section B: Renewable Energy Projects Financing

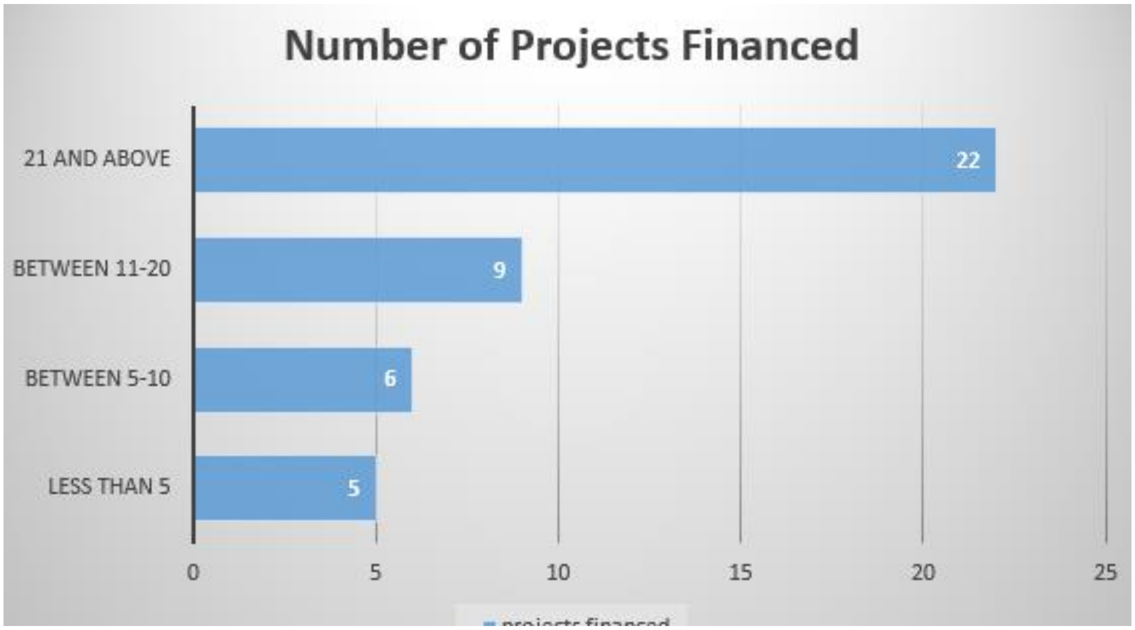

Figure 4.4:Renewable Energy Projects Financed (5 year's period)

Source: Survey Data

Over a period of 5 years, the obtained data showed that more than half of the total respondents (52.4%) of the respondents highlighted that they had financed above 21 projects, 21.4% of the respondents financed between 11 and 20 projects, and 14.3% financed between 5 and 10 projects. About 11.9% reported that they have financed less than 5 projects so far. These results cover projects ranging from institutional Biogas Digesters, Solar PV and mini hydro power generating projects.

4.3.1 Renewable Energy Projects Financed

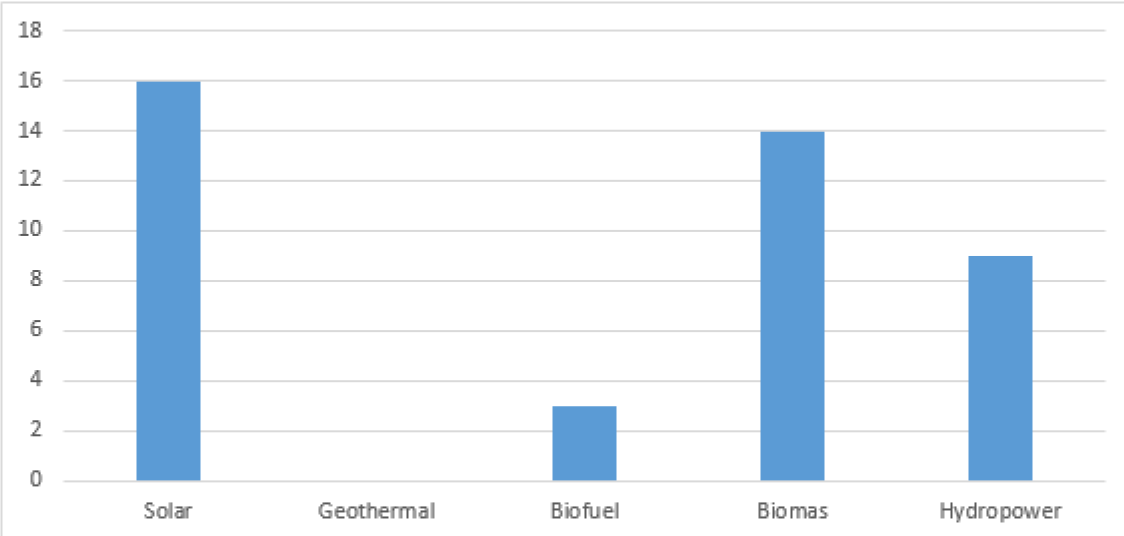

Figure 4.5:RE Technologies Financed (5 years' period)

Source: Survey data, 2021

The obtained data shows that solar projects are the main source of renewable energy being financed the most in Zimbabwe. This is shown by the highest response of 38.1%. This concurs with the Ministry of Energy and Power Development report (2021) which highlighted that solar energy is the most adopted form of renewable energy technology in Zimbabwe and many solar home systems have been installed at household level. The rebate on free duty on solar panels has contributed to the increase in solar adoption in Zimbabwe where investors find it lucrative to finance solar projects. Biomass technology has also gained traction as evidenced by the results. The introduction of the Zimbabwe Domestic Biogas Programme (ZDBP) promotes biogas technology as a clean, affordable and sustainable form of energy to replace traditional firewood and paraffin especially in rural areas. Mini hydro projects accounted for 21.4% of the financed projects.

4.3.2 Sources of Capital

Table 4.4:Sources of Capital

Source	Frequency	Percentage
Government grants	4	9.5
National Budget Financing	21	50
Equity financing	4	9.5
Debt (Loan)	6	14.3
Development partners	4	9.5
Mezzanine Finance	0	0
Consumer Credit	0	0
Multilateral institutions	3	7.1
Total	**42**	**100**

Source: Survey Data 2021

Table 4.4, shows different sources of capital for different projects. The Projects in the study were mainly financed from the national budget allocation as shown by the data, followed by Loans contributing 14.3%. Equity financing and government grants both have 9.5% contribution whilst no one highlighted that they used consumer credit financing or Mezzanine financing. Government is reportedly working with NGOs and multilateral institutions to obtain grants that are being used to finance renewable energy projects. On the National Budget front, the limited fiscal space is also limiting the government from heavily investing in renewable energy projects.

Table 4. 5:Recommended Sources of Finance

Finance Source	Frequency	Percentage
National Budget Financing	21	50
Equity Financing	14	33.3
Debt	5	11.9
Development partners	2	4.8
Total	**42**	**100**

Source: Survey data

As shown in Table 4.5, the majority of the respondents recommended that the finance to develop RE projects should be sourced from the national budget allocation.

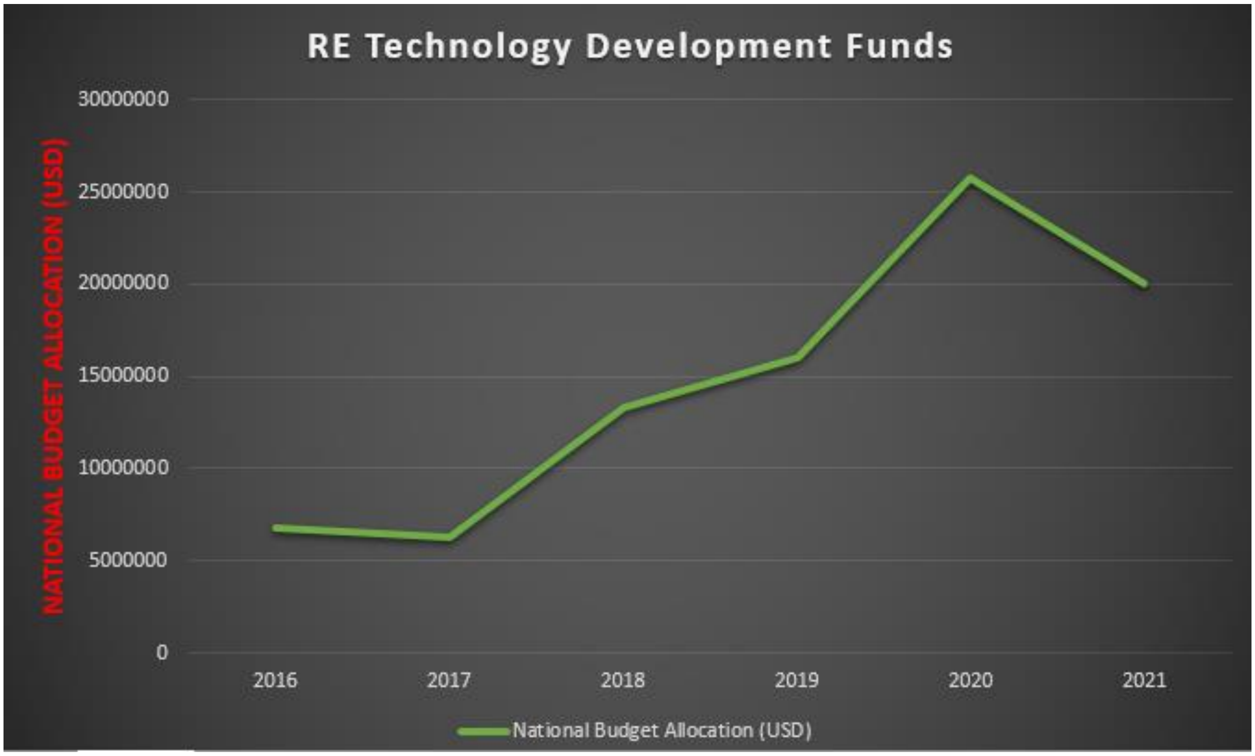

Figure 4.6:Government Funds Allocation to RE Projects (2016-2021)

Source: Zimbabwe National Treasury, 2021

4.5 Barriers to RE Financing

Table 4.6:Barriers to RE Financing

Barrier	Frequency	Percentage
High capital costs	13	31
High interest rates	3	7.1
Low credit repayment rates	1	2.4
Low access to capital	9	21.4
Lack of awareness on RETs	6	14.3
Inconsistent government policies	10	23.8
Total	**42**	**100**

Source: Survey data 2021

Table 4.6 shows that high capital costs (31%), is the major barrier to renewable energy financing in Zimbabwe. Inconsistency government policies have contributed to the slow investment in renewable energy projects. The volatile financial sector has been highlighted as the risky factor in renewable energy investment. This was supported by 23.8% of the respondents. The security of investments in renewable energy lies in the hand of a stable financial system. Low access to capital, shown by 21.4% and lack of awareness (14.3%) were also highlighted as another barrier in financing RE projects. Continuous information dissemination on the subject is of utmost importance.

4.4Section C: Government Policy and Renewable Energy

The respondents highlighted their views on the recently launched National Renewable Energy Policy and Bio-fuels policy. The study found that 93% of the total sample pointed out that the policies significantly affect investment decision.

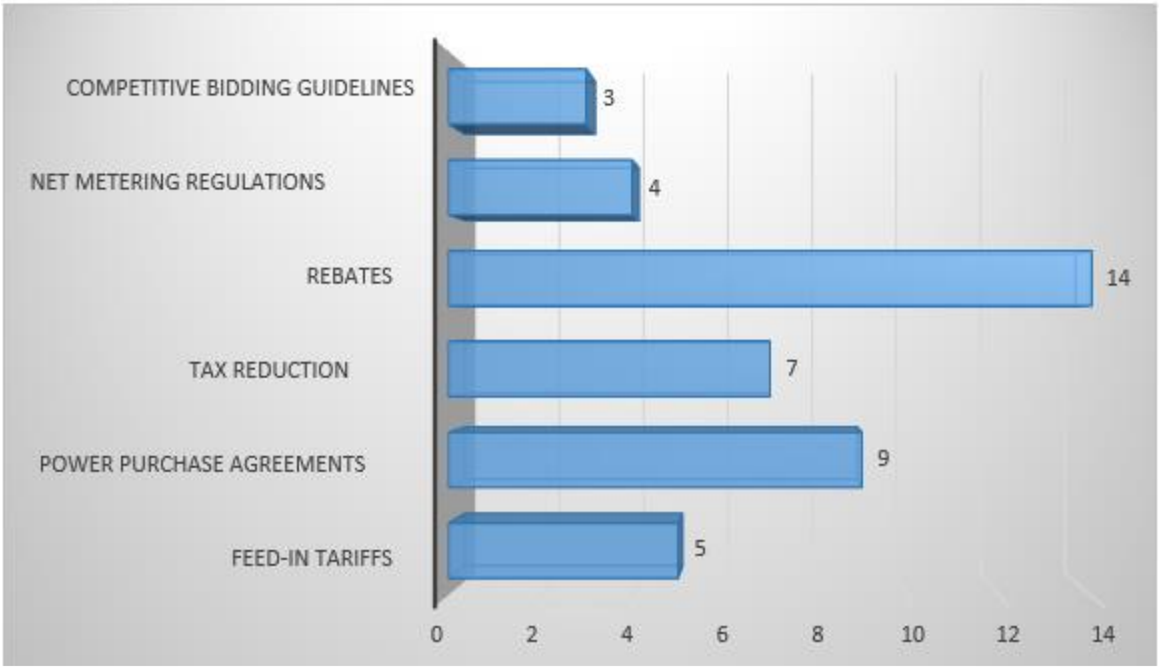

Figure 4.7:Energy Policies/Incentives

Source: Survey data

Study results shows that 33.3% of the respondents are of the view that rebates are the best policy which triggers financing of renewable energy. This is witnessed by the widespread of solar adoption across the country driven by the duty-free rebate on solar projects. Power purchase agreements have been highlighted as the issue of concern especially with IPPs. The study found that 21.4% of the respondents are of the view that well-articulated power purchase agreements and bankability of these agreements can speed the adoption and financing of the RE technologies

Tax reductions (16.7%), Feed-in-tariff (11.9%) and net metering regulation (9.5%) were also highlighted as the other policy measures which can best trigger renewable financing.

The study found that the separation of US$ and RTGS$ accounts in 2018 led to loss of revenues and value for many investors who had invested prior to the policy announcement. Interview with management of IPPs also found that, there was lack of a currency convertibility guarantee in their Power Purchase Agreements which was a result of the currency volatilities.

4.5 Concept of Environmental Protection

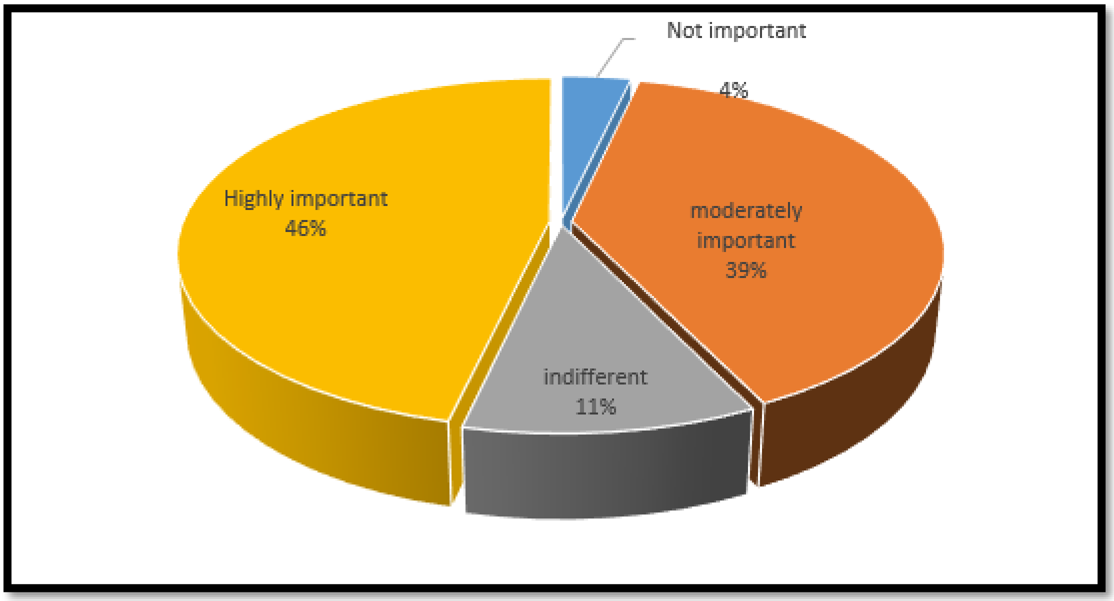

Figure 4.8:Importance of Environmental Protection on Investment Decision

Source: Survey data

The study found that 46% of the respondents considered that abiding to the requirements of Environmental Management Agency(EMA) significantly affects their Investment decision. 4% of the sample highlighted that environmental protection does not affect investment decisions.

Standard LCOE Modelling per KW of Energy Produced

The author looked at the energy economics of solar PV energy generating plant and hydro power plant, these two were standardized per KW of energy produced. The following data guided the author in the modelling process.

Table 4.7:Range of CAPEX for mid-scale generation projects (SE4all,2018)

		Hydro	Wind	Solar PV	Biomass Combustion electricity plant	Biogas digester & electricity generator	Diesel generator
Range in KW							
CAPEX ($/KW)	From	2000	2200	1300	2500	3000	1000
	To	5000	2600	2000	4500	6500	1300
	Average	**3500**	**2400**	**1650**	**3500**	**4750**	**1150**

Table 4.8:Range of OPEX for mid-scale projects (SE4all,2018)

		Hydro	Wind	Solar PV	Biomass Combustion electricity plant	Biogas digestor & electricity generator	Diesel generator
Fixed OPEX (% capex)	From	3%	4%	2%	4%	5%	2%
	to	7%	6%	3%	6%	8%	4%
	Average	**5%**	**5%**	**2%**	**5%**	**7%**	**3%**
Variable non fuel OPEX ($/KW)	**From**	**0**	**0.002**	**0**	**0.002**	**0.02**	**0.014**
	to	**0**	**0.005**	**0**	**0.004**	**0.03**	**0.028**
	Average	**0**	**0.0035**	**0**	**0.003**	**0.025**	**0.021**
Variable fuel OPEX ($/KW)	From	0	0	0	0.005	0.014	0.3
	to	0	0	0	0.022	0.058	0.5

	Average	**0**	**0**	**0**	**0.0135**	**0.036**	**0.4**

Table 4.9:Range of technical life duration of project components (SE4all,2018)

		Hydro	Wind	Solar PV	Biomass Combustion electricity plant	Biogas digester & electricity generator	Diesel generator
Electromechanical Equipment(year)	From	10.0	10.0		10.0		
	to	15.0	15.0		15.0		
	Average	**12.5**	**12.5**		**12.5**		
Solar module (year)	From			20.0			
	to			25.0			
	Average			**22.5**			
Invertor (year)	From			5.0			
	to			10.0			
	Average			**7.5**			
Battery (year)	From			2.0			
	to			5.0			
	Average			**3.5**			
Thermal engine	From					5.0	5.0
	to					15.0	10.0
	Average					**10.0**	**7.5**

Table 4.10:Range of capacity factor for mid-scale generation projects (SE4all,2018)

		Hydro	Wind	Solar PV	Biomass Combustion electricity plant	Biogas digester & electricity generator	Diesel generator
Capacity factor (%)	From	55%	20%	15%			
	to	80%	35%	20%	85%	90%	95%
	Average	**68%**	**28%**	**18%**	**43%**	**90%**	**95%**

Table 4. 11:RETs Feed In Tariffs (Renewable Energy Policy,2019)

	Hydro	Wind	Solar PV	Biomass Combustion electricity plant	Biogas digester & electricity generator	Diesel generator
Tariff (USD/KWh)	0.14	0.10	0.13	0.10	0.11	

The LCOE financial model is shown in Appendix 2. The following results were obtained using the model and would greatly assist investors in making sound decisions.

4.6 LCOE Model for Solar PV and Hydro Power Plants

4.6.1 Effect of Government Subsidy on LCOE and NPV

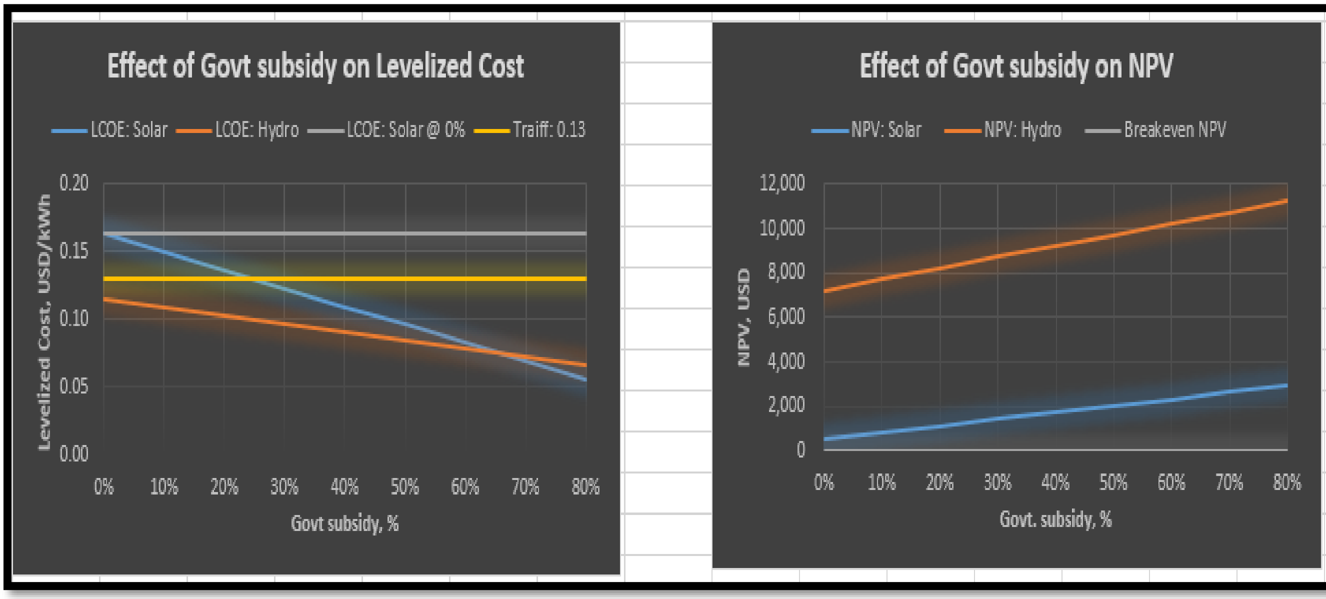

Figure 4. 9:Effect of Government Subsidy on LCOE and NPV

Source: Author's work

The graphs above show that increasing the percentage of subsidy lowers the LCOE and increases the NPV of solar PV and hydro power generating technologies. Government subsidy is an important incentive as it supports renewable energy developments by lowering LCOE of both technologies (solar and hydro). These results give opinions to investors who plan to enter the renewable energy sector in Zimbabwe. Solar PV technologies have high dependency on financial costs, thus the duty free rebate on solar equipment would greatly promote investments in Solar PV plants.

4.6.2 Effect of Tariff Escalation on NPV

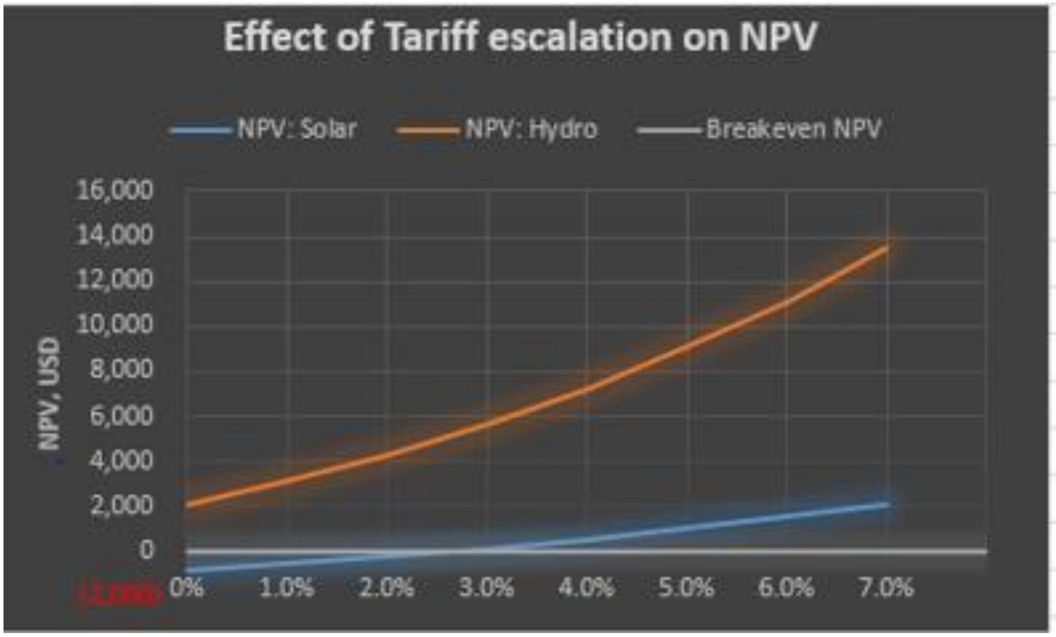

Figure 4.10:Effect of Tariff Escalation on NPV

Source: Author’s work

Tariff escalation usually has an effect on the revenue side. In this study, a 4% tariff escalation rate was used and it shows that an increase in tariff annually improves financial feasibility of the project. However, in Zimbabwe since 2014 tariffs were adjusted in 2019 due to political reasons. The set tariff does not allow cost recovery resulting in financial distress of the utility. The tariffs are set in USD but due to currency volatility, it results in exchange losses resulting in uncertainties on the NPV.

4.6.3 Effect of Government Subsidy and Tariff on NPV

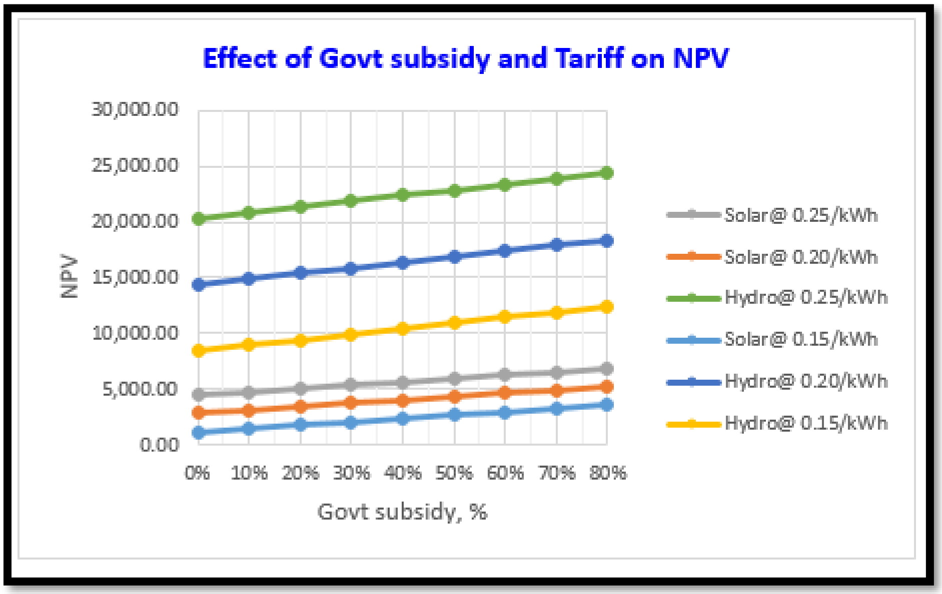

Figure 4.11:Effect of Government Subsidy and Tariff on NPV

Source: Author's work

The figure above shows that at different tariff levels, the NPV increases with an increase in the percentage of government subsidy.

4.7 Energy Consumption and GDP Growth

Energy consumption and GDP growth rate have a positive correlation as shown in figure 4.7 below. Investing in renewable energy technologies would ensure reliable supply of power which in turn promotes economic growth due to production in the industrial sector.

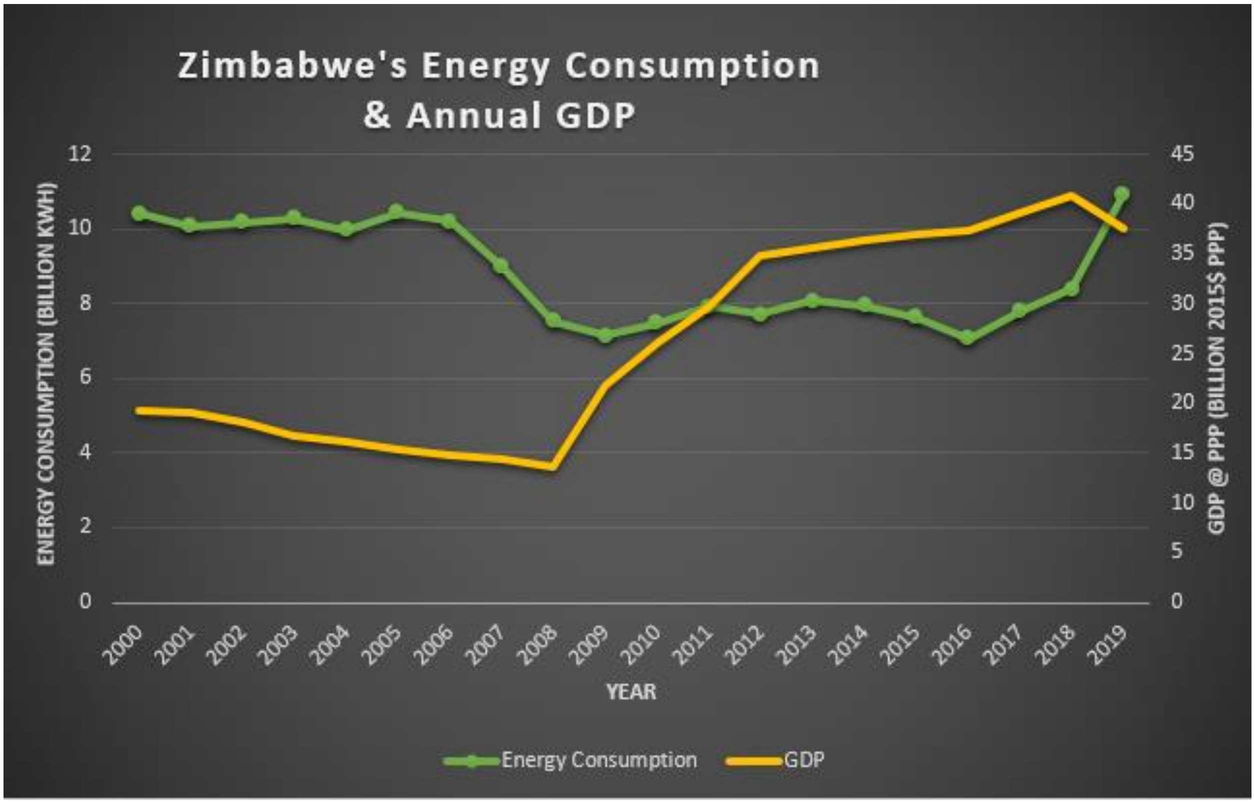

Figure 4. 12:Zimbabwe's Energy Consumption and Annual GDP

(Author's Illustration)

Data Source: EIA,2021 & World Bank,2021

4.8 Models in Community Electrification

The author managed to illustrate financing models from the information she obtained during interviews.

4.8.1 Community Hydro Mini Grid

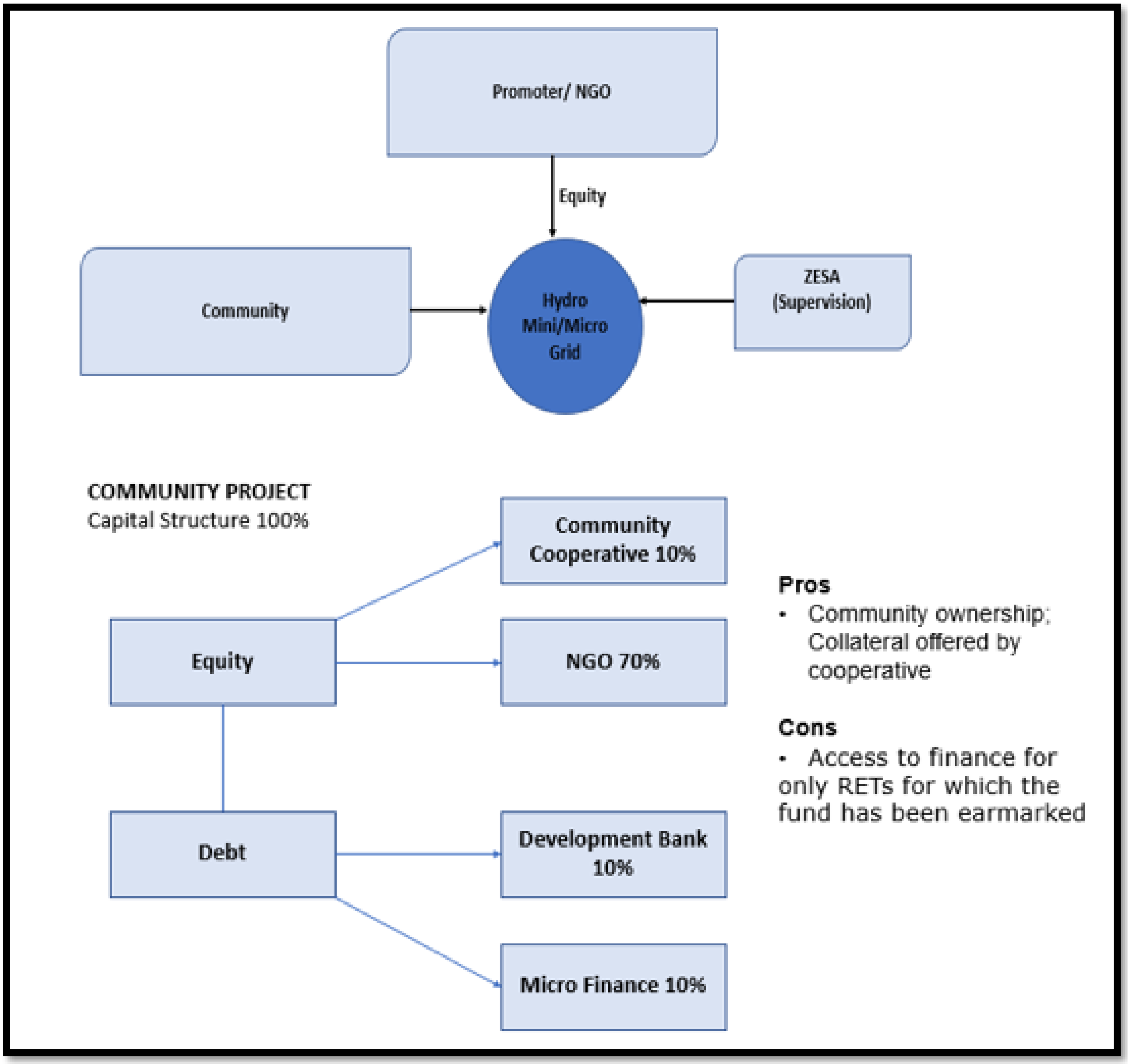

Figure 4.13: Community Mini Grid Illustration

Essential features:

Promoter – Good quality equipment, proper installation, performance guarantees, O&M

Distributor – Proper metering, Day time power sale to commercial ventures at higher tariff

Community – Timely payment of tariff, energy efficiency at household level

4.8.2 Cooperative Wind Powered Irrigation System

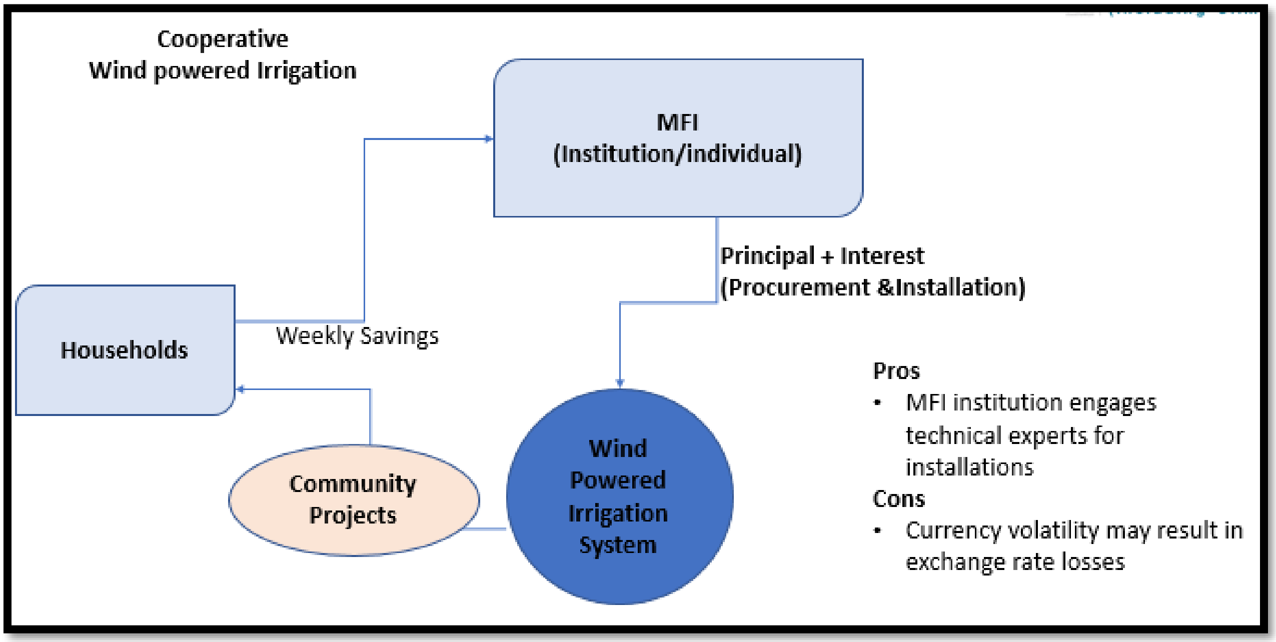

Figure 4.14:Cooperative Wind Powered Irrigation System

4.8.3 Small Scale Distributed Generation

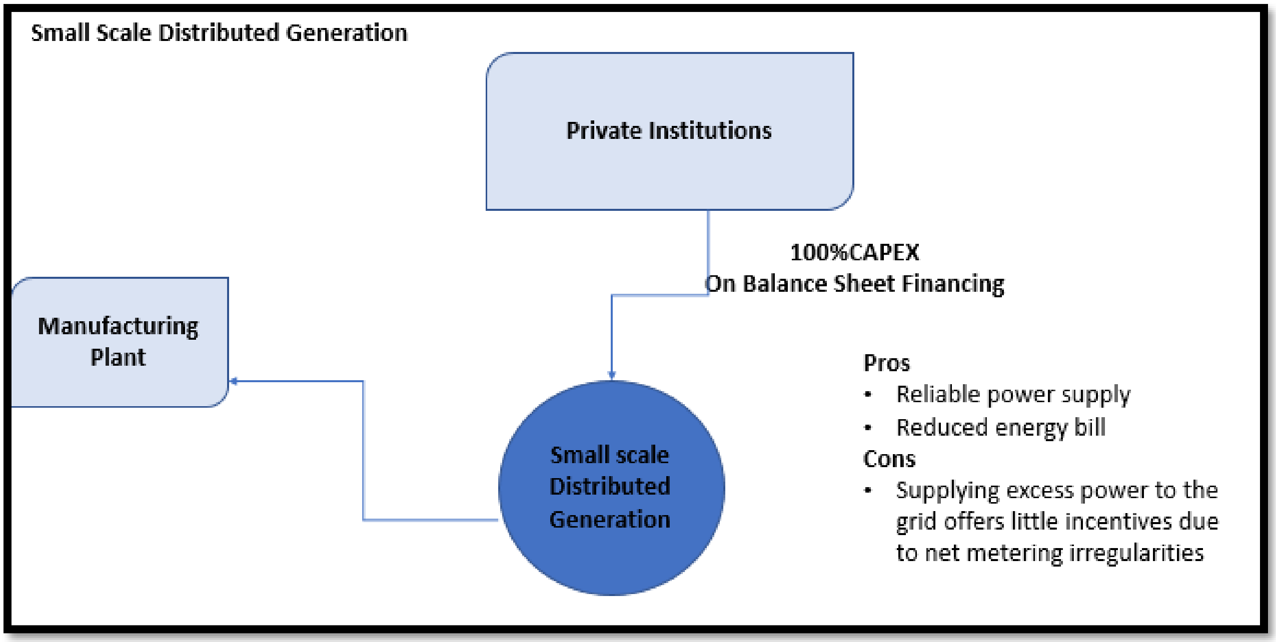

Figure 4.15: Small Scale Distributed

4.8.4 Pay-As-You Go-Solar Home System

The author is recommending the following system for the uptake of solar home systems

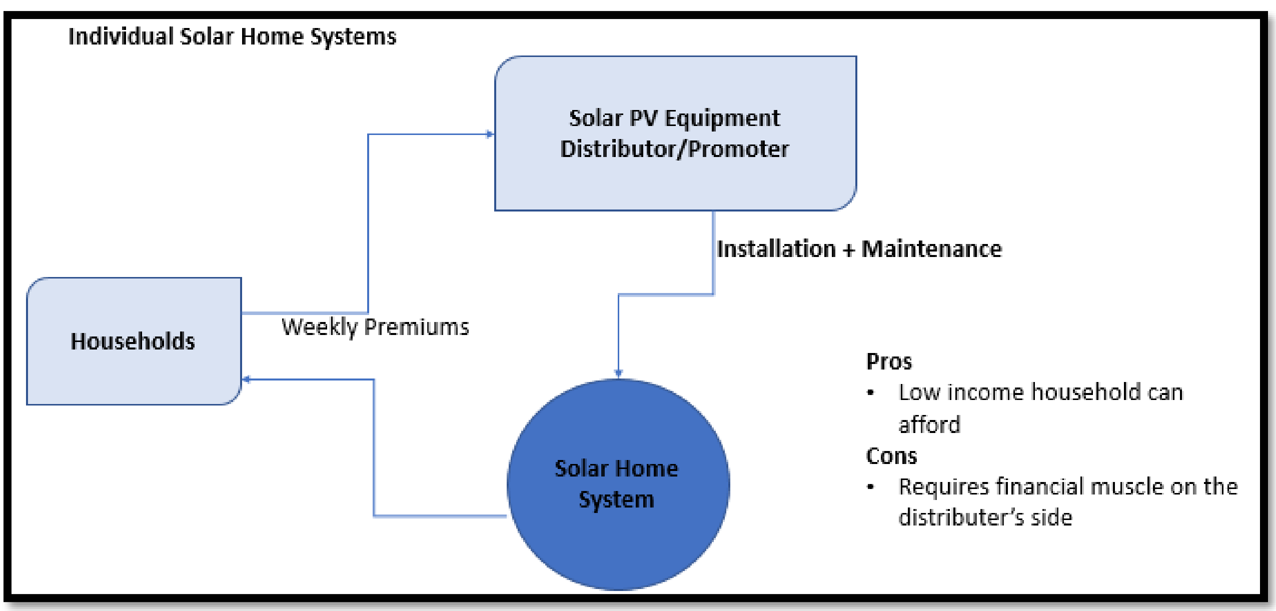

Figure 4.16 1: Pay-As-You-Go Solar Home System

4.9 Conclusion

The study found that Zimbabwe has a vast amount of renewable energy sources. Due to Rebates, Solar PV technology has gained traction in communities together with the commercial and industrial sector to ensure reliable supply of power. The majority of the projects have been financed by the government, however, shortage of foreign currency, and policy inconsistencies are the major drawbacks to lure investments.

CHAPTER FIVE: SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section covers the summary of the core study findings, conclusion and research recommendations. The study also discusses suggested areas for future research about renewable energy.

5.2 Summary of Findings

Government support has the highest share in renewable energy financing despite slow growth in the sector. The Ministry of Finance and Economic Development is embracing all efforts in financing both large and small renewable energy projects to ensure reliable energy supply and self-sufficiency. REA is playing a pivotal role in mini-grids projects in rural areas with support from National Budget and the rural electrification fund. A mixture of debt and equity financing are favoured by investors. For instance, Richsaw Solar Tech project located in Gwanda is financed on debt and equity basis. The study revealed that many IPPs are also using the strategy of combining debt and equity in order to raise the capital. The study found that access to credit and loans from local banks and high cost of finance driven by high interest rates are preventing are retarding investment in Renewable energy. The introduction of the free duty rebate on solar products has accelerated the investment and financing in solar energy as investors are reportedly finding it cheap to import equipment. Absence of clear tariff structures especially by IPPs for grid-connected green projects, conflict exists between IPPs and the power utility), which is a competitor and owns the grid. The introduction of rebates, bankability of power purchase agreements and tax reductions respectively were highlighted as the renewable energy policies that best triggers financing. Processing the bankability challenges of PPAs was reported to be a good move to increase investment in the renewable energy sector. It is difficult to sign a power purchase agreement with Zimbabwe Electricity Transmission and Distribution Company (ZETDC) since at the time of the study it was not possible to negotiate based on a USD$ tariff due to Statutory Instrument 142/2019 and 212/2019. As a result, the generation licenses and power purchase agreements are un-bankable and developers are unable to raise finances required to build these projects. This is a major impediment in financing these projects where foreign investors are finding that they do not have guarantee that they will be able to repatriate their profits. Outside the policy framework, there is an issue where ZERA has licensed IPPs and they fail to access foreign currency, at the same time government is importing power and paying for power from Mozambique and South Africa. This is an indication of lack of prioritization on allocation of foreign currency to local power producers.

5.3 Conclusion

The first objective was to investigate policy issues that act as barriers to unlock investment in RETs in Zimbabwe. The study concluded that, during the recent years, inconsistency government policies have contributed immensely in holding back financing in Renewable Energy Technologies. Government through the central bank was highlighted to be announcing policies and statutory instruments which are not investor friendly. Thus, a change in government policy could see many investors being attracted to invests in RETs. The second objective was to identify investment models that can be used to fund renewable energy projects in Zimbabwe. The study revealed that national budget financing, equity financing and debt financing are the key financing models which can be best used in Zimbabwe to fund RETs. Shortage of foreign currency is hindering many domestic investors; hence a debt can relieve them.

5.4 Recommendations

- The government of Zimbabwe should promote public-private partnerships in the renewable energy sector.
- Efforts must be made to establish a domestic financial institution which deals with domestic RE financing loans in Zimbabwe, as the case with Agriculture.
- Many projects are on hold due to lack of foreign currency. This study recommends that, the Auction system that was introduced in 2020 should give special priority to renewable energy projects.
- Introduction of performance-based payments whereby concessional loans are disbursed in tranches against the verified fulfilment of predefined targets. This kind of financing is aimed at rewarding innovation and successful implementation of renewable energy projects.
- The Government, together with the private sector can join efforts to create the combined capacity of a lending institution, a credit guarantee facility and a consulting company for renewable energy projects specializing in different technologies.

- There is need for awareness campaign initiatives to promote awareness of renewable energy technologies such as biogas technology. There must be an allocation of the energy budget for conducting awareness campaigns country wide.
- The study recommends a well-defined timeline be set for licensing RETs, grid-connection guidelines and regulations, clear land acquisition processes, and other approvals. Again, time required in obtaining approvals should be reduced.

Table 5. 1: Proposed Finance Models

Technology	Proposed Innovative Finance Model
Solar Home Systems, Pico PV	Pay –as –you-go Scheme. Requires investors with financial muscle so as to push volumes as the customers pay premiums for a certain period of time until they own the system.
Micro/Mini grids	• Government time-bound subsidies whereby Output-based Aid is given to community projects or IPPs on providing evidence of installation of a renewable energy system. This system does not meet 100% cost of the systems thus loans from banks can pay up the balance. • BOOT Models- Build, Own, Operate & Transfer mechanism where private sector entities design, construct, operate and maintain the power plant for a predetermined time frame. During this period, they recover their investments from the project outputs. Additional support can be offered under this model such as 1. Credit Guarantee (Full or Partial) Fund 2. Interest buy-in by donors 3. green finance

5.5 Suggestions for Further Research

This study focussed on policy issues which act as barriers to unlock investments in RETs. Further study should establish an econometric test on the impact of government policy on RETs. Furthermore, future research should also look at the contribution of Independent Power Producers in Renewable energy adoption in Zimbabwe. Feasibility of Peer to peer electricity trading and energy as a service model need to be studied on.

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APPENDICES

Appendix 1: Research Questionnaire

Dear Respondent

This questionnaire is designed to gather information on **RENEWABLE ENERGY DEVELOPMENT: AN ANALYSIS OF INVESTMENT MODELS IN ZIMBABWE.** The study is being carried out as partial fulfillment of the requirements for the conferment of the Master's Degree of **Energy Engineering, Pan African University Institute for Water & Energy Sciences** in **Algeria**. The questionnaire aims to gather data on which financing models currently in use in Zimbabwe to fund Renewable energy and the existing policies which affects investments in Renewable energy. The information is necessary to develop theories in which finance would play greater roles in increasing the adoption rates of Renewable Energy Technologies.

The information shall be treated with confidentiality and no instances will your name be mentioned in this research. The information will not be used for any other purpose other than for this academic exercise.

Your assistance in facilitating the same will be highly appreciated.

Thank you in advance

Yours sincerely

Erica Makoni
makoni.erica5@gmail.com

Instructions:

i. Give brief answers in the spaces provided.
ii. In the boxes given, please tick appropriately

SECTION A: General Background

1. **Gender**

Male [ ] Female [ ]

2. **Age**

Below 25 years [ ] 26-35 years [ ]
36-45 years [ ] 46 years and above [ ]

3. Organisation……………………………………………………..
4. Number of years worked with the organisation…………………….

Below one year [ ]
Between 1-4 years [ ]
Above 5 years [ ]

5. What function do you currently perform at your firm?

Advisory Risk management [ ] Investment analysis [ ]
Operations management [ ] Accounting & Finance [ ]
Other (please specify)………………………………………………………..

Section B: Renewable Energy Financing Models

1. How many renewable energy projects has your organisation/firm financed since the beginning?

Less than 5	[ ]	Between 5 and 10	[ ]
Between 11 and 20	[ ]	Above 20	[ ]

2. What is the source of capital for financing renewable energy projects at your firm? Government grants [ ]

Budget Financing [ ]

Equity financing [ ]

Debt (Loan) [ ]

Mezzainine Finance [ ]

Consumer Credit [ ]

Other (please specify) ……………………………

3. What renewable energy resource is your company mostly involved in financing?

Solar Wind	[ ]	Geothermal Biofuel	[ ]
Biomass	[ ]	Hydropower	[ ]

Other (please specify)……………………………………………………………

4. What is you organisation motivation for choosing this method?

Increase in Profits [ ]

Investment is easy to monitor [ ]

Potential to icrease energy access [ ]

Other (Specify)………………………….. ………………………….

1. What is the most important barrier to increasing financing operations of renewable energy projects for your firm?

High capital costs	[ ]	High interest rates	[ ]
Low credit repayment rates	[ ]	Low access to capital	[ ]
Lack of awareness on RETs	[ ]		

Other (please specify)……………………………………………………………….

2. Which finance model do you think is the best to finance renewable energy projects in Zimbabwe?

……………………………………………………………………………………………………
…………………………………………………………………………………..

3. Do you think your renewable energy financing operations has contributed to developing communities economically?

Yes [ ] No [ ]

4. What is the most common change observed in the communities due to the availability of renewable energy?

Higher societal status [ ] Better living standards [ ]

More disposable income [ ] Other (please specify)…………………………..

5. Do you think that increasing finance for renewable energy projects can accelerate efforts to achieve the objectives of sustainable development and vision 2030?

Yes [ ] No [ ]

6. Where would your firm most probably choose to finance renewable energy projects in?

Urban areas [ ] Semi-urban areas [ ]

Rural areas [ ] Other (please specify) [ ]

Section C: Government Policy and Renewable Energy Policy

1. Does the local renewable energy policy influence your firm/organisation's choice of financing methods?

2. Yes [ ] No [ ]

3. What renewable energy policy best triggers an increase in renewable energy project financing operations and investments?

Feed-in tariffs [ ] Renewable energy certificates [ ]

Tax reduction [ ] Rebates [ ]

Grants [ ] Production credits [ ]

Power purchase agreements [ ]

Other (please specify………………………………………………………………

4. Please estimate the contribution of renewable policies in increasing technology adoption for climate change mitigation as we target NDS1 and Sustainable Development Goal 7?

   No contribution [ ] Contribution is insignificant [ ]

Contribution is significant [ ] Contribution is highly significant [ ]

5. How important is the concept of environmental protection, particularly abiding with Environment Protection Agency (EMA), to your firm in making decisions to finance renewable energy projects?

Not important [ ] Indifferent [ ]

Moderately important [ ] Highly important [ ]

6. What policies/conditions were established by the government do you think are retarding progress in renewable energy in Zimbabwe

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………

7. How do you think renewable energy policy and Biofuels policy launched in 2019 would foster renewable energy technology deployment

……………………………………………………………………………………………………

…………………………………………………………………………………

8. Do you think renewable energy technologies have the potential to contribute towards addressing the challenge of energy access prevalent in Zimbabwe in line with SDGs, NDS1 and Vision 2030?

Yes [ ]   No [ ]

9. How do you think energy policy can be improved to promote increased investment in renewable energy projects, particularly from the private sector?

………
…………………………………………………………………………………………

10. The economy has benefited from the policies in place aimed at promoting investment in renewable energy?   [yes]   [no]

Explain…………………………………………………………………………………………
………………………………………………………………………………………….

The End

Thank you for your time

Appendix 2: LCOE Financial Model

	Solar	Hydro	
Cost of electromech equipment per KW installed		3000	
Electromech equipment useful life, yrs		15	
Cost of Civil works per KW installed, USD		2000	
Cost of Balance per KW installed,USD	1600		
Cost of Pv cells per KW installed,USD	1000		
Cost of Inverter per KW installed,USD	400		
Battery useful life, yrs	10		
Real Discount Rate, %	6.0%	6.0%	
Study period , yrs	25	25	
Installed capacity, kW	1	1	Standardised per KW
Inverter Useful Life (M), yrs	15		
Battery Cost/KW installed	800		
Electricty Generation, kWh	1927.20	7008	
Electricity Generation Degradation rate, %	1.0%	1.0%	
CAPEX (USD/KW)	3,000.00	5,000.00	
Government Subsidy, %	0%	0%	
Cash Equivalent of Government Subsidy, USD	0	0	
Installed Cost, USD	3,000.00	5,000.00	
Specific Installed cost, USD/kW	3000.00	5000.00	
Inverter replacement Cost, USD	400.00		
Annual O&M Cost as percentage of CAPEX, %	0.2%	5.0%	
Annual O&M, USD	4.50	250.00	
Electricity price in Yr 1, USD/kWh	0.1300	0.1400	
Electricity Price Escalation Rate, %	4.0%	4.0%	
Finacial Indicators			
PV Cost	($3,671)	($9,448)	
PV Prod	$22,541.87	$81,970.44	
LCOE	0.163	0.115	
NPV	526.16	7,233.57	
AW	41.16	565.86	
IRR	0.08	0.17	
PV Revenue	4,259.66	16,681.20	