INVESTIGATING THE EFFECT OF DE-RISKING STRATEGIES ON IMPLEMENTATION TIMELINES FOR UTILITY SCALE SOLAR PHOTOVOTAIC PROJECTS IN ZAMBIA: A CASE STUDY OF NGONYE SCALING SOLAR PROJECT

BY

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A Dissertation submitted to the University of Zambia in Partial Fulfillment of the Requirements for the Degree of Master of Engineering in Engineering Management

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DECLARATION

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The Dissertation By Chama Chilomo Entitled: "Investigating The Effect of De-Risking Strategies on Implementation Timelines For Utility Scale Solar Photovoltaic Projects In Zambia: A Case Study of Ngonye Scaling Solar Project" Is Approved As Fulfilling The Requirement For The Award of The Degree Of Master Of Engineering In Engineering Management By The University Of Zambia.

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ABSTRACT

Utility scale Solar PV power generation is for the first time being added onto the Zambian national electricity grid to increase capacity of electricity generation and to reduce over-dependence on hydropower generation. The World Bank group recently funded a ‘Solar Photovoltaic (PV) Utility Scale Program’ in which, two utility scale solar PV power plants in Lusaka South Multi facility economic zone were installed namely West Lunga and Ngonye Solar Power Plants. A project finance model based on de-risking strategies was employed to implement the Ngonye Scaling Solar project. However project implementation was delayed by 14 months as indicated in a 2018 case study on the implementation of scaling solar in Zambia. The main critical success factors that impacted project implementation included; Appropriate allocation of risks, Participation of experienced and solid private sector participants, Political support, Public and community support and a Transparent procurement process. It was perceived however that the strategy to appropriately de-risk the project beforehand would improve project implementation deliverables. Therefore, the study aimed at establishing the effects of the employed de-risking strategy on project implementation timelines. The study adopted an explanatory (case study) research design and used a mix of both qualitative and quantitative techniques to collect and analyse primary data. The effect of the de-risking instruments on the project were analysed by characterizing the risk profile in terms of risk awareness levels and then assessing the impact on project implementation timelines for each respective de-risking strategy. Results show that among the notable risks that were identified and the de-risking strategies that were employed thereof, Market risk, which had a risk awareness level of 50 percent and a de-risking impact of 4.15 out of 5, significantly contributed to project implementation delay. This respective risk was mitigated by securing a Power Purchase Agreement (PPA). Although the de-risking impact was significantly high, findings suggests that securing the PPA was characterised with delayed negotiations arising from the aspect of risk allocation between the project company and the off-taker. The study therefore, suggests that the envisioned project finance de-risking approach whose objective was to improve project implementation time lines was compromised and as such project implementation was delayed beyond target.

DEDICATION

I dedicate this dissertation in memory of my late parents. Special dedication goes to my uncle, Mr. Phillip Chilomo for the academic support and encouragement throughout my educational endeavors. To my loving wife Pamela, my children Betty, Mark and Faith, I am grateful for your understanding and support when I spent little time with you to focus on my studies.

ACKNOWLEDGEMENT

This project would not have been possible without the support of many people. My heart is full of gratitude for the supervisory guidance I received from Dr. Victor Kaluba. Sir, your questions, insights, guidance and words of encouragement meant a lot to me. My co-supervisor Dr. Erastus Mwanaumo, I am grateful Sir. I would be failing if I do not acknowledge Mr. Ackson Mwale, the lecturer at the School of Humanities and Social Sciences, for facilitating my training in quantitative and qualitative data analysis and the free provision of SPSS software which I have used throughout my research.

I am particularly indebted to the Project Manager for Ngonye Solar PV Power Plant, Mr. Derek Ryan who accorded me the opportunity to work at the project site during construction of the plant. I must mention that the exposure I got working on this project really helped me to appreciate and further understand utility scale solar PV technology. Special thanks goes to the management at Ministry of Energy, Ministry of Finance, the World Bank Group, IDC, ERB, ZESCO, Enel Green Power, to name but a few, for granting me authority to conduct my research with their institutions.

My family you have been so understanding and supportive. My Wife and children, you are such a blessing. I am particularly grateful for your love and support rendered to me during this journey.

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BOO	Build Own Operate
BOT	Build Own Transfer
CSP	Concentrating Solar Power Systems
DBFO	Design Build Finance Operate
EPC	Engineering, Procurement and Construction
ERB	Energy Regulation Board, Zambia
EU	European Union
GET Fit	Global Energy Transfer Feed in Tariff
GHG	Green House Gas
GPD	Gross Domestic Product
GRZ	Government of the Republic of Zambia
GSA	Government Support Agreement
GWh	Giga Watt Hours
IDC	Industrial Development Corporation
IFC	International Finance Corporation
IPPs	Independent Power Producers
KWh	Kilo Watt Hours
MFEZ	Multi-Facility Economic Zone
MoDNP	Ministry of Development and National Planning
MoE	Ministry of Energy
MoF	Ministry of Finance
MWh	Mega Watt Hours
O&M	Operation and Maintenance Agreement
OECD	Organization for Economic Co-operation and Development

OPPPI	Office for Promoting Private Power Investment
PPP	Public Private Partnership
PSDMP	Power System Development Master Plan
PV	Photovoltaic
REFiT	Renewable Energy Feed In Tariff
SADC	Southern African Development Corporation
SAPP	Southern Africa Power Pool
SDG	Sustainable Development Goals
SNDP	Seventh National Development Plan
SPV	Special Purpose Vehicle
TWh	Tara Watt Hours
USA	United States of America
WBG	World Bank Group
WEC	World Energy Council
ZDA	Zambia Development Agency
ZEGC	Zambia Electricity Grid Code
ZEMA	Zambia Environmental Management Agency
ZESCO	Zambia Electricity Supply Company

CHAPTER 1: INTRODUCTION

1.1 Background

According to ZDA (2017), the Zambian government has embarked on implementing industrialization development strategies which have impacted the demand for electricity. Furthermore, (ZDA, 2017) adds that the peak demand for electricity in Zambia increased from 1,100 MW in 2001 to 1,600 MW in 2009 while the country's installed generation capacity remained at 1,970 MW. The installed capacity (MW), does not meet peak demand for power thereby causing a power deficit. Figure 1.1, illustrates how the peak demand for power surpasses the installed capacity. This partly explains the power deficit currently experienced in the country.

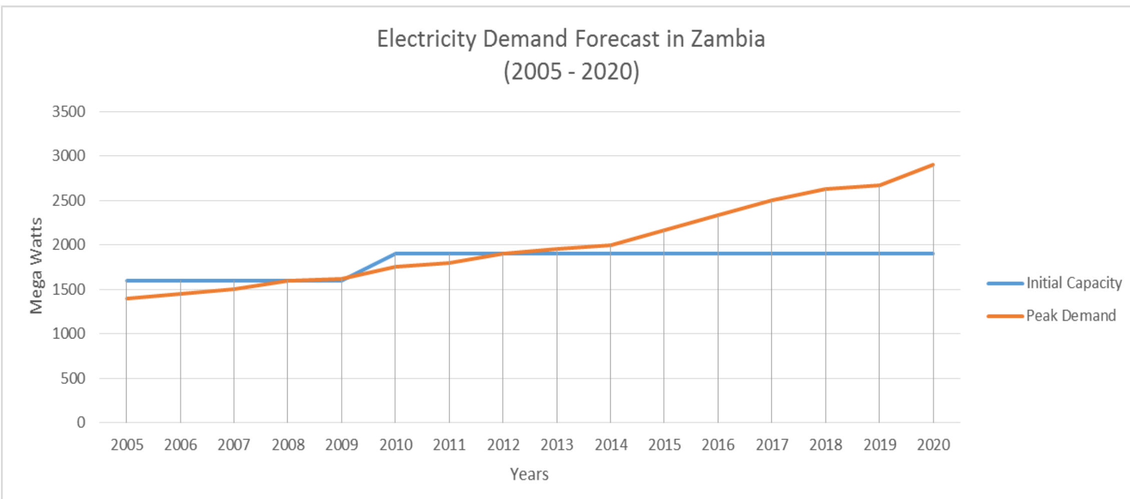

Figure 1. 1**:** Electricity Demand Forecast in Zambia (2005 to 2020)

Source: Zambia Development Agency (2017)

The need to mitigate such a deficit cannot be overemphasized. One way of achieving this is by increasing power generation capacity through development of additional and sustainable power generation infrastructure.

In response to the power deficit, the Industrial Development Corporation (IDC) embarked on the development of up to 600 MW of solar PV capacity. IDC, is an investment company incorporated in January 2014 and wholly owned by the

Government of the Republic of Zambia (GRZ) , via the Ministry of Finance. It is the Zambian Government's Agent in the scaling solar program.

The scaling solar program is an initiative of the World Bank designed to increase access to clean energy in line with the United Nations sustainable development goals (SDGs). According to (Stritzke, 2018) it was anticipated that substantial development works would be done upfront by IDC, with support from the International Finance Corporation (IFC) advisory as a lead transaction advisor. The overall objective of the scaling solar program was to minimize the amount of work required from prospective bidders, with the expectation that the 'de-risking' strategy of the project would reduce uncertainty and result in the lowest possible prices ultimately being offered (IDC, 2015). De-risking in this context implies the effective allocation of risks to parties best suited to hanlde them and the application of mitigation measures to curtail the identified risks. However, despite the political support which the roll-out of Scaling Solar in Zambia had received, project implementation had faced challenges that delayed financial close and commissioning (Stritzke, 2018).

The Project Finance Model from which the derisking strategy was derived is referred to as 'Limited Recourse' or 'Non-Recourse Financing'. Limited recourse in this context implies that credit default risk was limited to the assets of the project company and not the project shareholders (International Finance Corporation, 2015). Project financing normally takes the form of limited recourse lending to a special purpose vehicle (SPV) which has the right to carry out the construction and operation of the project. It is typically used in a new build or extensive refurbishment situation and so the SPV has no existing business. The SPV will be dependent on revenue streams from the contractual arrangements and/or from tariffs from end users which will only commence once construction has been completed and the project is in operation. It is therefore a risky enterprise and before any agreement to provide financing to the project, the lenders will want to carry out an extensive due diligence on the potential viability of the project and a detailed review of whether the project risk allocation protects the project company sufficiently.

The study therefore sought to investigate how the employed project finance framework affected the implementation of the scaling solar program in Zambia. The study picked on a case of a utility scale Ngonye Solar PV Power project to illustrate the effects of the 'de-risking' strategy on project implementation.

1.2 Statement of the Problem

The results of the scaling solar program in Zambia which targeted to add about 100MW of solar PV power to the national grid by December 2017 were not achieved. Two sites namely Ngonye and West Lunga (Bangweulu) were scheduled to add about 34MWp and 54MWp each respectively by the target date. Preliminary literature review indicates that these two projects that were selected for implementtation were behind schedule. As of 30th April 2019, both projects, that is, West Lunga and Ngonye, were commissioned after 14 months of delay. The most notable problem in both cases has been delayed financial close. It was therefore, imperative to investigate the cause and effect of the employed project finance framework in the implemention of the Ngonye project.

1.3 General Objective of the Study

The general objective of the study was to establish the effects of the employed Project Finance De-risking strategy on the implementation timeline of the Ngonye Solar PV Power Plant project in Zambia.

1.4 Specific Objectives

The following were the specific objectives:

1) To characterize the risk profile and de-risking strategy.
2) To assess the influence of the de-risking strategy on implementation timelines.
3) To establish other constraining factors that lead to project implementation delay.

1.5 Research Questions

In order to investigate the identified problem, the study was guided by the following research questions;

1. Which risks significantly impacted the scaling solar project?
2. Which de-risking strategies significantly impacted implementation time lines?
3. What was the impact of risk mitigation strategies on the identified risks?
4. To what extent has the de-risking strategy affected project implementation timeline?
5. What factors contributed to Project implementation delay?

1.6 Significance of the study

Zambia's electricity generation mix is dominated by hydropower generation which accounts for more than 90% (IDC, 2015). The balance of the generation mix is diesel, gas and heavy fuel oil. ZESCO Limited, a state-owned utility, is the main supplier of electricity in Zambia, while the rest is supplied by independent power producers. There is however, poor private sector investment in the power sector despite the enormous potential for investment opportunities to meet the country's demand for electricity (IDC, 2015).

Figure 1.2 shows the national electricity utility company's (ZESCO) electricity exports and imports. There was a significant decrease in electricity exports from 1,175.9 GWh (2015) to 794.1 GWh (2016), indicating a 32.5 percent decrease. . The decrease in exports was on account of a reduction in the utility's hydro power generation capacity caused primarily by poor rainfall patterns experienced during the period (ERB, 2016).

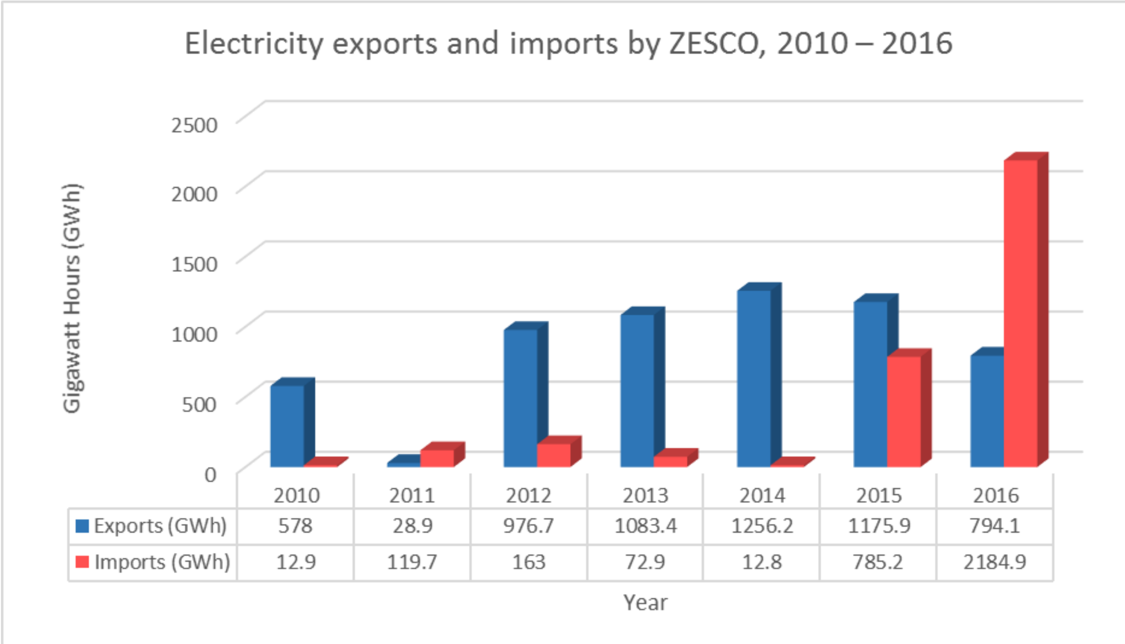

Figure 1. 2**:** Electricity exports and imports by ZESCO, 2010 – 2016

Source: (ERB, 2016)

In view of mitigating the power deficit scenario, the government has set targets to diversify the energy mix through the addition of more resilient renewable energy sources.

Government is however limited in raising finance to facilitate the implementation of such projects and remains resolute to embracing innovative financing strategies. The application of project finance to raise funds in the development of energy infrastructure has been prioritized in this regard.

Project Finance is important for project implementation, especially for Zambia because it offers various benefits such as the opportunity for sharing risks, extending the debt capacity, the release of free cash flows, and maintaining a competitive advantage in a competitive market.

The effects of the employed project finance de-risking strategy on project implementation timelines have been explored and recommendations to improve the effectiveness of the de-risking model thereof have been suggested. Consequently, the lessons learnt from this research will benefit government through realization of its strategic goal of diversifying the country's energy mix in a timely and cost-effective manner which is necessary to support industrial growth.

1.7 Theoretical Framework

This study was anchored on Gatti's theoretical model of project finance to explore and investigate the effects of the employed de-risking strategy on the implementation timelines of the Ngonye scaling solar project. According to (Gatti, 2013), project finance is the structured financing of a specific economic entity, the SPV, also known as the project company created by sponsors using equity or mezzanine debt and for which the lender considers cash flows as being the primary source of loan reimbursement, whereas assets represent only collateral. A successful project financing initiative is based on a careful analysis of all the risks the project will bear during its economic life (Gatti, 2013). Cash flows can be affected by risk, and if the risk has not been anticipated and properly hedged it can generate a cash shortfall.

Gatti (2013) further adds that there are three basic strategies the SPV can put in place to mitigate the impact of a risk. This is illustrated in Figure 1.3.

1. Retain the risk
2. Transfer the risk by allocating it to one of the key counterparties
3. Transfer the risk to professional agents whose core business is risk management (insurers)

It therefore follows that the effect of mitigating risks (de-risking) will be observed as results of project deliverables in terms affecting implementation timelines.

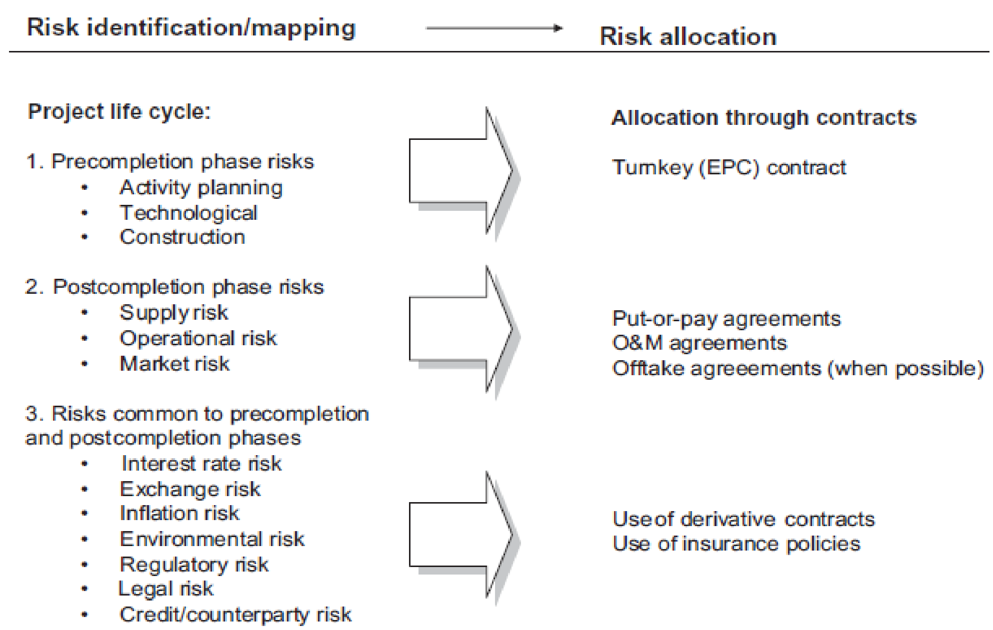

Figure 1. 3 Classification of risks and strategies for mitigation

Source: (Gatti, 2013)

1.8 Scope of study

The research was structured as a case study that was conducted on Ngonye Solar PV project situated in the natural setting of Lusaka South Multi facility economic zone (LS-MFEZ). The study involved collection of primary information from both public and private organizations that participated on the project. No information relating to the similar West Lunga project was investigated. The researcher also worked at the construction site to gain an in-depth understanding of the construction phase of the project. However, the operational phase of the project was not covered in this study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter presents literature review on the technical characteristics of global energy resources. Trends of interest have been discussed from global perspectives that include power generation trends, energy consumption trends and renewable energy investment trends. The Zambian energy supply mix has been reviewed to highlight the current energy mix scenario. The chapter further highlights policy reforms from the National Energy policy of 2008 as well as the concomitant regulatory frameworks from both the regional and national perspective. An overview of financing power plant projects in developed countries is given. Additionally, a variety of de-risking measures and incentives are reviewed for utility scale solar PV projects to show their underlying implications on project finance. Furthermore, case study reviews of similar projects are presented to illustrate the impact of de-risking strategies and critical success factors on project implementation. Finally, an overview of the implementation of the scaling solar program in Zambia is described.

2.1 Energy Resources

According to the (International Energy Agency, 2016) sufficient and secure energy is the main enabler for welfare and economic development of a society. As energy-related activities have significant environmental impacts, it is indispensable to provide an energy system which covers the needs of the economies and preserves the environment. The past 15 years have seen unprecedented change in the consumption of energy resources. Unexpected high growth in the renewables market, in terms of investment, new capacity and high growth rates in developing countries have changed the landscape for the energy sector (IRENA, 2016). Figure 2.1 shows a graph for comparative primary energy consumption over the past 10 years.

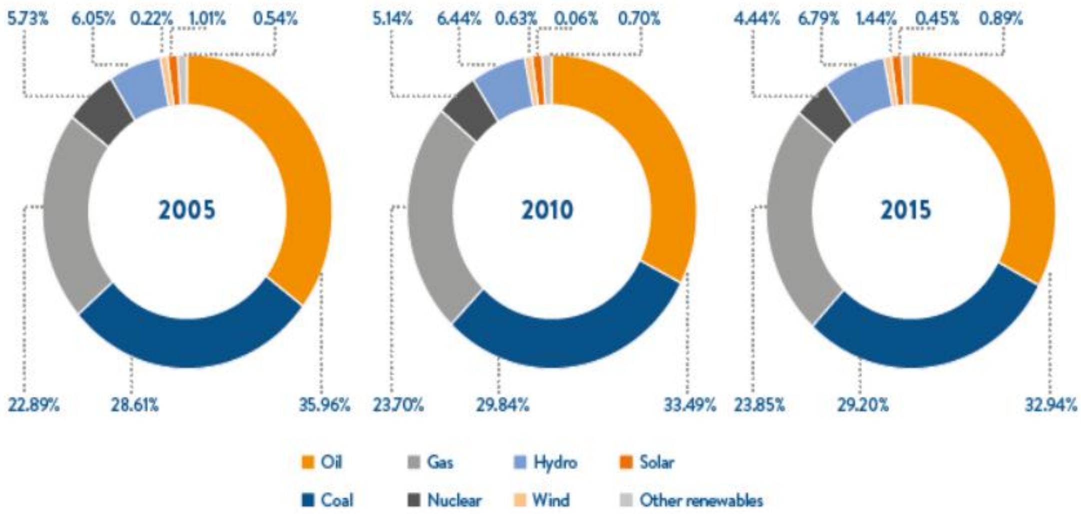

Figure 2. 1**:** Comparative Primary Energy Consumption

Source: The World Energy Resources, Report 2016

2.1.1 Fossil Fuels

According to (Environmental and Energy Studies Institute, 2017) fossil fuels, that include coal, oil and natural gas, are currently the world's primary energy sources. Formed from organic material over the course of millions of years, fossil fuels have fueled global economic development over the past century. However, fossil fuels are finite resources and they can also irreparably harm the environment. On the other hand, (United States Environmental Protection Agency, 2019) adds that carbon emissions from fossil fuels have gradually increased on the global scale throughout the past century. Agriculture, deforestation, and other land-use changes have been the second-largest contributors.

2.1.2 Nuclear Energy

According to the (World Nuclear Association, 2020), Nuclear technology uses the energy released by splitting the atoms of certain elements. Nuclear Fission has been commercialized for power generation and industrialization in the developed nations. Through the use of regional transmission grids, many countries depend partly on nuclear generated power, with some importing this power.

According to Environmental and Energy Studies Institute (2017), there are various advantages of Nuclear power generation, such as large power-generating capacity, low costs of operation, and no green-house gas emissions. However, Nuclear power generation is also associated with various disadvantages, such as high cost of investment, and high financial risks due to extended time frames given to realize returns on initial investment (CLP Group, 2019).

2.1.3 Renewable Energy Sources

Wind: According to (National Renewable Energy Laboratory, 2018), Wind energy is another form of solar energy in some way due to the effect of changing atmospheric temperatures that in turn generate wind pressure. Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity.

According to (Environmental and Energy Studies Institute, 2017) wind is a clean, inexhaustible source of domestic energy that can be transformed into electricity using a wind turbine. On the other hand (Dunlop, 2006) adds that, wind powered electrical energy has potential to meet widespread demands in the most diverse and sparse localities in any region that possesses this wind potential. Globally, China has the largest wind energy capacity, followed by the United States of America (Environmental and Energy Studies Institute, 2017).

Hydropower: According to (Student Energy Association, 2019), Hydro power generation is a process which involes the conversion of mechanical energy from flowing water into electricity, through the use of turbines and generators, ultimately creating electrical energy as the water spins the turbines. Despite hydropower being an abundant, low cost source of power, power generation plants are associated with high building costs (PowerAfrica, et al., 2016).

Geothermal: According to (Barbier, 1997), Geo-thermal energy is the energy contained as heat in the Earth's interior. Geothermal energy, as natural steam and hot water, has been exploited for decades to generate electricity, both in space heating and industrial processes. Electricity produced from Geo-thermal energy has proven to be cost efficient over the past decades, and has shown an electrical installed capacity to be twice that produced from solar and wind sources of energy summed together. Geothermal energy can be used to supplement the significant electricity deficits in developing countries, thus contributing to energy generation diversification.

Biomass: According to (Miguel, 2019), Biomass refers to all organic matter existing in the biosphere, whether of plant or animal origin, as well as those materials obtained through their natural or artificial transformation. Moreover, according to (Andreas, 2018), Bioenergy is renewable, in contrast to fossil fuels, but as it relies on combustion, it still produces notable amounts of air pollution. The global proportion of installed capacity of bioenergy among all renewable energy technologies was 5.3 percent, and of electricity generation 8.6 percent, in 2015 (Andreas, 2018).

Solar Energy: Solar energy systems use the sun's rays for electricity or thermal energy. According to (Samo, 2012), Solar energy can be used either directly or indirectly. In direct system solar energy can directly be converted into electricity by the use of photovoltaic cell. Solar energy can also be used indirectly for heating purpose by using solar collectors.

On the other hand, (Leandro, 2015) adds that solar photovoltaic (PV) industry growth in recent years has surpassed any other renewable energy sources worldwide as the need for carbon neutral electricity continues to increase. Commercially available PV panels are up to 22.5 percent efficient at converting sunlight into electricity in optimal conditions. When linked to the transmission grid, Solar PV systems can supplement utilities' energy supply during peak energy demand which usually falls during daylight hours (BP, 2017).

2.2 Power Generation Trends – Global Perspective

According to (Ricthie, 2018), in the early 1800s nearly all of the world's energy was produced from traditional biomass which essentially involved burning of wood and other organic matter. The world was using a small amount of coal- only around two percent until around 1870's when the expansion into oil consumption began.

Natural gas and Hydroelectricity was introduced as a source of energy two decades later. By 1900, coal consumption had increased significantly, accounting for almost half of global energy. The other half remaining biomass, since oil, gas and hydroelectricity remained small.

The electricity sector at the start of 2018 was in the midst of fundamental change. Renewable energy has become increasingly competitive over fossil fuels (National Renewable Energy Laboratory, 2018). Distributed energy is dominating the economics of the grid while climate change is presenting new threats to power systems and their regulatory models (Enel Group, 2018).

2.3 Energy Consumption Trends – Global Perspective

According to (International Energy Agency, 2016), the use of oil and natural gas also had considerable growth, followed by hydropower and renewable energy. Renewable energy grew at a rate faster than any other time in history during this period. The demand for nuclear energy decreased, in part due to nuclear disasters in the past three decades (BP, 2017). More recently, consumption of coal has declined relative to renewable energy. Coal dropped from the global total primary energy consumption from 2015 to 2017, and non-hydro renewables increased (Henrique, 2007).

According to (Beckstead, 2015) in 1965, the bulk of total energy was consumed in the USA, Europe and Eurasia. Collectively, they accounted for more than 80 percent of global energy consumption. Despite energy consumption having increased in these regions since the 1960s, their relative share of the total has declined significantly (Johnson, et al., 2017).

Figure 2.2 shows that, in 2015 Asia Pacific was by far the largest regional consumer with 42 percent. This was about the same as North America, Europe and Eurasia combined at 43 percent. The Middle East, Latin America and Africa account for around seven, five and three percent, respectively.

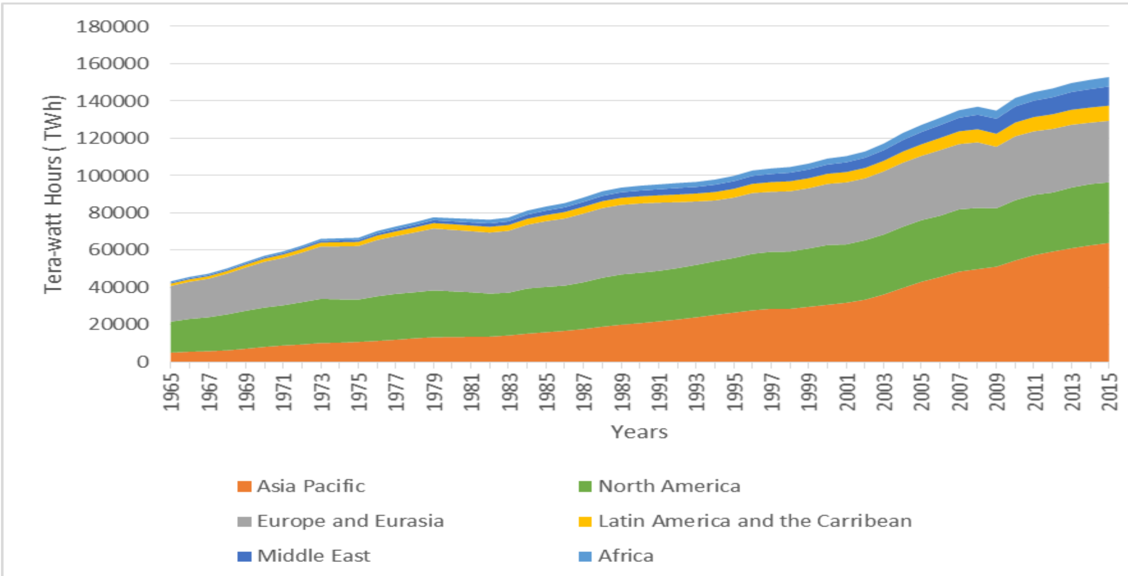

Figure 2.2: Primary Energy Consumption by World Region

Source: Our World in Data, 2018

According to (Ricthie, 2018), a shift in energy systems has historically been a slow process, with regards to long-term infrastructure. Figure 2.3 shows the primary energy consumption by source.

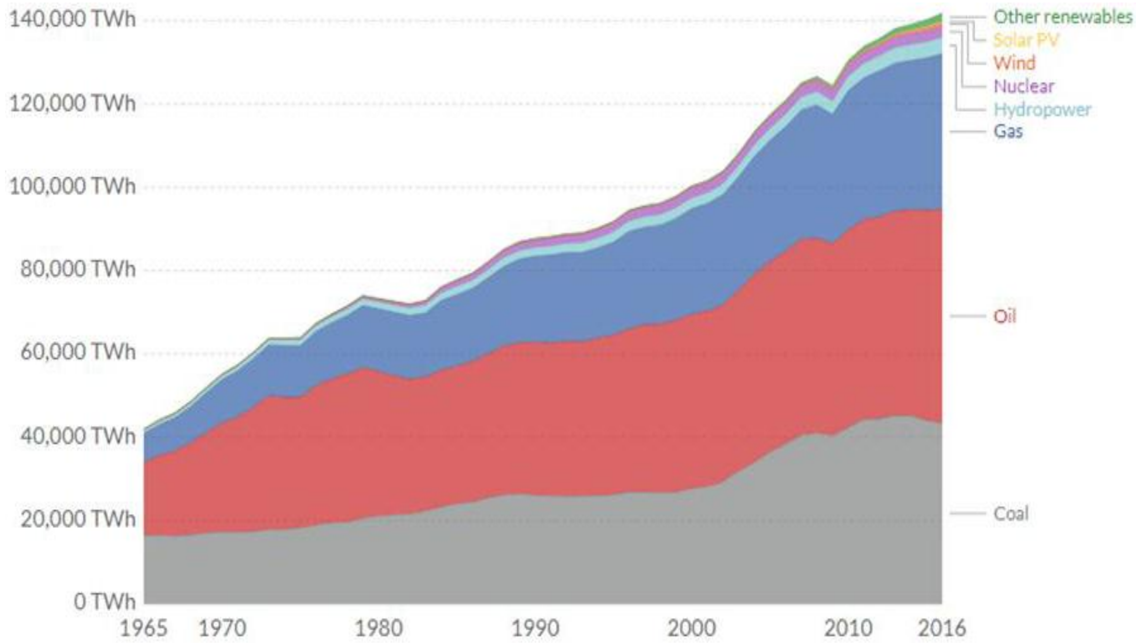

Figure 2.3: Primary Energy Consumption by Source

Source: Our World in Data, 20

2.4 Renewable Energy Investment Trends – Global Perspective

According to (Ricthie, 2018) shifting energy systems away from fossil fuels towards renewable technologies will require significant financial investment. Figure 2.4 shows global investment trends in renewable technologies from 2004 to 2015, measured in billion USD per year. In 2004, the world invested USD 47 billion. By 2015, this had increased to USD 286 billion, an increase of more than 600 percent (Ricthie, 2018). On the other hand (Mazzucato, 2017) adds that investment has grown across all regions, but at significantly different rates. Growth has been greatest in China, increasing from USD 3 Billion in 2004 to USD 103 billion in 2015, an increase of 3400 percent.

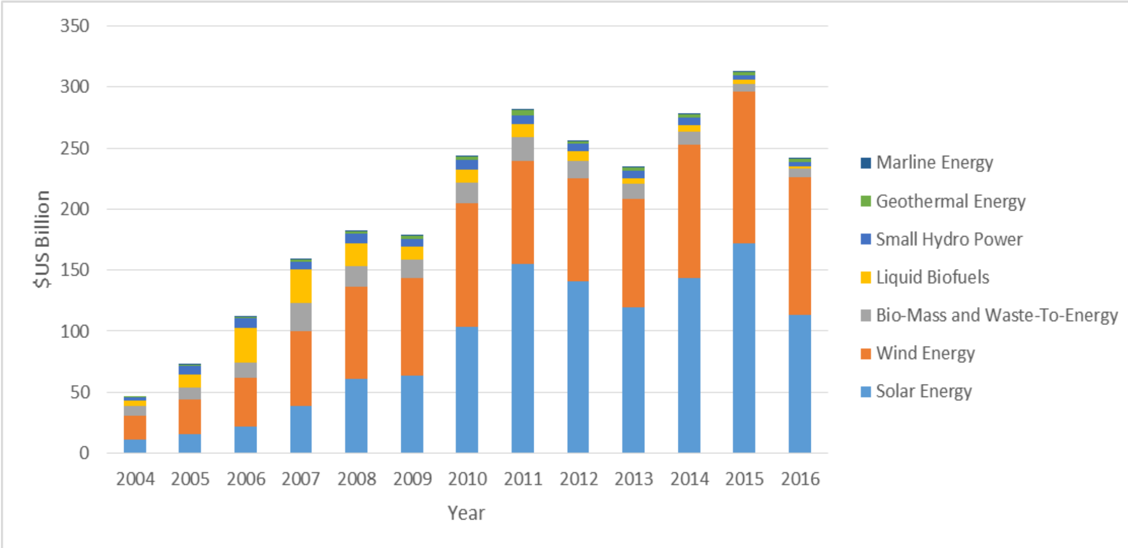

Figure 2. 4. Investment in Renewable Energy by Technology

Source: Our World in Data, 2018

According to (Ricthie, 2018), solar and wind energy both received 47 percent of combined investment to account for 94 percent of global finance. In 2017, solar energy dominated global investment in new power generation like never before. The world installed a record 98 Giga-watts of new solar capacity, far more than the net additions of any other technology. These trends insinuated that the investors see solar and wind energy as the dominant renewable technologies of the future (Ricthie, 2018).

2.5 Energy Supply Mix – Zambian Perspective

Primary Energy Supply: According to (Ministry of Energy, 2018), Zambia is endowed with a wide range of energy resources, particularly woodlands and forests, hydropower, coal and renewable sources of energy. Despite the availability of these energy resources, electrification levels still remain low with only about 31.2 percent of the population being connected to the grid (ERB, 2017).

Electricity Supply and Consumption: According to (ZDA, 2017), electricity is the second most dominant energy source in Zambia after wood fuel, providing about 10 percent of the national energy supply.

Zambia has a total installed electricity generation capacity of 2,827 MW and heavily relies on large hydro power plants for power generation (2,388 MW), the remaining balance being provided by coal (300 MW), heavy fuel oil (105 MW), diesel (89 MW) and solar (0.06 MW) power plants (ERB, 2017).

Figure 2.5 shows a realistic primary energy supply mix scenario by share by the year 2050 depicted in. Hydro power and thermal coal will contribute 34.6 and 37.2 percent respectively, followed by solar at 24.9 percent. Biomass, bagasse, geothermal and wind energy will contribute 3.3 percent (Kaela, 2018).

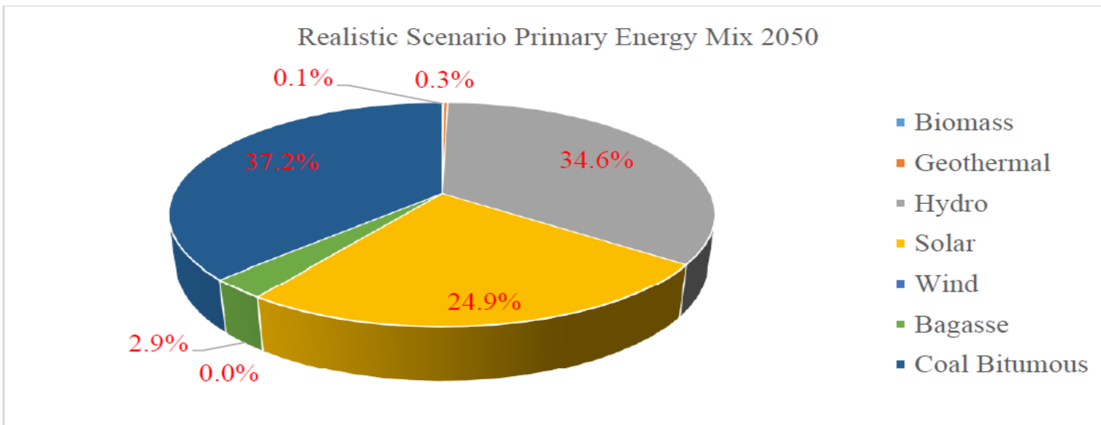

Figure 2. 5 Primary Energy Supply Mix 2050 Realistic Scenario

Source: Kaela (2018)

According to (Kaela, 2018) renewable energy sources, excluding hydro, are increasingly being used but still remain insignificant in terms of contribution to the total national energy mix. Solar energy utilization is lower and should be scaled up to 25 percent of the installed capacity in the energy mix to shift away from hydro and coal dependence. Additionally, scaling up the alternative energy mix may improve the utilization of existing hydro power in that draining down of the energy stocks in the dam could be controlled by energy supplemented from other sources (Kaela, 2018).

According to (ERB, 2017), the ramifications of the country's failure to diversify its electricity generation mix became marked in 2015 when the energy deficit resulted in unprecedented levels of electricity supply rationing to all consumers.

Demand for electricity stood at 1,949 MW; however, the sector was only able to generate 1,281 MW. This situation was largely as a result of inadequate and delayed investments in generation and transmission infrastructure and the failure to diversify energy generation sources over the last 30 years. This was further compounded by inadequate incentives to attract investment in the sector (ERB, 2017). The energy road map shows that the country may have sufficient energy and can avoid the 2015 energy crisis if capacity addition is systematically planned and primary energy mix is diversified (Kaela, 2018).

2.6 Energy Policy Reforms

According to (OECD, 2017) the problems of energy production and demand are not temporary; they can continue well into the next century and beyond. The world is passing through a transition from exclusive dependence on usual fossil materials towards an energy predicament that can be sustained in the long run. Furthermore, (OECD, 2017) continues to add that there are prevailing economic challenges that add pressures on what kind of transition is possible and how quickly it can be achieved. Most policy makers have a wide range of options. These include: structural changes in their economies, different fuel mixes, improved efficiency of energy use, increased indigenous energy production, and application of new prevailing renewable energy technologies.

2.6.1 Energy Policy Framework - Zambia

According to (Ministry of Energy, 2018), the National Energy Policy (NEP 2008) adopted in 2008 provides the overarching sector policy framework. Its main thrusts are: diversifying the energy mix through the use of renewable energy, private participation and creating conditions that ensure availability of adequate supply of energy from various sources which are dependable and at the lowest economic, financial, social and environmental costs consistent with the national development goals. Furthermore, (Ministry of Energy, 2018) adds that in addition to the NEP 2008, there are other strategic and legal instruments which support developments in the energy sector. Under this policy framework, the intention is to create an enabling environment for private sector participation by introducing cost-reflective electricity tariff regime, establishing an open and non-discriminatory transmission access regime in the electricity sector, and introducing an appropriate cost-effective renewable energy feed-in tariff (FiT).

The following sections highlight the major policy and regulatory frameworks:

a) **The Power Systems Development Master Plan (PSDMP, 2010):** According (Ministry of Energy, 2018) as part of the implementation of the NEP 2008, Government developed the Power System Development Master Plan (PSDMP) whose objective is to provide a blueprint for power system development in the country up to the year 2030. The plan highlights least cost expansion options for generation, transmission and distribution in the country and has prioritized power generation projects which when developed would add a total of 4,337 megawatts to the national electricity grid by 2030. According to (Kaela, 2018), energy modeling should be used in conjunction with financial models when prioritizing and scheduling energy project implementation for regions and nations.

b) **REFIT Strategy (2017):** According to (Ministry of Energy, 2018), the objective of the REFiT strategy is to harness the renewable energy sector's potential to drive economic growth and improve the quality of life for all Zambians. This will be achieved through the promotion of small and medium-sized renewable energy projects of up to 20 MW, quick deployment of private investment for small- and medium-sized renewable energy projects and ensuring cost-effective tariffs through transparency and competition in the sector.

c) **Electricity Amendment Act (2003):** This Act was formulated to regulate the generation, transmission, distribution and supply of electricity and to provide for matters connected with or incidental to the foregoing. It liberalized the electricity sector by opening all three segments to private operators (Ministry of Energy, 2018).

d) **Energy Regulation Act (2003):** This Act established the Energy Regulation Board and defines its functions and powers; To provide for the licensing of undertakings for the production of energy or the production or handling of certain fuels; To repeal the National Energy Council Act and the Zambia Electricity Supply Act; And to provide for matters connected with or incidental to the foregoing (Ministry of Energy, 2018).

e) **Zambia Electricity Grid Code (ZEGC) - SI No. 79 of 2013:** According to (Ministry of Energy, 2018), the Grid Code legally establishes technical requirements for the connection to, and use of the electrical transmission system by parties other than the owning electricity utility, in a manner that will ensure reliable, efficient, economic, secure and safe operation. The Grid Code seeks to ensure that investments are made within the requirements of the code and provide access, on agreed standard terms, to all parties wishing to connect to or use the transmission system and applies the principle of non-discrimination through the provision of consistent and transparent criteria and procedures.

f) **Zambia Distribution Code:** According to (Ministry of Energy, 2018) the Distribution Code is designed to provide clear procedures for both planning and operational purposes to ensure efficient development, operation and maintenance of a coordinated and economical distribution system and also to promote grid integration of renewable energy technologies. The Distribution Code seeks to avoid undue discrimination between Distribution Network Service Providers (DNSPs) and other categories of participants.

g) **Energy Regulation Board (ERB)**: According to (ERB, 2017), the Energy Regulation Board approved several power purchase agreements and developed the Zambia Distribution Code; which is a code intended to complement Statutory Instrument No. 79 of 2013, the Electricity (Grid Code) Regulations. The Distribution code is intended to facilitate nondiscriminatory access to the electricity distribution network in Zambia.

Furtheremore, (ERB, 2017) adds that, in addition to the above, the energy sector revised and published several Zambian standards on renewable energy (solar): The use of batteries, charge controllers, lighting devices, design and installation of photovoltaic systems. In its quest to regulate the quality of solar energy products imported into the country, the authority also revised the licensing criteria for the license to manufacture, wholesale, importation and installation of solar energy systems.

h) **Public Private Partnership (PPP) Framework**: According to (ZDA, 2017), the PPP Act No. 14 of 2009 mandates the PPP Unit to promote, facilitate, implement and monitor the procurement, contracting and delivery of public infrastructure and social services through partnerships between public sector and private sector entities. One of the primary objectives of the PPP Unit is to facilitate the effective and efficient delivery of public infrastructure and related services, and promote innovation in the development of infrastructure and social services, through private sector participation. With regards to the type of PPP framework available, there are various PPP models that can be employed such as service contract, management contract, leasing, joint venture and partnership, concessions and Build Operate Transfer (BOT) and Build, Own and Operate (BOO). ZDA (2017) argues that although Zambia has taken a step in introducing the PPP regulatory framework to facilitate PPP type of investment projects, there has been limited experience with PPP projects in Zambia as is the case with the rest of the world. The PPP framework has not been effective in the delivery of public goods and services due largely to the bureaucracy within Government in decision-making to effect PPP projects.

i) **The Seventh National Development Plan (SNDP):** According to (Ministry of National Development Planning , 2017), the Seventh National Development Plan (SNDP) energy sector strategy one is focused on enhancing generation, transmission, and distribution of electricity.

The objective is to expand and improve electricity generation, transmission and distribution, as well as encourage the development of small and mini/micro hydro power stations. Further, the Government will promote the establishment of an open and non-discriminatory transmission access regime in the electricity sub-sector, implement a cost-reflective electricity tariff regime and adopt the electricity grid code. Furthermore, (Ministry of National Development Planning , 2017) adds that the energy sector strategy three is focused on promoting renewable and alternative energy. This strategy aims at promoting the development and use of renewable and alternative energy sources, such as solar, wind, biomass, geothermal and nuclear as a way of diversifying the energy mix and improving supply.

2.7 Project Development Risk Perspective

Project development involves the process of risk management. This section describes the holistic view of risk profiling techniques in the context of renewable energy project development. The theoretical frameworks of risk quantification and risks analysis are described below.

Risk Quantification: According to (Project Management Institute, 2013) Risk quantification is the process of evaluating the risks that have been identified and developing the data that will be needed for making decisions as to what should be done about them. Risk management is done from very early in the project until the very end. For this primary reason qualitative analysis should be mostly used at some of the cardinal points in the project, and quantitative techniques should be used at other times. The objective of the quantification is to first and foremost establish a way of arranging the risks in the order of importance. Severity of the risk is that it’s a practical combination of the risk probability and the risk impact. In its simplest form the risks can be ranked as high and low severity or possibly high, medium, and low. At the other extreme, the probability of the risk can be a percentage or a decimal value between zero and one, and the impact can be estimated in monetary value

(Project Management Institute, 2013).
Risk

2.7.1 Risk Analysis

According to (National Academic Press, 2005), qualitative risk analysis is appropriate early in the project and is effective mostly in categorizing which risks should or should not be planned for and what corrective action should be taken for them. Quantitative values may be applied to risks when using qualitative analysis. Values such as very risky, not so risky; high and low; high, medium, and low; high, high medium, medium, medium low and low are generally used. Qualitative evaluation might also evaluate the risks on a scale of one to ten. These values can be mostly, but not exclusively, applied to both the probability and the impact of the risk.

Sensitivity analysis: According to the (Project Management Institute, 2013), sensitivity analysis seeks to place a value on the effect of change of a single variable within a project by analyzing that effect on the project plan. It is the simplest form of risk analysis. In practice, such an analysis is only done for those variables which have a high impact on cost, time or economic return, and to which the project is most sensitive.

Probability Analysis: According to the (Project Management Institute, 2013), Probability analysis overcomes the limitations of sensitivity analysis by specifying a probability distribution for each variable, and then considering situations where any or all of these variables can be changed at the same time. Defining the probability of occurrence of any specific variable may be quite difficult, particularly as political or the commercial environments can change quite rapidly.

Decision Tree Analysis: A major feature of project work is that a number of options are typically available in the course of reaching the final results.

An advantage of decision tree analysis is that it forces consideration of the probability of each outcome. Thus, the likelihood of failure is quantified and some value is place on each decision. This form of risk analysis is usually applied to cost and time considerations, both in choosing between different early investment decisions, and later in considering major changes with uncertain outcomes during project implementation (National Academic Press, 2005).

2.8 Case Study Reviews: Impact of Risk and De-Risking Strategies

2.8.1 A Case Study on Hydropower in Africa - Uganda

According to (Valerio, 2015), this case study analyzes the financial structure of the Bujagali Hydropower project in Uganda. Bujagali offers a unique opportunity to assess the effectiveness of most of the instruments in supporting private renewable energy investments in high-risk environments and to consider their potential for replication at scale. The case study revealed that de-risking instruments mostly drove down the cost of power produced to around 105-110 USD/MWh.

Project Cost: The total cost for the final project amounted to approximately USD 900 million - 13% higher than the USD 798.6 million estimated when the project was re-launched in 2005 due to geological risks. These costs were also 55% higher than the contract negotiated in 2001, mainly due to inflation (20%) and cost increases in raw materials (17%) over the years (Valerio, 2015).

Risk Identification: Risks that could affect the project technical and economic performance were assessed according to their probability of occurrence (from low to very high) and their impact on the project's financial and non-financial objectives (from low to very high). Thereafter, the technique analyzed and presented the risk responses for most important risks and outlined the final risk allocation among the major stakeholders. Finally, a model of the impact of risk mitigation instruments provided by the World Bank Group on the project's financial metrics was developed.

High-Risk Events

According to (Valerio, 2015) risk events with moderate probability of occurrence, and medium to high impacts were as follows:

Political and off-taker risk: The risk that the country public entities were unwilling or unable to honor their off-taker obligations; the capacity payments; and act against the rights of the investors was classified as medium high given the high political risk measured for the country and the precarious financial health of the off-taker.

The impossibility of selling the power to an alternative purchaser increased the risk further.

Construction delays: A large-scale project in a land-locked country increased the risk of construction delays that would result in financial penalties for the project developer (World Bank Group, 2017) Construction delays actually occurred, with the project commissioned one year behind schedule.

Medium-Risk Events

Social opposition: The history of the project, its scale and the well-known environmental and social impacts of large hydropower plants increased the risk of local and international opposition that could have resulted in disruption of construction and operations. These could have further delayed construction, thus making it more expensive and making it impossible to operate the asset.

Low Risk Events

Power affordability: The risk that higher than expected costs, lower performance and power generation would compromise the goal of the project to lower the overall cost of power generation on the national grid and reduce either power tariffs or government's subsidies (Valerio, 2015).

2.8.2 The Financing Cost Waterfall: Quantifying the Impacts of Barriers and Risks on Financing Costs:

According to (UNDP, 2013), having identified the set of possible investor barriers and risks to the renewable energy technology, the next task was to understand the incremental contribution of each risk category to higher financing costs in a given country. The figure below shows an illustrative financing cost waterfall for the nine risk categories identified in the large-scale, on-grid barrier and risk table.

This quantification can subsequently inform the selection of public instruments to address these barriers and risks, as well as provide a means to calculate the impact of public instruments on reducing financing costs.

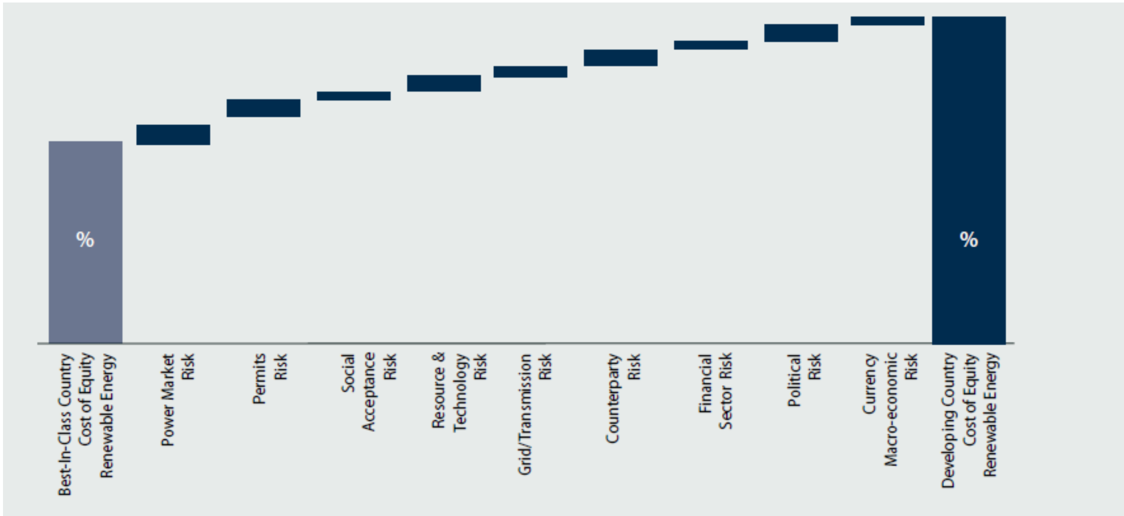

Figure 2.6 Illustrative financing cost waterfall, quantifying the impact of risks on increasing financing costs

Source: DB Climate Change Advisors (2011)

The concept of a financing cost waterfall was originally developed by Deutsche Bank and is based on the assumption that investors price investment risks into the cost of financing.

According to (UNDP, 2013), the financing cost waterfall is constructed on the basis of the barrier and risk table.

In a structured interview format, equity and debt investors are confronted with these categories and definitions and asked to score the risk categories. These risk scores, for each of cost of equity and debt, are then processed and risk waterfalls generated comparing the particular renewable energy investment in a developing country against a best-in-class country.

2.8.3 Case Study South Africa: 20-Year Target for Wind Energy

According to (UNDP, 2013) the modeling case study assumes an 8.4 GW 20-year target for wind investment in South Africa.

Risk Environment: The case study's analysis of the contribution of investor risks to higher financing costs for South African wind energy is shown in the risk waterfalls in Figure 2.7. These results identify power-market risk and currency/macro-economic risk as the most significant risk categories impacting financing costs in South Africa.

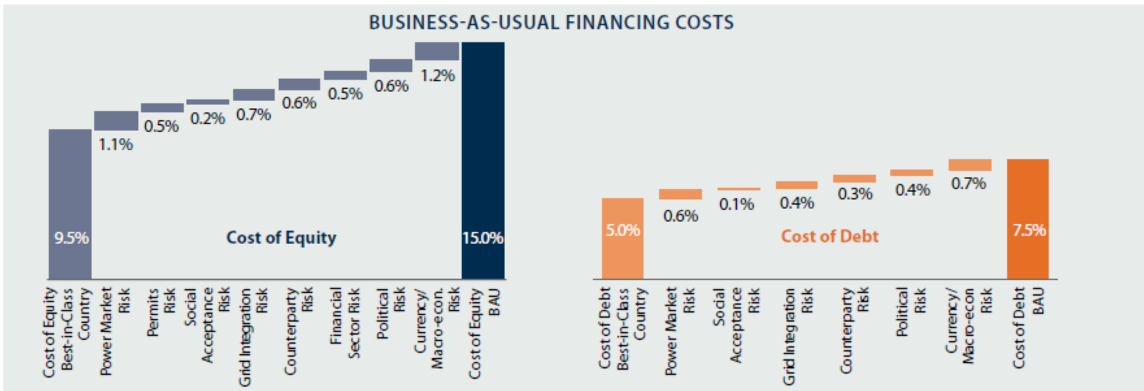

Figure 2.7 Impact of risk categories on financing costs for wind energy investment in South Africa, Business-as-usual scenario

Source: UNDP De-risking Renewable Energy Investment

Public Instruments: As an investment-grade country, the case study assumes no need for financial de-risking in South Africa and only implements a package of policy de-risking instruments. Based on the modeling analysis, the package of policy de-risking instruments is anticipated to reduce the average cost of equity over 20 years by 1.2 percent, and the cost of debt by 0.5 percent (Ibid). Figure 2.8 shows the impact of policy de-risking instruments on reducing financing costs for wind energy in South Africa.

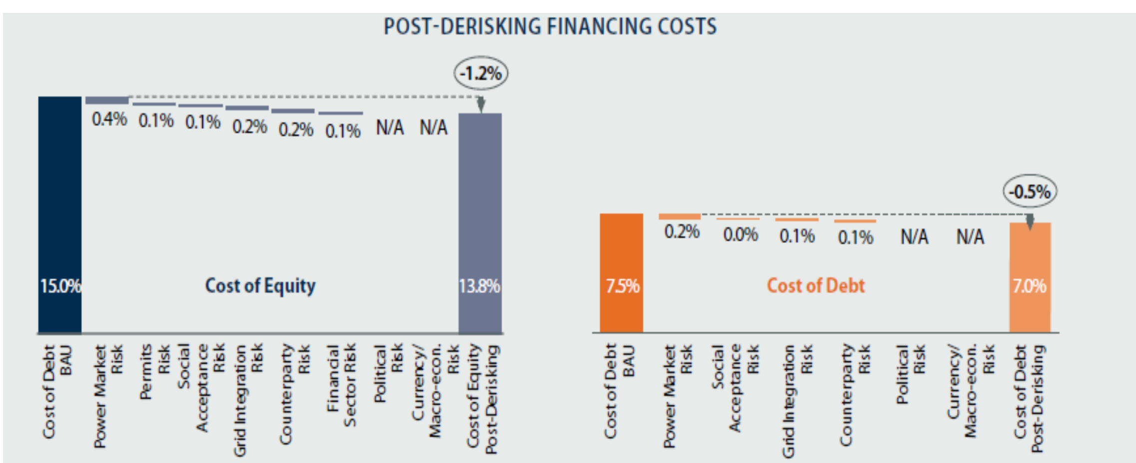

Figure 2.8 Impact of policy de-risking instruments on reducing financing costs for wind energy in South Africa

Source: UNDP De-risking Renewable Energy Investment (2013)

Investor feedback on risk categories for wind energy investment in South Africa

Power Market risk: This risk category has a high impact on financing costs. On the positive side, investors comment favorably on many aspects of the regulatory framework. South Africa has a clear long-term 2030 target for wind energy in place. The bidding process's stringent requirement on financing to ensure projects are commissioned is viewed positively.

Permits Risk: According to (UNDP, 2013) this risk category has a moderate impact on financing costs. Investors generally view the licensing process and other entities positively, noting good progress having been made in designing transparent, streamlined procedures, as well as in training staff specifically in wind energy. At the same time, some investors comment on a lack of coordination between entities issuing licenses and permits.

Social Acceptance risk: This risk category has a low impact on financing costs. Investors remark that public resistance to wind energy is low. They also note that the bidding process has trust-building requirements with local communities, with many communities holding stakes of up to 5 percent. Some investors, however, feel that social acceptance risk may increase overtime, particularly as wind farms become more widespread.

2.8.4 Clean energy for all: The implementation of Scaling Solar in Zambia

According to (Stritzke, 2017) the single case study was based on stakeholder interviews and the evaluation of primary and secondary sources of data. The study illustrated the implementation of Scaling Solar in Zambia and linked it to the formal PPP framework of the country. Central critical success factors (CSFs) for PPPs identified by previous research were compared. Furthermore it analyses whether these CSFs have affected the PPP project implementation in Zambia. The study however, reveals that project implementation was delayed by fourteen month as shown in figure 2.9.

The case study revealed that the design of the Scaling Solar programme largely mitigated the main financial and political risks identified in previous studies with regard to the uptake of energy infrastructure processes in developing countries. It reveals that government stakeholder alignment and institutional capacity are the central CSFs which impact the roll-out of the programme in Zambia.

Figure 2.9 Scaling Solar: Estimated project timeline and actual project status - Round 1

Source: World Bank, 2017 & www.scalingsolar.org

Critical Success Factors (CSFs) of Scaling Solar in Zambia: According to (Osei-Kyei & Chan, 2015), CSFs are the key areas of activity necessary to be focused to ensure competitive performance towards an organization's strategic goals. Stritzke (2017) identifies the major CSFs that impacted the scaling solar program as follows:

Appropriate risk allocation and sharing: Adequate risk allocation and sharing does not mean the simple outsourcing of perceived project risks from the government stakeholders to the private sector. Rather it is a comprehensive risk-identification and allocation between the stakeholders (Zhang & Asce, 2005). For a solar PV project which is based on a 25-year PPA, the financial risks of payment defaults due to illiquidity of the state-owned utility or political risks are substantial. In this regard, the proportional risk allocation was shifted from the government to a third party: the World Bank group in the Scaling Solar PPP (World Bank, 2017).

Experienced and Solid Private sector participants: This CSF for the implementation stage of PPPs was the second most identified and relates to the competency of the private sector company or a consortium which participates in the PPP (Osei-Kyei & Chan, 2015). Due to the complexity of PPP infrastructure projects it is essential that the private sector partners combine managerial, technical, and operational capacity (Zhang & Asce, 2005).

Public and Community Support: The third CSF identified by Osei-Kyei and Chan (2015) relates to public and community support for the implementation of PPP projects as public opposition can delay PPP projects, for example with regard to land acquisition (ibid). The Scaling Solar programme was aimed at promoting public and community support for the projects of round one by facilitating meetings with local communities immediately affected by the implementation of the project (Neon SAS, 2016).

Transparent Procurement: The fourth major CSF for implementing PPP projects is the transparency of the procurement process, which provides traceability of outcomes of the selection process that can be achieved through openness and communication among stakeholders and the public (Lui, et al., 2015). A lack of transparency can result in public opposition towards the implementation of a project which in turn can cause delays (Osei-Kyei & Chan, 2015).

2.9 Financing of Power Plant Projects

Prior to engaging in financing negotiations, power plant projects must go through a development phase. According to (Pike, 2005), the development process of a power plant starts once interest has been established in a specific power market. Assessment of the market opportunity considers a variety of issues at the national level, such as regulatory environment, power prices, structure of the power market and any specific financial incentives for developing power plants. Pike (2005) continues to add that as the project developer starts preparatory activities, including securing a land lease agreement and permits, preliminary financing schemes are assessed. The financial viability of the project is determined by energy yield, capital costs and tariffs.

Assuming that the company will be profitable, the cost of debt is generally lower than the cost of equity due to tax benefits. This creates an incentive to finance projects with debt rather than equity (Pike, 2005). In order to attract lenders, the project has to demonstrate highly predictable cash flows (International Finance Corporation, 2015). This is typically accomplished by acquiring a Power Purchase Agreement (PPA). PPA's are contracts between the electricity provider, and the purchaser, which is often referred to as the off-taker. The agreement contains all the commercial terms for the sale of electricity, timing of the project, scheduling for the delivery of electricity, penalties in the event of under delivery, payment terms and contract termination. According to (Gervokian, 2012) in addition to PPA terms, the credit quality of the off-taker is critical for project financing as the agreement allocates some of the key project risks such as market risk regarding fuel and electricity price to the off-taker.

2.9.1 Incentive Schemes

According to (Donovan, 2012) financial incentives exist for supporting the growth of renewable energy development. Incentive schemes include different types of investment subsidies, feed-in tariffs (FiTs) and renewable energy certificates (RECs). Donovan (2012) continues to add that Investment subsidies reward overstatement of power, and tolerate poor maintenance since they are paid out as a function of the declared capacity rather than its actual long-term power yield.

FiTs are predetermined fixed sales prices per kilowatt-hour of electricity produced by a solar PV power plant. The price is set at a sufficient level to ensure the profitability of the project and guarantee a solid profit margin to attract investors. FiTs are designed to protect solar PV project companies from competition with other power generation sources and from price fluctuations in the electricity market, resulting in less volatile revenues for the project company (Donovan, 2012).

2.9.2 Country Specific Risk: Financing in Emerging Markets

According to (Ganguin, 2005), industrialized and developed countries generally support business success due to effective utilization of natural resources, a well-educated workforce, strong fiscal and monetary policy, a stable domestic currency, a reasonable level of taxes and tariffs, sophisticated domestic capital markets, strong banking infrastructure and a presence of well-established businesses. These are all desirable qualities in a country from a financiers' point of view (Mweemba, 2015). On the contrary, (Ganguin, 2005) argues that emerging markets are economies that are progressing towards becoming advanced markets, as shown by some liquidity in local debt and equity markets as well as the existence of market exchange and regulatory body. These economies generally lack market efficiency and strict standards in accounting and securities regulation, creating a highly volatile investment environment. Ketelhodt (2016) on the other hand adds that, in emerging economies, high investment costs hinder fast renewable energy (RE) deployment. Compared to industrial states, higher financial costs originate mainly from investment barriers and consequently risks.

According to (Cavallo, 2009) government borrowing creates sovereign default risk, or country-specific risk, which may potentially increase the cost of debt for domestic firms. If the government experiences difficulties in servicing its debts, it will transfer those difficulties to the private sector by taxing, imposing foreign exchange controls or seizing firm assets. Sovereign risk is therefore a crucial factor in determining private sector cost of debt. Due to this linkage between sovereign and corporate risk, ratings agencies have justified the application of sovereign ceiling policy, according to which the debt of a company in a specific country cannot be rated higher than the debt of its government (Cavallo, 2009).

According to (S&P Global, 2017) overall sovereign creditworthiness in investment-grade emerging countries has remained stable between 2011 and 2016. The share of sovereign emerging countries with investment grade ratings is at 60 percent. Bhaumik (2017) adds that commercial banks are typically reluctant to provide long-term financing in countries with non-investment grade credit rating and as such power plant projects in emerging countries generally face difficulty in finding commercial banks as lenders.

2.9.3 Debt Financing: Firm Specific Risk – Default Risk

According to (Abeywardhana, 2017) a large proportion of working capital and capital expenditures are typically funded with debt in power plant project financing schemes. From debtors' point of view, the optimal amount of debt offers a balance between tax benefits, bankruptcy costs and agency costs. Sharpe (1964) market model, defines firm-specific risk as risk that is specific to a particular security, and it can be reduced by increasing the number of shares since positive and negative shocks affecting individual companies and assets will tend to cancel out. In financial theory, influences such as dividend yield, various price multiple ratios, quality of management and industry-specific factors are classified as firm-specific risk (Pilbeam, 2010).

Damodaran (2012) adds that Firm-specific risk can be further divided into a wide range of risks. The risk that a firm may have misjudged the demand for a product from its customers is called project risk. Competitive risk can arise from competitors proving to be stronger or weaker than anticipated. Risk measures can be extended to include risks that may affect an entire sector but are restricted to that sector. According to (Pilbeam, 2010), firm-specific risk is comprehensive from the point of view of an equity investor. However, from a creditor's perspective, it is crucial to further analyze all possible factors of a firm concerning default risk. Default risk is classified as the risk that companies who owe money will default on their obligations of principal or interest payments. Improving prospects of firm growth and profitability decrease the likelihood that the firm hits the default threshold (Avramov, 2005).

2.10 Renewable Energy Development in Zambia

According to (Ministry of Energy, 2018), renewable energy sources available in Zambia include Solar, Mini/Micro-Hydro, Geothermal, Wind and Biomass. Singh *et al*. (2013), adds that Zambia has an average solar potential of 5.5 kwh/m2/day with approximately 3,000 sunshine hours annually, providing good potential for solar thermal and photovoltaic applications.

Ministry of Energy (2018), adds that despite this huge potential, penetration of solar usage and its contribution to the national energy mix in Zambia still remains low mainly due to the high investment capital costs, which need guarantees of long-term stable income streams to ensure financial viability. In order to harness this solar energy potential, Ministry of Energy (2018) reports that the Government has undertaken several measures to promote solar including the development of the solar resource mapping atlas which began in 2015 with support from the World Bank Energy Sector Management Assistance Program (ESMAP). This initiative, completed in December 2017, aimed to deliver high quality solar resource mapping and measurement services for renewable energy development in Zambia. Ministry of Energy (2018) adds that, the position of solar meteorological stations was selected to achieve a representative geographical distribution within the territory of Zambia, as well as in proximity to the population centers, where potential solar power plants will be mostly deployed. The results of the solar resource mapping program were incorporated into the global solar atlas. The atlas provides quick and easy access to solar resource data globally with GIS layers and poster maps showing global, regional, and country level resource potential (Ministry of Energy, 2018).

2.10.1 Global Energy Transfer Feed –in- Tariff (GETFiT Zambia)

According to (Ministry of Energy, 2018) GET FiT Zambia is designed to assist the Zambian Government in the implementation of its REFiT Strategy to support small- to medium-scale Independent Power Producer (IPP) projects up to 20 MW. In line with this strategy, GET FiT Zambia aims to procure 200 megawatts (MW) of renewable energy projects within the next three years.

Ministry of Energy (2018), adds that the initial phase of the GET FiT Zambia program was a tender to procure up to 100 MW of solar PV capacity, which was launched in early 2018. The REFiT Strategy has also allocated 100 MW of capacity to hydro projects.

2.10.2 Scaling Solar Program

According to (International Finance Corporation, 2015), the Scaling Solar is a "one stop shop" program for governments to rapidly mobilize privately funded grid connected solar projects at competitive tariffs. The program was inspired by the experiences of large emerging markets like South Africa, Brazil, and India, where repeated auctions for renewable energy have resulted in dramatically lower tariffs as developers became familiar with bidding processes and the industry was allowed to evolve. International Finance Corporation (2015) adds that the program brings together a suite of World Bank Group services under a single engagement based on a templated approach to create viable markets for solar power in each client country. Utility-scale PV can be quickly and economically deployed to address supply-demand imbalances in national grids, lower power costs and improve the financial sustainability of power utilities.

Furthermore, International Finance Corporation (2015), adds that the scaling solar program was implemented in Zambia by including World Bank Group (WBG) technical advice and pre-negotiated template documents for governments and developers to use. This included a Power Purchase Agreement (PPA), Government Support Agreement (GSA), increasing transparency and reducing risks and costs. International Finance Corporation (2015) continues to add that Scaling Solar also includes an offer of WBG debt financing, guarantees, and insurance to boost confidence for first-of a-kind projects in challenging and nascent markets. .

2.10.2.1 Ngonye Scaling Solar Project – Financing Framework

According to (IDC, 2015), the project was implemented by Ngonye Power Company Limited, an SPV incorporated under the laws of Zambia. The Project Company is 80 percent co-owned by Enel Green Power (EGP) and 20 percent by IDC.

EGP had the responsibility for designing, financing, developing, commissioning, operating, and maintaining the proposed solar PV Power Plant. Figure 2.10 shows the project finance contractual structure.

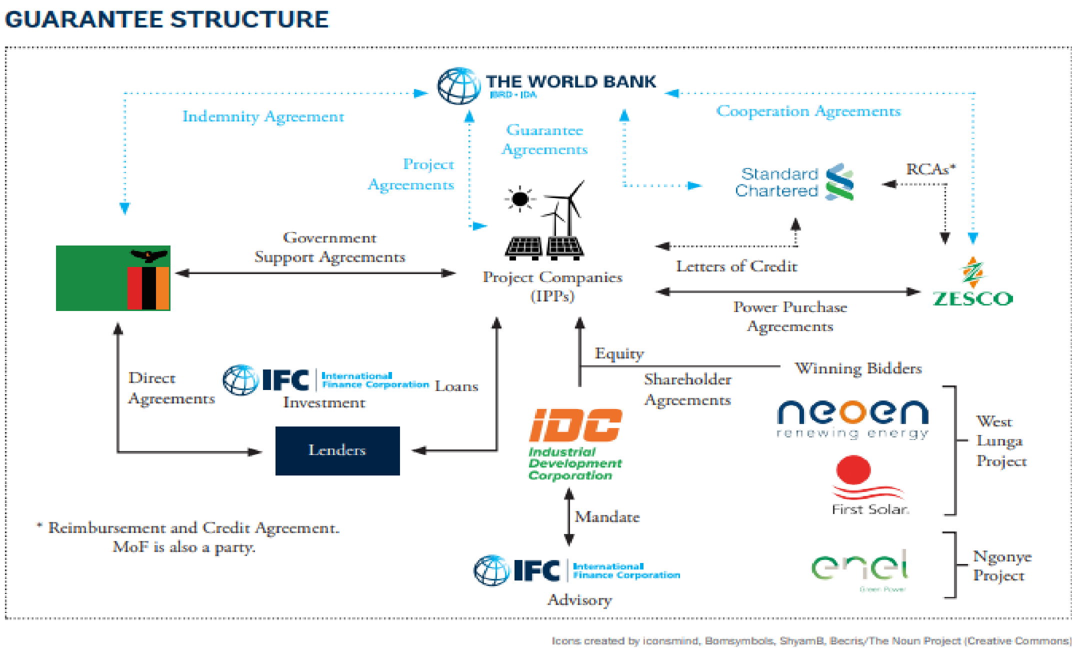

Figure 2.10: Project Finance Contractual Structure

Source: (International Finance Corporation, 2015)

According to (International Finance Corporation, 2015) the roles and responsibilities of each of the entities in the project finance contractual structure above were as follows:

1. Ministry of Finance (MoF), on behalf of GRZ, entered into a Government Support Agreement (GSA) with the Project Company (defining, in particular, GRZ commitment to support implementation and eventual termination of payments), an Indemnity Agreement with IDA (by which MoF committed to reimburse IDA in case of a call on the guarantee), and a Direct Agreement with the lenders to the Project Company (defining how the lenders could interact with GRZ).
2. Ministry of Energy (MoE) provided policy direction to IDC and ZESCO on the procurement of solar PV generation capacity.
3. IDC, on behalf of GRZ and as directed by MoE, conducted the competitive procurement of the solar PV power plant, in addition to co-sponsoring and retaining up to 20 percent interest in the Project Company.

4. ZESCO entered into a Power Purchase Agreement (PPA) with the Project Company and, under the terms of the PPA, procured a Letter of Credit (LC) in favor of the Project Company. The PPA defined the conditions of purchase of electricity by ZESCO, including the LC as a security against potential ZESCO default in the settlement of PPA invoices (IDC, 2015).

Furthermore, according to (International Finance Corporation, 2015) the key roles and responsibilities of the World Bank group instruments were as follows:

1. IDA provided a payment guarantee of up to USD 2.8 million, which will backstop the security mechanism (that is, LC) in case of a draw that the GRZ or ZESCO have not reimbursed after 12 months. ZESCO has selected Standard Chartered Bank as the LC bank through a transparent and competitive process.
2. IFC provided a Loan of up to USD 12 million; a senior loan of up to US$12 million from IFC acting as the implementing entity of the IFC-CCCP, and; one or more U.S. dollar interest rate swaps to hedge the interest rate risk in respect of the senior debt comprising the project financing in a notional amount of up to USS 36 million, representing a Loan Equivalent Exposure to the Project Company of up to USS 2.5 million. Further, IFC investment had signed a mandate with EGP, the lead sponsor, to act as the lead arranger for the project's financing, under which IFC mobilized an additional USD 12 million of long-term financing which came in as a parallel senior loan from the European Investment Bank (EIB). IFC's Advisory Services was the transaction advisor to the IDC in the implementation of the Scaling Solar Program in Zambia.
3. Multilateral Investment Guarantee Agency political risk insurance was offered but not requested for this project by the investors (International Finance Corporation, 2015).

2.10.2.2 Risk Profile – Ngonye Scaling Solar Project

According to (International Finance Corporation, 2015) the overall risk of the proposed Ngonye project remained substantial and was consistent with the West Lunga-Bangweulu Project as both are parts of Scaling Solar Round one.

Furthermore, International Finance Corporation (2015) adds that despite the recent positive developments in the power sector since the approval of West Lunga-Bangweulu, the Sector Strategies and Policies risk remained high, primarily due to the unsustainable financial situation in the sector. Even though most other risks were considered lower given the experience gained and capacity built by the GRZ and other key stakeholders in the first project (West Lunga), the Political and Governance and Institutional Capacity risk ratings remained substantial as shown in Table 2.8.

Table 2.1: The World Bank Risk Profile for Zambia Scaling Solar Project

	Risk Category	**Rating**
1	Political and Governance	Substantial
2	Macroeconomic	Moderate
3	Sector Strategies and Policies	High
4	Technical Design of Project or Program	Moderate
5	Institutional Capacity for Implementation and Sustainability	Substantial
6	Fiduciary	Moderate
7	Environmental and Social	Moderate
8	Stakeholders	Moderate
	OVERALL	**Substantial**

Source: International Finance Corporation, 2015

2.11 Summary of Literature Review

This section presented the various forms of renewable energy resources, production, consumption and investment trends, on a Global Scale. Thereafter, it narrowed down to illustrate the current energy regulatory and policy framework and presented the energy mix in Zambia. Moreover, it depicted various aspects of a Power Plant Financing Model, and further showed the status of Renewable Energy Development in Zambia, with a specific focus Solar PV Utility scale projects and various identified risks on these projects.

Finally, the section presented various approaches used in identification, quantification and analysis of risks on projects in general. Case studies reviewed have shown that much literature has been done on the impact of project risks and de-risking instruments, on investment and financial aspects of a renewable energy project. However, there is not much literature exclusively showing the impact of de-risking strategies on other aspects of a renewable energy project, such as timelines. The recent research conducted on scaling solar implementation in Zambia focused on the general impact of the central critical success factors but little was investigated regarding the effect of risk allocation and sharing on project implementation.

CHAPTER 3: METHODOLOGY

3.0 Introduction

The previous chapter presented the literature reviewed regarding the topic. This chapter examines the overall methodology of the research process by considering the various research methods to be employed on the study. The research methods are selected based on their strengths and limitations in achieving the objectives of the research. This chapter will therefore focus on presenting the research design that has been employed in this study.

3.1 Research Methods

There are various methods of research available in use today. Different research types also have different data gathering methods. Data collection techniques can be broadly classified as primary and secondary (Cooper, 2001).

3.1.1 Primary Technique

According to (Ngoma, 2015), this technique is used in original data collection. The primary data are those which are collected afresh and for the first time, and are original in character. This technique includes methods such as observations, interviews and administration of questionnaires. Focus Group Discussion is also one of the primary techniques of data collection.

3.1.2 Secondary Technique

This technique involves the use of available information that was collected by somebody else. The researcher in this case is the secondary user of the information. An example of such a technique is literature review (Dawson, 2007).

3.2 Research Design

This study was designed to address the problem identified in Section 1.2 and achieve the objectives outlined in Section 1.3. It was considered necessary to obtain a full understanding of the study by setting out the various elements in a logical sequence, so as to avoid misunderstanding at any point in the research.

The problem statement and objectives of the research were therefore stated at the outset. In order to present clear perspectives about the de-risking strategy in the implementation of the Ngonye project and to bring out the effects thereof, it was decided to conduct the study in three phases.

The first phase was a comprehensive literature review to understand the subject matter from different perspectives and to characterize the employed de-risking strategy. This phase overlapped all the other phases as it was important that even latest information on the research subject be incorporated. The second phase involved data collection which was done through structured interviews and questionnaire surveys to establish the factors that affected project implementation. Data triangulation of the various methods was done to enhance the confidence that can be placed on the research (Frisari & Micale, 2015). The third and final phase was the analysis of the data collected to examine the effects of the de-risking strategy on project implementation timelines from which recommendations were drawn.

3.2.1 Literature Review

Literature was reviewed in terms of its contents and methodology used by other researchers in similar studies. This approach was fundamental in laying the foundation of the research, building it up on what has been done in other parts of the world. Literature from journal articles was of interest during the review period because they offered a relatively concise, up-to-date format for research and all reputable journals were used. Where adequate information was missing, other articles were sought for. These included: conference proceedings; government/corporate reports; thesis and dissertations; and e-journals.

The main objective throughout the review stage was to identify factors likely to be relevant in studying renewable energy finance and the scaling solar program. In order to address this objective, a systematic literature review was conducted.

The objective was to:

i. Define and limit the research questions being worked on;
ii. Place the study in a historical perspective;
iii. Avoid unnecessary duplication;
iv. Identify approaches to research design and methodology; and
v. Clarify the future direction for the study.

3.2.2 Data Collection

3.2.2.1 Questionnaire Survey

A self-administered questionnaire survey (Appendix I) was adopted as the main research instrument based on the advantages that a representative sample would be realized with little time and costs. Further, the questionnaire was designed to meet the research objectives. The method allowed key stakeholders on the project to make their contributions. The respondents were assured of anonymity which in turn helped them to be honest with their answers. Also bias due to personal characteristics of the interviewer was avoided. This method also allowed respondents to have adequate time to consult where they were not sure, thereby answering the questions more appropriately.

The information presented in the previous chapters helped to widen the author's knowledge and created an awareness of other issues that might not otherwise have been taken into account. This preliminary knowledge helped to develop a questionnaire that cover all aspects needed to accomplish the purpose of the research. However, it was also necessary to ensure that the questionnaire was reliable by ensuring that the questionnaire was approved by the supervisor before distribution to the participants. The purpose of the questionnaire survey therefore, was to identify the various risks associated with the Ngonye project, determine timelines for critical milestones, to measure the levels of impact of each de-risking strategy and to determine the factors that led to project implementation delay.

In order to present the questionnaire in a systematic way, it was decided to divide the questions into five sections:

i. General questions concerned with respondents' experience in similar projects and the role that each respondent played;
ii. Questions to determine the various project risks that the respondents may have identified.
iii. Questions dealing with influence (impact) of the de-risking strategy on identified risks. The responses had a scale range of 1 to 5 for the levels of influence/impact of each employed de-risking strategy.
iv. Questions about the time frame for implementing each de-risking strategy. The responses were grouped in 5 time ranges of 3 months per range.
v. Questions dealing with perceptions on the scaling solar project design. The responses had a scale range of 1 to 5 for the levels of influence/impact of each project design aspect.

The questionnaire made provisions for capturing extreme cases by providing options that allowed for recommendations to be made by the respondents.

3.2.2.1.1 Questionnaire Administration

The questionnaire was written in one format and distributed to professionals working for The Contractors, Developer, off taker, Lender, Investor, government departments and agencies in Zambia.

The following issues were considered in order to obtain a high response level. Providing an ethical clearance letter accompanied with an introductory covering letter issued by the School to:

i. Identifying the type of research, sponsoring organisation and the researcher's details;
ii. Explaining the purpose and the benefits of the study;
iii. Encouraging the participants to fill in the questionnaire in a solicitous language;
iv. Informing the participants about ethical and confidentiality matters by way of the ethical clearance letter, that their name, department name would not appear in the report;

v. Structuring the questionnaire in a neat format; and

vi. Keeping the questionnaire as short as possible, but comprehensive enough.

It was decided to use appropriate distribution method for each respondent. For speed of response, some questionnaires were distributed personally and collected by hand. This method was effective as it ensured that the questionnaires reached the targeted organizations in good time and within budget. For the other respondents who could not be easily reached, the questionnaires were distributed and collected via email.

3.2.2.1.2 Sample Survey

The population sample of this research was composed of five strata: Government ministries and agencies, lenders (financiers), developers, off taker and contractors were purposively sampled by virtue of the roles they played on the Ngonye Scaling solar project.

Purposive sampling technique was employed due to the specialized nature of project stakeholders. In this regard only nineteen participants were targeted across the strata. According to (Dawson, 2007) this technique was preferred because it is fast, inexpensive, easy and the subjects are readily available. These were identified by their unique respondent identification numbers as shown in table below:

Table 3.1 Sampling Profile

QID	ORGANISATION	PROJECT ROLE	DEPARTMENT
1.0	MINISTRY OF ENERGY (DOE)	POLICY	TECHNICAL
2.0	MINISTRY OF ENERGY (OPPPI)	ADVISORY	TECHNICAL
3.0	ERB	REGULATOR – ENERGY	TECHNICAL
4.0	ZEMA	REGULATOR (ENVIRONMENTAL)	TECHNICAL
5.0	IDC	DEVELOPER	COMMERCIAL
6.0	LS-MFEZ	LAND LEASE	TECHNICAL
7.0	LUSAKA PROVINCE PLANNING AUTHORITY	LOCAL AUTHORITY	TECHNICAL
8.0	ENEL GREEN POWER	EPC CONTRACTOR/O&M	COMMERCIAL
9.0	ENEL GREEN POWER	EPC CONTRACTOR/O&M	TECHNICAL
10.0	ENEL GREEN POWER	EPC CONTRACTOR/O&M	TECHNICAL
11.0	WBHO	CONTRACTOR	TECHNICAL
12.0	FIRMER	CONTRACTOR	TECHNICAL
13.0	CONVERT	CONTRACTOR	TECHNICAL
14.0	ZDA	REGULATOR	TECHNICAL
15.0	WORLD BANK GROUP – IFC	FINANCING	TECHNICAL
16.0	STANDARD CHARTERD BANK	FINANCING	COMMERCIAL
17.0	ZESCO	OFF-TAKER (PPA)	COMMERCIAL
18.0	MINISTRY OF FINANCE	GUARANTOR	ECONOMICS
19.0	MINISTRY OF COMMERCE	POLICY	TECHNICAL

3.2.2.2 Interviews

Interviews were conducted after the questionnaire surveys with the aid of an interview guide (Appendix II). The interviews were aimed at validating the data obtained from the questionnaire survey and to obtain in depth information about the study. As such, the sample was restricted to 7 participants who were selected to ensure that various viewpoints of key stakeholders on the Ngonye project were incorporated.

The interviews were targeted at professionals who played a role in the Ngonye project ranging from the Policy maker, the Lender, the Developer/Investor and the Off-taker. The professionals interviewed had reasonable experience in the renewable energy subsector and were subject matter experts in their respective organisations. The interviews were conducted in person and recorded and on phone for interviewees who could not be reached. Thereafter, the audio interviews were transcribed into word format for ease of qualitative data analysis.

Further, in order to obtain in depth insights, the interviews were conducted in an exploratory manner in which the interviewee was allowed to dominate the interview and the questions asked were not restricted to the interview guide.

3.2.3 Data Analysis

The total number of questionnaires distributed was 21 but only 17 (81%) were received. The remaining 4 (19%) questionnaires were not received at the time of data analysis. Further, structured interviews were conducted to source additional qualitative data as described in the research methodology. This was necessitated so as to gain an in depth understanding of risks and challenges associated with the case under review. The interviews were targeted at 7 key stakeholders but only 6 (85%) key stakeholders were successfully interviewed. The remaining 1 (15%) interview was not successfully conducted at the time of data analysis.

The key stakeholders that were interviewed included one (1) participant from the lender/financier, three (3) participants from the Off-taker, one (1) participant from the Developer and one (1) participant from the Policy Maker. All the participants that were interviewed were experts in their respective fields and played a particular role in the project development process.

Quantitative data collected from the questionnaire survey was analysed using descriptive statistical techniques. An advanced and accurate analysis method was needed to arrange the large body of data in a systematic, fast and reliable way. For this purpose the computer software Statistical Package for Social Science (SPSS, version 16.0) and Ms Excel were chosen as the best options available.

Quantitative data analysis consisted of examining, categorizing, tabulating and recombining evidences to address the research questions. Further, quantitative data was analyzed through the use of statistical techniques such as frequency counts, percentages, pie charts and tabulation to show differences in frequencies. Descriptive statistics for all evaluation indicators was calculated as required using cross-tabulations between variables of interest. Bar charts were used to display nominal or ordinal data.

Qualitative data collected from the questionnaire survey and interviews was presented descriptively through the use of responses from the questionnaires and the interviews. Furthermore, according to Mugenda (2003) data obtained from the field in raw form is difficult to interpret unless it is cleaned, coded and analyzed. In this regard, qualitative data was grouped into meaningful patterns and themes that were observed to help in the summarizing and organization of the data. This approach involved breaking the data down into component parts (words, phrases, sentences), which were given standard codes, and then assessed as patterns. In order to organize data in this manner, computer software N-Vivo was used to code in-depth interviews. Thereafter, qualitative verbatim was pasted in the final report in order to triangulate the findings of the quantitative survey.

In order to address the specific objectives of the study, the questionnaire and interview guide was designed to answer the research questions. This was done as follows:

3.2.3.1 Specific Objective One - To characterize the risk profile and de-risking strategy

Stakeholder Capacity: The researcher identified stakeholder competency and capacity as a major determinant of project success, hence being a de-risking strategy in one way.

Firstly, respondents were probed on various aspects relating to their institutional capacity and competencies, such as; Years of Experience in Solar PV Projects, Area of specialization in the utility scale solar PV project, stage of participation in project development, organization’s project team size, skill set of the project team members, and relevant trainings provided for the project team.

Risk Awareness: The respondents were further probed on awareness of various risks associated with Solar PV project development. The researcher extracted these risks from literature review (Figure 1.3). Respondents were probed to state whether or not they were aware of the following risks: Activity Planning Risk, Technological Risk, Construction Risk, Operational Risk, Supply (Solar Resource) Risk, Market Risk, Interest Rate Risk, Exchange Rate Risk, Inflation Rate, Environmental Risk, Legal/Regulatory Risk, Credit /Counterparty Risk. In this regard, the level of awareness of a particular risk was assumed to be correlational to the perception of the impact of risk.

Furthermore, respondents were probed to specify the respective de-risking/mitigation strategies that were implemented to address each identified risk or each risk that they were aware of.

Interview Guide: On the other hand, the interview guide also had questions that allowed respondents to further categorize the de-risking strategies. The respondents were probed on various aspects of organizational capacity and competency such as; relevant work experience in the Renewable Energy sector, their role in the scaling solar project, and stakeholder category.

Respondents were further asked to state the major risks and barriers that were identified in developing and investing in the renewable energy space, particularly in the utility scale solar PV projects. The respondents were then asked to list the top five risks for developing and investing in the renewable energy space in Zambia's energy sector.

3.2.3.2 Specific Objective Two - To assess the influence of the de-risking strategy on implementation timelines

Influence of De-risking Strategies on Identified Risk: In order to establish the factors that lead to project implementation delay, respondents were firstly asked to rate the influence of the de-risking strategies on the identified risks. A standard rating scale of 1 to 5 was used, with the following weights: (Not at all = 1; Almost not at all = 2; Neutral =3; Almost Completely =4; completely = 5).

This rating indicates the extent to which each respective de-risking strategy achieved its intended purpose, thus affecting project implementation.

Specifically, respondents were asked to rate the influence of the following aspects; impact of the EPC contractor on Activity Planning Risk; impact of Interconnection Agreement on project outcome; level of accuracy of the Solar Radiation Geometry report on available Solar resource; Influence and competency of EPC contractors and sub-contractors on power plant construction risks; Impact of O&M Agreement on project outcome; Impact of Power Purchase Agreement on project outcomes; Respective impact of the sensitivity analysis done on interest rate, exchange rate and inflation rate. In addition, respondents were also asked to rate the influence of the Environmental and Social Impact Assessment report on project outcome; Influence of ReFIT benchmark for Solar PV tariffs on project outcome; and also the extent to which the Letter of Credit (Payment Guarantee) and other related guarantees influenced investors and lenders comfort.

Moreover, respondents were further asked to rate the influence of various financial de-risking instruments such as; Influence of Public Loans on Solar power deployment; Influence of partial risk guarantees on solar power deployment, and the Influence of political risk guarantee on solar power deployment.

On the other hand, respondents were asked to rate the influence of the direct financial incentives that were implemented in the Ngonye project. These included; influence of the ReFIT on solar power deployment, influence of tax credit on solar power deployment, influence of electricity tariff hike on the Ngonye project. Finally, respondents were probed to provide verbatim on what the main factors that led to project implementation delay in the Ngonye scaling solar project were.

Interview Guide: The key informant respondents were probed to illustrate how they managed to mitigate against the identified risks, specifically related to leading edge utility scale solar PV power plants under implementation. Finally, respondents were required to highlight the major challenges encountered on the project.

3.2.3.3 Specific Objective Three - To establish other constraining factors that lead to project implementation delay

Duration taken to Implement De-risking Strategies: The Ngonye project was planned to be installed and commissioned within a specific timeframe. Various de-risking strategies were implemented at different stages of the project cycle to minimize on the impact of the identified risks. In order to assess the influence of the de-risking strategies on project timelines, respondents were asked to indicate the duration taken to implement each respective de-risking strategy. The following time scales for implementing each strategy were considered; (1-3 months; 3- 6 months; 6-9 months; 9-12 months; more than 12 months). Data arising from these duration estimates was triangulated with qualitative data to gauge whether the respective de-risking strategies was implemented within the expected time frame. Judgment was therefore made as to whether or not a particular de-risking strategy contributed to implementation delay.

The de-risking strategies for each respective duration range included; Engineering, Procurement and Construction agreement (EPC Contract), Grid Integration Agreement, Solar Radiation Geometry Report, Operation and Management Agreement, Power Purchase Agreement (PPA), Project Sensitivity Analysis (Interest, Inflation, Exchange Rates), Environmental Impact Assessment Report, REFiT benchmark tariff for Solar PV, Standard License, Letter of Credit (Payment Guarantee).

On the other hand, respondents were asked to state what factors contributed to the delayed implementation schedules between the Ngonye and West-Lunga solar projects, despite being commissioned at the same time.

Interview Guide: In order to establish the factors that influenced project implementation timelines, the key informant respondents were asked to state whether or not the scaling solar projects (Round one) were conducted within the stipulated timelines. Thereafter, respondents that indicated any timeline discrepancies were probed to share their reasons.

Descriptive Statistics

Measures of Central Tendency (Mean, Mode, Median, Standard Deviation): were used to analyze some of the study findings. The mean and the median are both measures of central tendency; they give an indication of the average value of distribution of figures (Cooper, 2001).

The mean is the arithmetic average of a group of scores; that is, the scores are added up and divided by the number of scores. The mean is sensitive to extreme scores when population samples are small (Chama, 2012).

According to (Mugenda, 2003), the median is the middle score in a list of scores; it is the point at which half the scores are above and half the scores are below. Medians are less sensitive to extreme scores and are probably a better indicator generally of where the middle of the class is achieving, especially for smaller sample sizes. Standard deviation (SD) is a widely used measurement of variability used in statistics. It shows how much variation there is from the average (mean). A low SD indicates that the data points tend to be close to the mean, whereas a high SD indicates that the data are spread out over a large range of values (Mweemba, 2015).

3.3 Limitations of the Study

This study should be considered with some limitations as it focused on the IFC funded utility scale solar PV project as a case study used to understand solar PV projects development at a national level. The findings might vary from other utility scale solar PV projects at national level in countries where solar generation has realized its full potential with regards to electricity generation. However, the basic principles certainly encompass all the main dynamics of utility scale solar PV project development. Off-grid solar power generation projects might have other challenges that are different from the ones highlighted in this study.

Furthermore, the suggested recommendations present casual relationships between the respective project challenges, project risks and de-risking strategies, and their impact on anticipated outcomes for future projects of similar scope.

Additionally, the project was the first of its kind and scale, to be implemented in Zambia. Hence this provided a limited sample size of respondents to interview on the study as it mainly focused on stakeholders that were directly involved in the Ngonye Scaling Solar project implementation.

3.4 Ethical Considerations

Questionnaires and interviews were accompanied by an ethical clearance letter to guarantee anonymity so that honest responses could be obtained.

3.4.1 Informed consent/Anonymity: The aim of the questionnaire survey and interviews was explained to all participants and if they agreed to participate they were asked to complete a written consent form. The information shared was treated with respect and confidentiality. Confidential consent and assent forms and interview audio recordings and transcripts will be kept for 12 months and then destroyed. Every participant was requested to consent to participate and no form of penalty was applied for refusing to participate or stopping participation during the discussions. Furthermore, the study accepted participants who wished not to disclose their personal identity and had their personal identity withheld from the study report.

3.4.2 Confidentiality/Privacy Protections: All study-related information has been stored securely and records that contain names or other personal identifiers, such as informed consent forms, have been stored securely in areas with access limited to study staff only. The audio recordings and transcripts from interviews have been kept securely. The researcher will be responsible for destroying the data appropriately.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

Chapter three discussed the research methodology adopted for this study to address the research objectives as set out in Chapter one by explaining the research approach, research design, research population, the sample, sampling process, and justification for choosing particular research methods. The areas discussed in chapter three are important as they provide the basis on which the findings of the research could be generalized and authenticated. This chapter presents the findings of the study which will assist in understanding the effects of de-risking strategies in the implementation of utility scale solar PV projects in Zambia.

4.2. Interpretation of Results

4.2.1 Quantitative Data Analysis

4.2.1.1 Technical Capacity of Project Team Members

The technical capacity of the various stakeholders engaged in the scaling solar round one project, was a vital element in evaluating the reliability and validity of the primary research data and aided in fully understanding the dynamics of project implementation. Stakeholder technical capacity was determined by a wide range of aspects such as; Years of experience in utility Scale Solar PV projects, stakeholder area of specialization, relevant personnel trainings, team size, and specific roles played on the project. This is shown in table 4.1.

Table 4.1: Years of Experience Working on the Development of Utility Scale Solar PV projects

Project Role	**Less than 5 Years**	**5 - 10 Years**	**More than 10 Years**	**Total**
Policy	0	1	0	1
Regulator	0	0	1	1
Advisory	0	0	1	1
Regulator – Energy	0	1	0	1
Regulator – Environmental	1	0	0	1
Developer	1	0	0	1
Land Lease	1	0	0	1
Local Authority	1	0	0	1
EPC Contractor/O&M	0	0	3	3
Contractor	0	2	1	3
Guarantor	1	0	0	1
Off-taker – PPA	1	1	0	2
Total	**6**	**5**	**6**	**17**

Majority of 11 out of 17 of the respondents on the study stated that their respective organizations had between 5 to 10 years' experience working on utility Scale Solar PV projects although most projects had not been implemented yet. This indicated that more than half the organizations engaged on the study had considerable hands on experience in utility scale solar PV projects. Implying that the research information provided was reliable to generalise the research findings. Similarly, table 4.2 depicts the specific areas of specialization for each organization engaged on the project.

Table 4.2: Areas of Specialization – Solar PV Project

Project Role	**Levels of specialization in the scaling solar project development**
Policy	Policy guidance on how the solar projects are to be implemented
Regulator- Investment	Investment endorsements
Advisory	Technical Advisory, Government Support (Incentives, Guarantees, Risk Management, M&E)
Regulator – Energy	Licensing process, Issuance of license waivers for solar equipment that was utilized during construction
Regulator – Environmental	Environmental management and regulations, EIA process
Developer	Procurement and Project Finance
Land Lease	Provision of land for the development of the project and other utility services such as water, power and drainage to the site
Local Authority	Planning Permit
EPC Contractor/O&M	Engineering, Procurement, Construction, Operation and Maintenance
Contractor	Plant Construction
Guarantor	Processed and executed the financing facility between the Government of the Republic of Zambia and the International Development Association.
Off-taker – PPA (R1)	Negotiations for the up take agreement (PPA) and allied documents, collaboration in evacuation studies, creation of Quality control standards.
Off-taker – PPA (R2)	Integration of solar PV projects to the grid, drafting of grid connection requirements, Power Purchase and Connection Agreement, and undertaking grid impact studies.

On the other hand, it was identified that the technical skill set of the respective project team members was a vital component for the required capacity if a desirable project output was to be attained.

Table 4.3: Project Technical Skills

Project Role	**Skill Set of Project Team**
Policy	Engineers and Economists
Advisory	Engineers (Electrical - 3, Mechanical - 1)
Regulator – Energy	Respondent did not give response
Regulator – Environmental	Engineers, Scientists, Social Scientists
Developer	Engineers, Economists, Environmentalists
Land Lease	Planners, Surveyors, Lawyers, Engineers, Environmentalists
Local Authority	Planners, Architects, Environmentalists, Lawyer, Technicians, Surveyors
EPC Contractor/O&M	Commercial Managers, Lawyers, Engineers, Environmentalists, Regulatory Experts, Social Scientists, BD, O&M, Safety Health
EPC Contractor/O&M	Project Manager, Project Engineer, Civil Supervisor, Electrical Supervisor, Mechanical Supervisor
EPC Contractor/O&M	Project Site Manager-Contractors, Quality Assurance, Engineers(Civil, Electrical, Geo-tech, Mechanical) Surveyors, Technicians, Accountants
Contractor	Commercial Managers, Project Managers, Technicians, Engineers
Contractor	Project Manager, Engineer, Technicians & Safety Officer
Contractor	Technicians, Engineers, and Project Managers
Regulator - Investment	Economist, Scientist, Business Admins.
Guarantor	Data Analysts, Financial Analysts, Project Appraisal
Off-taker PPA (R1)	Engineers from Transmission and Generation, Finance experts, Business analyst/ development, Legal experts.
Off-taker PPA (R2)	Transmission and Protection Engineers, Accountants, Economists, Environmentalists and Social scientists.

Requirements such as team training and development were also identified as essential, in order to fully understand the competency levels of the project team members engaged on the project. Table 4.4 depicts whether or not the respondents on the study as well as other team members, had specific trainings relevant to the project.

Table 4.4: Project Specific Skills Training

Project Role	Project Team Specific Training
Policy	Investment Facilitation
Regulator - Investment	No Response
Advisory	No formal training. The Engineering was based on pre-engineering to customers specifications and requirements
Regulator - Energy	Project Management, Business Development, Construction Management, Regulatory Frameworks, Environmental and Social Analysis
Regulator – Environmental	No specific training, however, officers are trained in environmental management
Developer	Project team already had required skills, lucking skills were sub-contracted. The project was intended to resolve a crisis, so skilled personnel were identified way ahead
Land Lease	No training & it was not required
Local Authority	No Response
EPC Contractor/O&M	General training was provided to technician-on circuit reading , wiring, operators, Engineers were trained to align into PV plant configuration; Project Management, Renewable Energy Resources, Integration of Renewable Energy on grid, Policy Formulation; Connection of motor and control box, installation of structures and solar panels
Contractor	Operation of inverters & cable connections
Guarantor	The team were already trained and equipped with skills relevant for project evaluation. In addition, the respondent indicated that there is a section that deals with project development.
Off-taker PPA (R1)	No Response
Off-taker PPA (R2)	Specialized training was done in-house by outsourced experts at local training centers and abroad. Study tour for solar PV power plants was undertaken abroad.

4.3.2 Risk Awareness Profile

The risk awareness percentage distribution on the Ngonye scaling solar project is shown in figure 4.1. The risk that had the highest awareness level as identified by respondents was exchange rate risk at 64 percent. Interest rate risk and construction risk had the second highest risk awareness level at 57 percent each respectively.

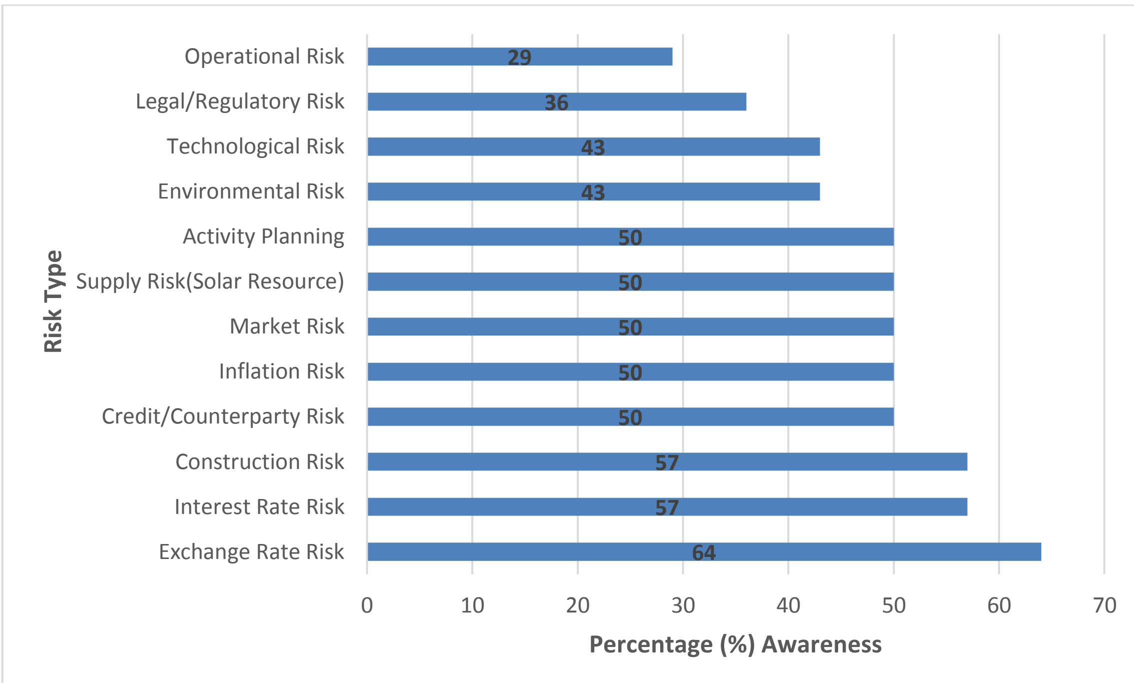

Figure 4.1: Risks awareness profile for the Scaling Solar program

The risk awareness percentage distribution on the Ngonye scaling solar project is shown in figure 4.1. The risk that had the highest awareness level as identified by respondents was exchange rate risk at 64 percent. Interest rate risk and construction risk had the second highest risk awareness level at 57 percent each respectively. Furthermore, other risks that had an awareness level of 50 percent included; Credit/Counterparty Risk, Inflation rate risk, Market risk, Supply Risk, and Activity planning risk. The risks with the lowest awareness levels included: Operational risks and Legal/Regulatory risks at 29 and percent each respectively. Furthermore, the study recorded a number of missing responses from respondents. This is depicted in table 4.5.

Table 4.5: Missing Responses for Identifying Risk Awareness Levels

Risks	YES	NO	MISSING
Activity Planning	7	5	5
Technological	6	5	6
Construction	8	4	5
Supply	7	4	6
Market	7	6	4
Interest Rate	8	4	5
Exchange Rate	9	3	5
Inflation	7	3	7
Environmental	6	5	6
Legal/Regulatory	5	6	6
Credit/Counterparty	7	5	5

According to Table 4.5 the highest missing response rate of 7 out of 17 respondents was experienced with regards to Inflation rate risk, while the lowest missing responses were identified for market risks at 4 out of 17 respondents respectively. Other risks that recorded a low missing response included; the activity planning, construction risk, interest rate risk, exchange rate risk, and credit/counterparty risk each recording 5 missing responses respectively.

4.3.3 Strategies that have been employed to mitigate the identified risks

There were various strategies that were employed to mitigate the identified risks as indicated by various respondents. According to respondents, the following strategies were employed to mitigate various risks.

i. Policy Maker:

- **a.** Activity Planning Risk: "*To adequately plan for all aspects before commencement of the project; well-designed long term strategy, government programs to diversify the national energy mix; the permit process was easily facilitated by government*".

ii. Advisory:

- **a.** Technological Risk**:** *"Procurement of tested equipment/power technology"*.
- **b.** Construction Risk: "*Was allocated to EPC contractor*".

c. Market Risk: "*A 25 year, Power Purchase Agreement (PPA) was secured with the off-taker*".

d. Interest Rate Risk: "*Private sector takes the risk*".

e. Inflation and Exchange Rate Risk: "*Hedging funds*".

f. Environmental Risk: "*Environmental and Social Impact Assessment (ESIA) was done by consultants approved by ZEMA*".

g. Regulatory and Legal Risk: "*Investment endorsement during development stage*".

h. Credit/Counterparty Risk: "*Guarantees from government/World Bank was secured*".

iii. Energy Regulator:

a. Regulatory and Legal Risk: "*Investment and Endorsement audits, issuance of license waivers for solar equipment that was utilized during construction*".

b. Environmental Risk: "*Implementation of ESIA process*".

iv. Environmental Regulator:

a. Environmental Risk: "*Implementation of environmental regulations and environmental impact assessments*".

v. Developer:

a. Construction Risk: "*Insurance was taken by the EPC contractor*".

b. Market, Interest rate and Exchange rate Risk: "*Hedging in place with IFC and Partial Risk Guarantee supported by letter of credit*".

c. Regulatory/Legal Risk & Credit/Counterparty Risk: "*Was covered by the government support agreement and partial risk guarantee*".

vi. EPC / O&M Contractor (R1):

a. Technological Risk: "*Failure rate above 15% was to be passed on to the manufacturer to replace the whole asset at no cost*".

b. Construction: "*EPC contract provision to claim liquidated damages from contract for breach*".

c. Supply Risk: "*Trading system to optimize resource*".

d. Market Risk: "*25 years PPA with off-taker to lock market*".

e. Interest Risk: "*locked margin above labor to debt*".

f. Exchange Risk: "*Dollar based PPA*".

g. Regulation/Legal: "*GRZ/Off taker to take on risk of change in law*".

h. Credit Risk: "*Payout-security letter of credit, Government Guarantee, Partial Risk Guarantee was secured*".

vii. EPC / O&M Contractor (R2):

a. Activity Planning Risk: "*Ensuring that all logistics are closely monitored and recovery plans are implemented where need be. Ensuring that program of works is revised as frequently as possible to give a clear status of activities on site*".

b. Technological Risk: "*Resource monitoring tools to give a clear picture on the availability of the solar resource in that given region*".

c. Construction Risk: "*Ensure that a proper performance ratio study is done prior to construction work*".

d. Environmental Risk: "*ESIA to be done to mitigate risk to the environment caused by the clearing of vegetation for construction and displacement of wildlife*".

viii. EPC / O&M Contractor (R3):

a. Activity Planning Risk: "*Well studied feasibilities, project schedules - start in April/May and end in September(Dry Season); To ensure local manpower is developed, Procurement of materials should be processed before commencement of land clearing*".

b. Construction Risk: "*Manual method engaged to plant piles due to Non-availability of technology, right use of machinery*".

ix. Contractor:

a. Activity Planning Risk: "*Past experience in renewable energy projects to accurately plan and execute; understanding of the permit process and allocating more time towards customs clearance and staff training*".

b. Technological Risk: "*Local sub-contractors require regular additional training*"

c. Construction Risk: "*The Engineering was based on pre-engineering to customers' specifications and Bill of quantities (BOQ)*".

x. Investment Regulator:

a. Activity Planning Risk: "*Was transparent and monitored the project from inception*".

b. Technological Risk: "*Product must be of quality and must have been used in other countries*".

c. Regulatory/Legal: "*Issued investment license and Investment Promotion Protection Agreement (IPPA)*".

4.3.4 Impact of mitigation strategies on identified risks

In order to ascertain whether the concerned project stakeholders addressed the identified risks and mitigation strategies thereof, specific questions were asked to assess the impact of each respective de-risking strategy on various identified project risks. This was done in order to investigate the effectiveness of the employed strategies on the various identified project risks.

Respondents on the study were probed to rate the impact of the de-risking strategy ranging on a scale of 1 to 5, with 1 indicating 'Not at all' while 5 indicated 'Completely'. The meaning of each score rating used for analysis purposes is described as follows; 1 – Not at all; 2 – Almost Not at All; 3 – Neutral; 4 – Almost Completely; and 5 – Completely (Appendix I).

The Mean score was calculated for each respective de-risking strategy rating, and ranked in ascending order. The de-risking strategy with a lower mean score indicated a low impact on identified risk, while a de-risking strategy with a higher mean score indicated a higher impact of the de-risking strategy on project risk. The results are shown in Table 4.6. The table also depicts the inferential statistical analysis regarding the impact of various de-risking strategies, on project outcome. The various statistics measured included the total respondent responses, the mean score, and the standard deviation for each respective de-risking strategy.

Table 4.6: Impact of Mitigation Strategies on Identified Risks

De-risking strategy Outcome	Responses	Mean Score	Standard Deviation
1. To what extent did the Operation and Maintenance Agreement yield favorable outcomes?	12	3.5	1.168
2. Did the sensitivity analysis conducted on inflation rate accurately impact the project?	12	3.58	0.793
3. Did the sensitivity analysis conducted on interest rate accurately impact the project?	12	3.67	0.985
4. To what extent did the Engineering Procurement and Construction Contractor adequately address the activity planning risk?	12	3.92	0.996
5. Did the sensitivity analysis conducted on exchange rate accurately impact the project?	12	3.92	0.9
6. Did the Solar Radiation Geometry report provide accurate estimates regarding available solar radiation resource?	12	4.083	0.793
7. To what extent did the Power Purchase Agreement yield favorable outcomes?	13	4.15	0.899
8. Did the REFiT benchmark for solar PV tariff yield the expected positive outcomes?	11	4.18	1.471
9. Did the Environmental risk assessment report accurately depict the situation on the ground?	14	4.36	0.842
10. To what extent did the Letter of Credit (Payment Guarantee) and other related guarantees influence investors and lenders comfort?	11	4.36	0.924
11. To what extent did the Interconnection Agreement yield favorable outcomes?	11	4.36	0.924
12. Did the Engineering, Procurement and Construction contractor and other sub-contractors exhibit full competencies during PV power plant construction?	12	4.42	0.669

According to table 4.6, the respondents' overall perception on the impact of the mitigation strategies on identified risks shows that 'Operation and Maintenance Agreement' resulted into the lowest Mean score rating of 3.5 slightly above a neutral impact implying that the strategy did not impact project outcome; while the 'EPC contract' showed the highest Mean score of 4.42 implying that the strategy significantly impacted project outcome.

4.3.4.1 Impact of EPC Contract on Activity Planning Risk

However, another point noted was that the sample distribution per respondent category was unevenly distributed due to the purposive sampling approach implemented on the study. A further breakdown of the impact of a specific de-risking strategy on the identified project risk by stakeholder is shown in the following section.

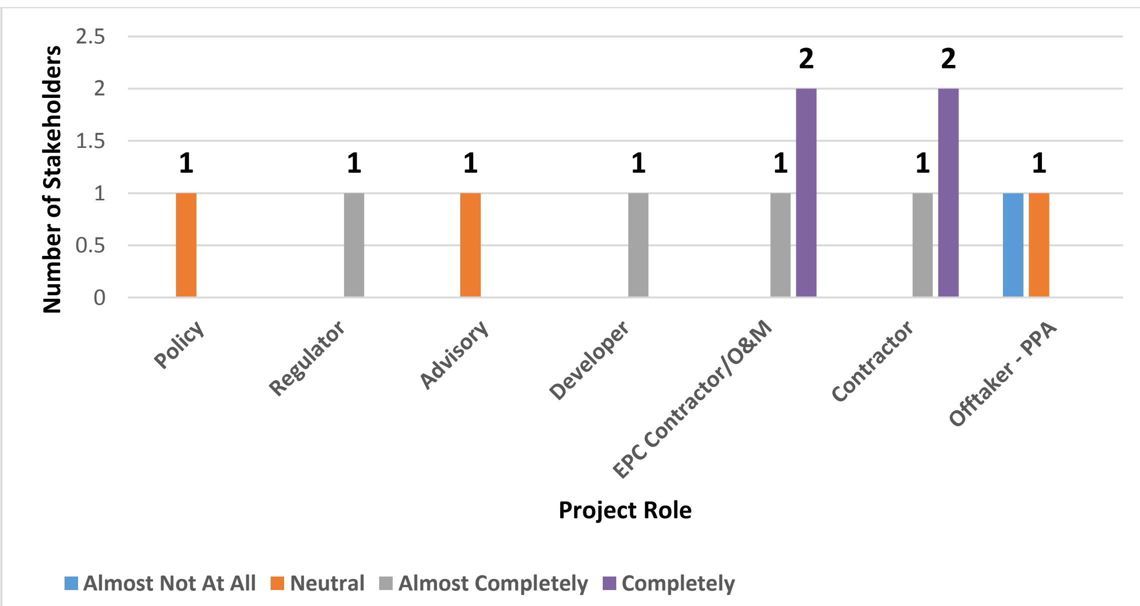

Figure 4. 2: Impact of EPC Contract on Activity Planning Risk

Respondents were asked to indicate the extent to which the EPC contractor adequately addressed the activity planning risks. Out of 12 respondents 4 (2 contractors and 2 EPC contractor respondents) stated that the EPC contractor completely addressed the activity planning risk, while 4 out of the 12 respondents stated that the EPC contractor almost completely addressed the activity planning risk. A minor 3 respondents were neutral with regards to the above aspect, while 1 respondent (Off-taker) stated that the EPC contractor almost not at all addressed the activity planning risk.

4.3.4.2 Impact of Interconnection Agreement on Project outcome

According to figure 4.3, respondents were asked to indicate whether or not the interconnection agreement yielded favorable project outcomes. 4 out of the 12 responses stated that the interconnection agreement completely yielded favorable outcomes, while 5 out of the 12 responses stated that it almost completely yielded favorable outcomes.

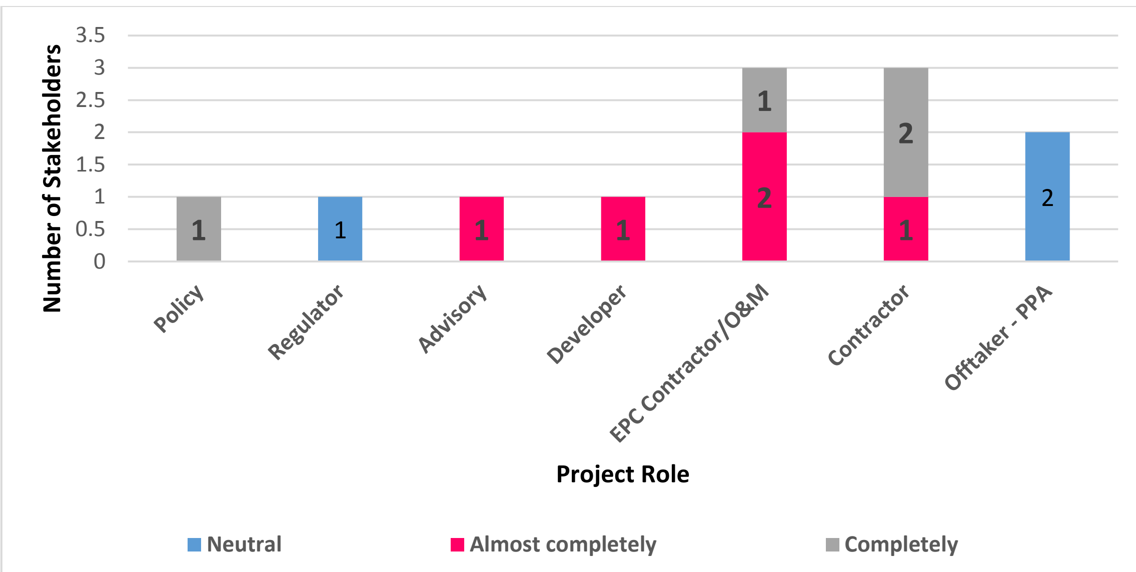

Figure 4.3: Impact of Interconnection Agreement on Project outcome

4.3.4.3 Competency of EPC contractor and Subcontractors on Power Plant Construction

According to figure 4.4, a majority 6 out of 11 responses stated that the EPC contractor and other sub-contractors ‘completely exhibited full competencies during the solar PV power plant construction, while 5 out of the 11 responses stated that EPC contractor and sub-contractors, almost completely exhibited full competencies.

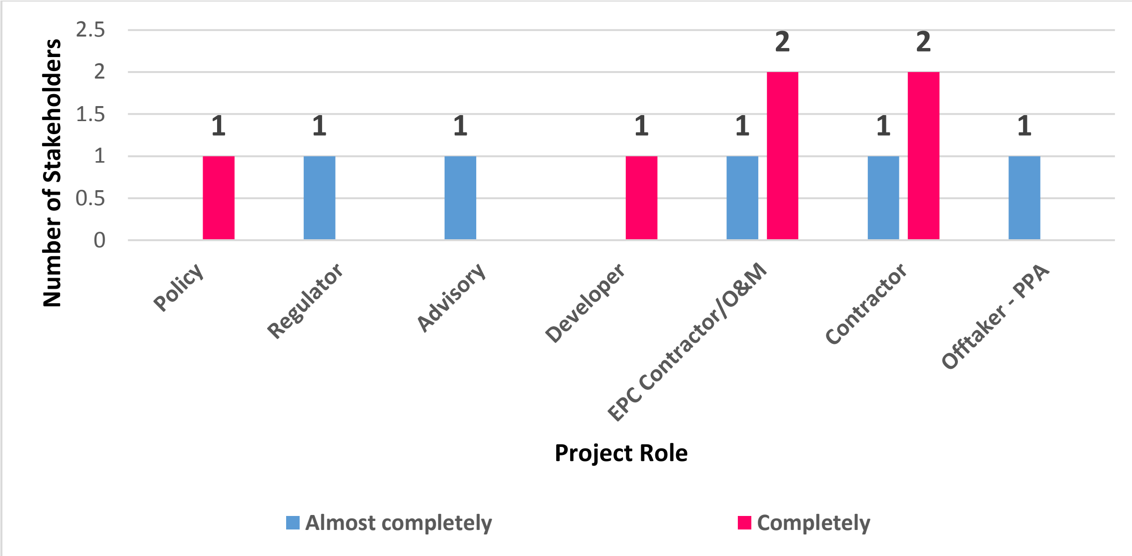

Figure 4.4: Competency of EPC contractor and subcontractors on PV Power Plant Construction

4.3.4.4 Impact of Operation and Maintenance Agreement

According to figure 4.5, out of the 12 respondents 6 stated that they were neutral with regards to the outcome of the Operation and Maintenance agreement. However, 3 out of the 12 responses stated that the O&M agreement completely yielded favorable outcomes. On the other hand, only 1 respondent stated that the O&M agreement did not at all yield any favorable outcomes.

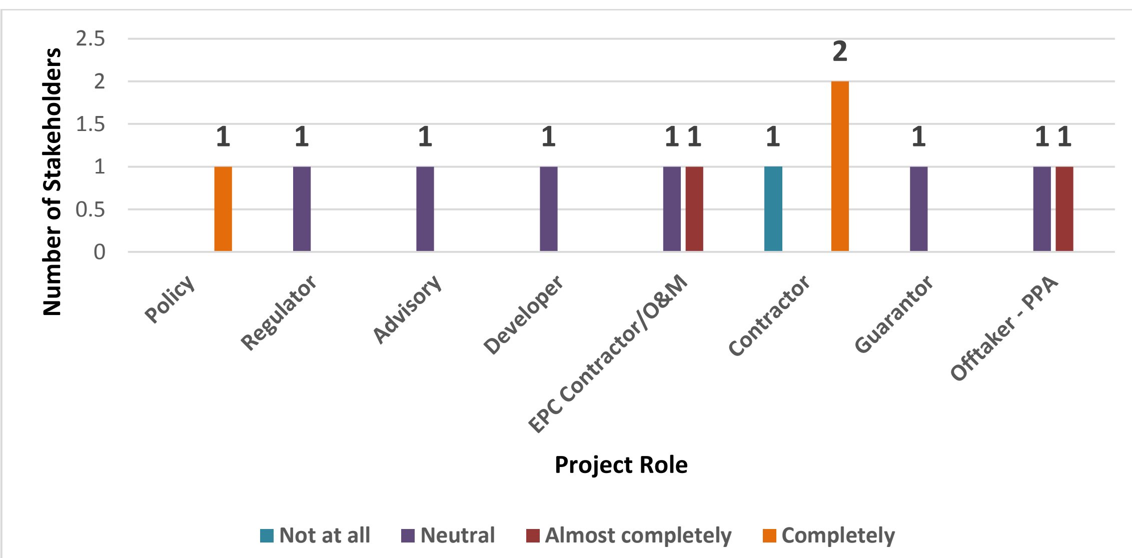

Figure 4.5: Impact of Operation and Maintenance Agreement

4.3.4.5 Impact of the Power Purchase Agreement on Project Implementation

According to Figure 4.6, out of 13 responses 6 stated that the Power Purchase Agreement completely yielded favorable outcomes, while a minor 3 respondents stated that it almost completely yielded favorable outcomes. On the other hand 4 respondents were neutral about the aspect.

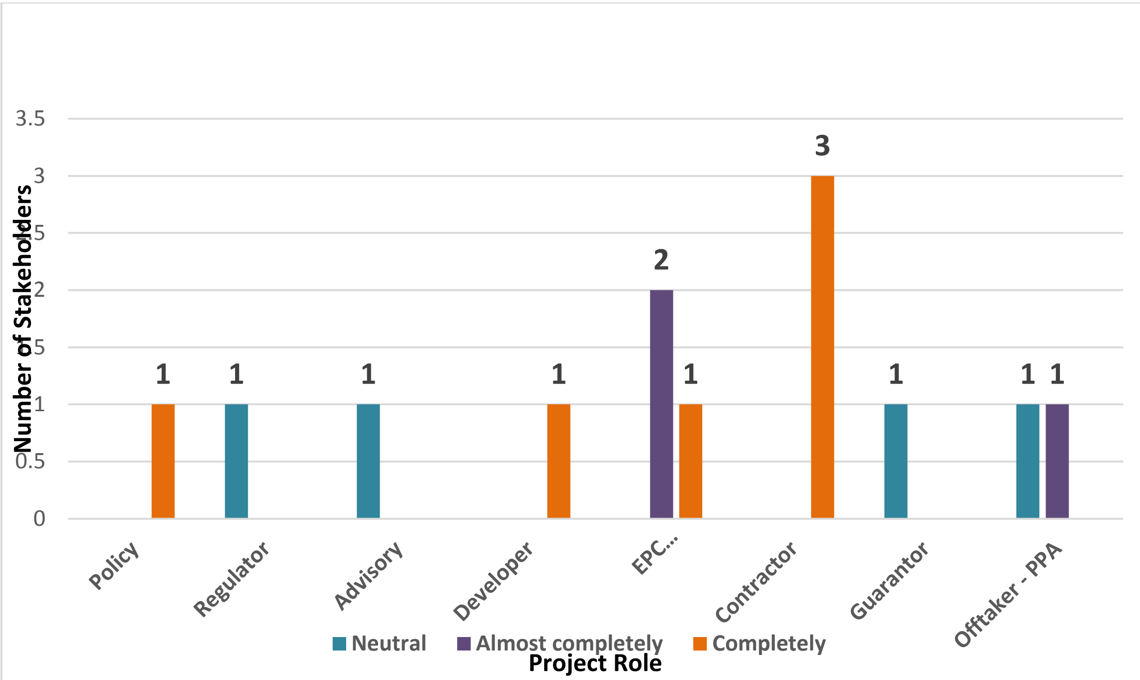

Figure 4.6: Impact of the Power Purchase Agreement on project implementation

4.3.4.6 Impact of Interest Rate on Project Financial Sensitivity

Respondents were asked whether the sensitivity analysis conducted on interest rate positively impacted the project. According to figure 4.7, a minority of 3 out of 12 responses stated that the sensitivity analysis provided accurate estimates of the impact of interest rates on the project, while another 5 respondents stated that they were neutral.

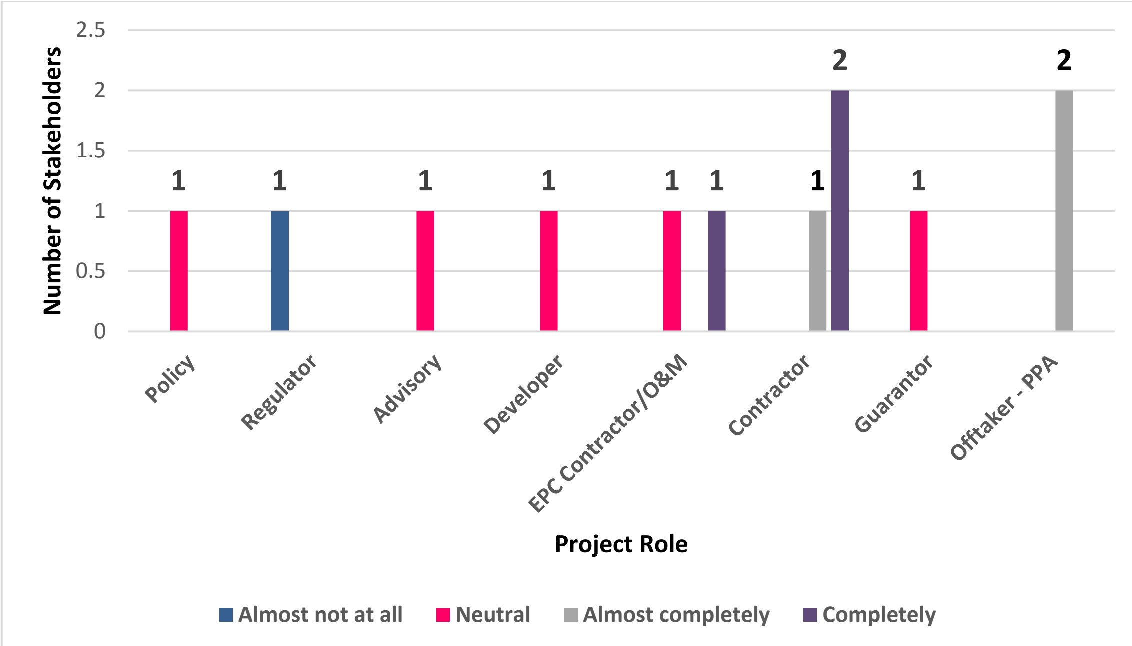

Figure 4.7: Impact of Interest Rate on Project Financial Sensitivity

4.3.4.7 Impact of Inflation Rate on Project Financial Sensitivity

According to figure 4.8, a majority of 7 out of the 12 respondents stated that they were neutral about the aforementioned aspect, while a minor 2 out of 12 respondents stated that the sensitivity analysis conducted on inflation rate accurately depicted that the project financial returns were positive.

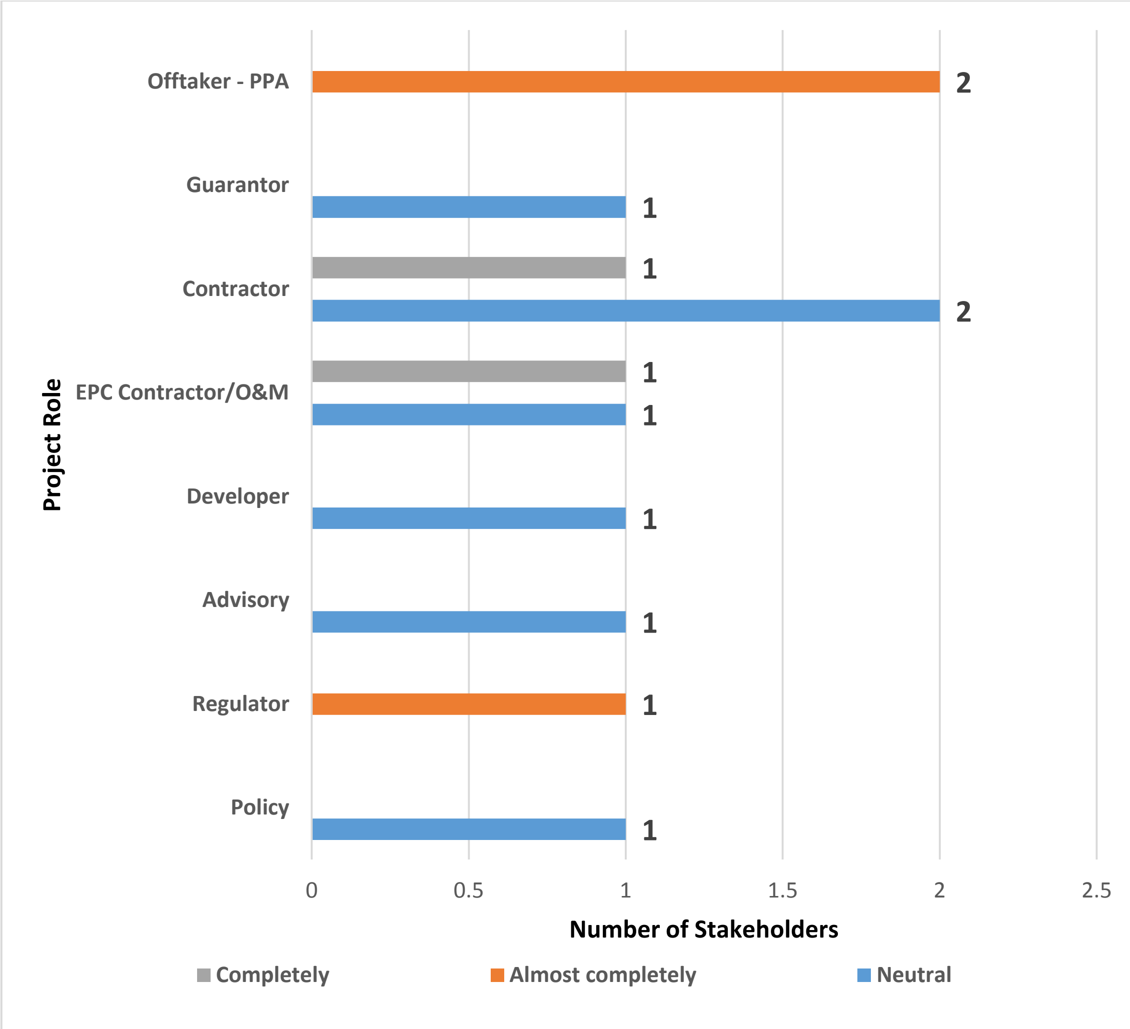

Figure 4.8: Impact of Inflation Rate on Project Financial Sensitivity

4.3.4.8 Impact of Exchange Rate on Project Financial Sensitivity

According to figure 4.9, out of 12 respondents 4 stated that the sensitivity analysis conducted on exchange rate completely depicted positive project financial returns, while another 5 out of 12 respondents were neutral. Only 3 respondents stated that sensitivity analysis conducted on exchange rates almost completely depicted positive project financial returns.

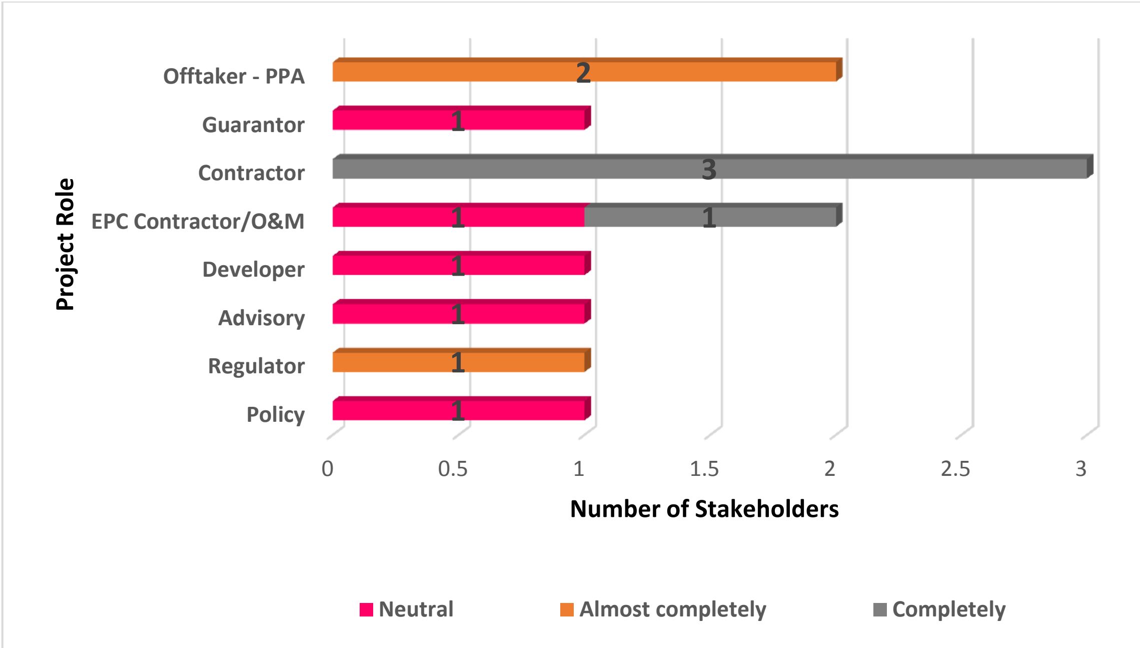

Figure 4.9: Impact of Exchange Rate on Project Financial Sensitivity

4.3.4.9 Impact of the Environmental and Social Impact Assessment Report (ESIA)

According to figure 4.10, a majority 8 out of 14 respondents stated that the ESIA report completely addressed the identified environmental risks and mitigation strategies thereof, while only 3 respondents stated that this aspect almost completely addressed the environmental risks. On the other hand, 3 respondents were neutral about the aspect.

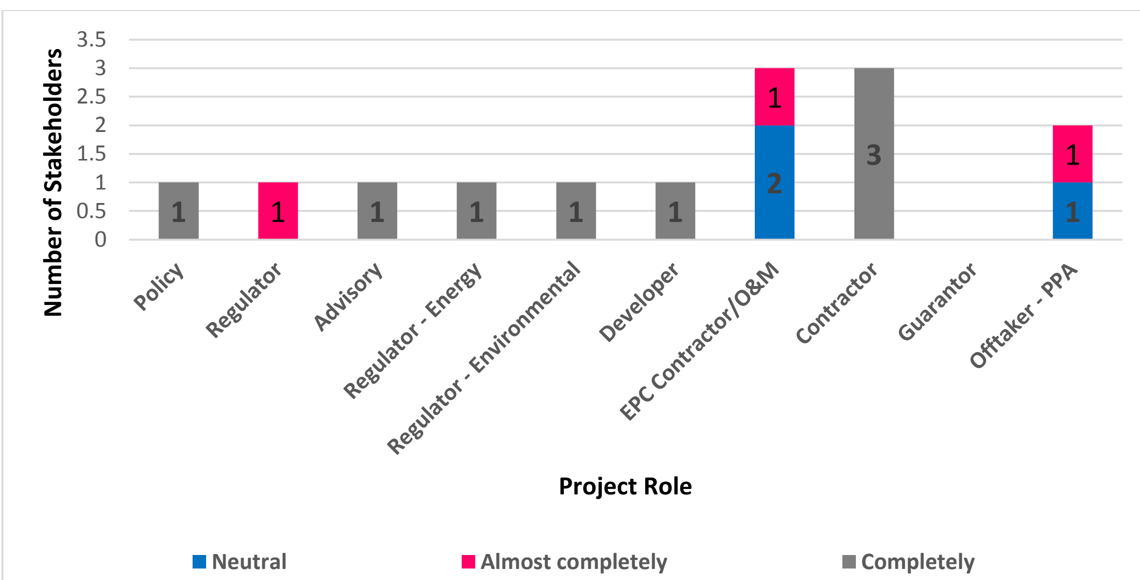

Figure 4.10: Impact of the Environmental and Social Impact Assessment Report

4.3.4.10 Impact of Payment Guarantee (LC) on Investors and lenders Comfort

According to figure 4.11, a majority threshold of 7 out of 11 respondents stated that the Payment Guarantee (Letter of Credit) and the Partial Risk Guarantee (PRG), positively influenced investors and lenders comfort, while only 3 respondents were neutral about the aspect.

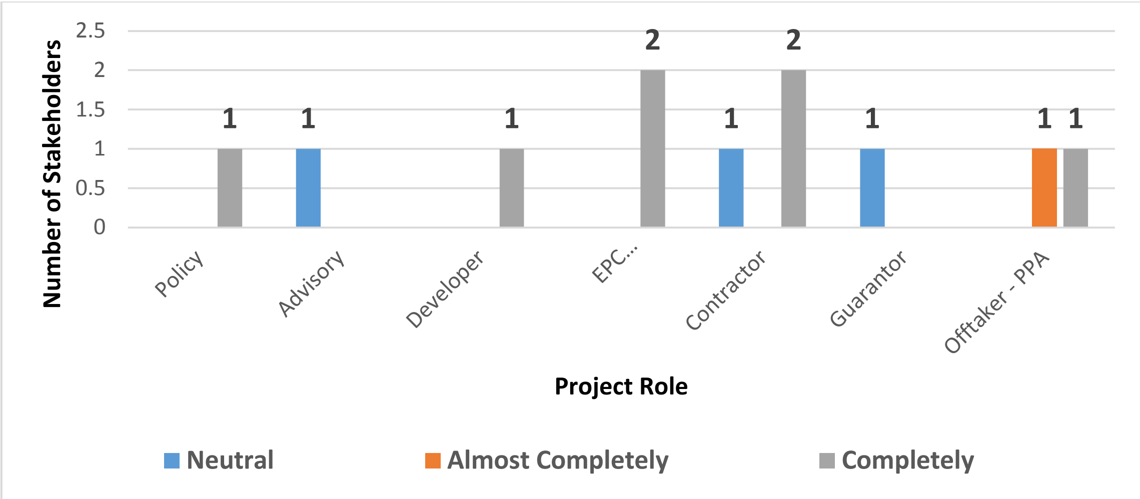

Figure 4.11 Impact of Payment Guarantee (LC) on Investors and lenders Comfort

4.3.6 Effect of the De-Risking Strategy on Project Implementation Timeline

The following tables indicate the estimated duration taken to implement each of the respective de-risking strategies/risk mitigation measures throughout the project life cycle. In most cases, the duration was identified using the 'Mode Score', and in other cases where there where more than one mode score, the 'Median Score' was used to determine the average duration for effecting each respective de-risking strategy. This measurement of duration however was triangulated with qualitative findings to generalise the findings.

The following tables depict the results of respective durations for implementing each respective de-risking strategy.

Table 4.7: Duration to secure EPC Contract De-risking Strategy

Strategy	1 - 3 months	3 - 6 months	6 - 9 months	9 - 12 months
Policy	0	0	0	1
Developer	1	0	0	0
EPC Contractor/O&M	0	0	1	0
Contractor	1	1	1	0
Total	**2**	**1**	**2**	**1**

Respondents on the study were asked to indicate an approximate duration to implement the EPC contract de-risking strategy. According to table 4.7, the median statistics indicates a range of 3-6 months as the duration taken to conclude the EPC contract.

Table 4.8 Duration to conclude Solar Radiation Geometry Report De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months
Policy	1	0	0
Developer	0	0	1
EPC Contractor/O&M	2	0	0
Contractor	1	1	1
Total	**4**	**1**	**2**

According to table 4.8, the mode statistics showed that the respondents with the highest frequency of response indicated that the Solar Radiation Geometry report took a duration of 1 -3 months to be completed.

Table 4.9: Duration to conclude Grid Integration Agreement De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months	More than 12 months
Policy	0	0	0	1
Developer	1	0	0	0
EPC Contractor/O&M	0	1	0	0
Off taker - PPA	0	0	1	0
Contractor	0	1	1	1
Total	**1**	**2**	**2**	**2**

Table 4.9 indicates that the median number of respondents stated that the Grid Integration Agreement which is part of the Power Purchase Agreement took 6 -9 months to be concluded.

Table 4.10: Duration to conclude O&M Agreement De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months	More than 12 months
Policy	0	0	0	1
Developer	1	0	0	0
EPC Contractor/O&M	1	0	0	0
Contractor	0	1	1	0
Total	**2**	**1**	**1**	**1**

Table 4.10 indicates that the median number of respondents stated that the Operation and Maintenance (O&M) Agreement took 3 -6 months to be concluded.

Table 4.11: Duration to conclude the Power Purchase Agreement De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months	More than 12 months
Policy	0	0	0	1
Developer	1	0	0	0
EPC Contractor/O&M	1	1	0	0
Guarantor	2	1	0	1
Off taker - PPA	0	0	1	0
Contractor	0	1	1	0
Total	**4**	**3**	**2**	**2**

According to Table 4.11, the median number of months that was taken to conclude the Power Purchase Agreement was 3 – 6 months.

Table 4.12: Duration to conclude the Project Sensitivity Analysis De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months	More than 12 months
Policy	0	0	0	1
Developer	0	1	0	0
EPC Contractor/O&M	1	1	0	0
Guarantor	0	1	0	0
Contractor	1	1	1	0
Total	**2**	**4**	**1**	**1**

According to Table 4.12, the median number of months that was taken to conclude the Project Sensitivity analysis was 3 – 6 months.

Table 4.13: Duration to conclude the ESIA Report De-risking Strategy

Stakeholder	1 – 3 months	3 – 6 months	6 – 9 months	More than 12 months
Policy	0	0	0	1
Regulator – Environmental	0	1	0	0
Developer	1	0	0	0
EPC Contractor/O&M	1	1	0	0
Contractor	1	1	1	0
Total	**3**	**3**	**1**	**1**

According to Table 4.13, the median number of months indicated that it took 3 – 6 months to conclude the ESIA report.

Table 4.14: Duration to secure Standard License/Endorsement De-risking Strategy

Stakeholder	1 – 3 months	3 – 6 months	6 – 9 months
Policy	1	0	0
EPC Contractor/O&M	2	0	0
Contractor	0	1	1
Total	**3**	**1**	**1**

According to Table 4.14, the mode number of months indicated that it took 1 – 3 months to secure the standard license / endorsement approvals from the regulators.

Table 4.15: Duration to secure ZESCO Payment Guarantee De-risking Strategy

Stakeholder	1 - 3 months	3 - 6 months	6 - 9 months	More than 12 months
Policy	0	0	0	1
Regulator	1	0	0	0
Developer	0	1	0	0
EPC Contractor/O&M	1	1	0	0
Contractor	0	1	1	0
Total	**2**	**3**	**1**	**1**

According to table 4.15, the median number of months indicates that it took 3 – 6 months to secure the Letter of Credit - ZESCO Payment Guarantee.

Table 4.16: Impact of Scaling Solar Program Design on Project Timelines

Stakeholder	Not at all	Almost not at all	Neutral	Almost completely	Completely
Policy	0	0	0	0	1
Regulator	1	0	0	0	0
Advisory	0	1	0	0	0
Developer	0	0	0	1	0
Local Authority	0	0	0	0	1
EPC Contractor/O&M	0	0	1	2	0
Off-taker - PPA	0	1	0	1	0
Contractor	0	0	0	1	2
Total	**1**	**2**	**1**	**5**	**4**

Furthermore, respondents on the study were asked to rate the impact of specific policy de-risking strategies on project implementation timelines. In particular, respondents were asked to rate whether the long term Scaling Solar programs are well designed and attainable. Table 4.16 shows that 4 out of the 13 respondents stated that it was completely well designed and attainable, while 5 out of 13 respondents stated that it was almost completely well designed and attainable.

Table 4.17: Impact of Scaling Solar Permitting Process on Project Timelines

Strategy	Neutral	Almost completely	Completely
Policy	0	0	1
Regulator	0	1	0
Advisory	0	1	0
Regulator - Energy	0	0	0
Regulator - Environmental	1	0	0
Developer	0	1	0
Land Lease	0	0	0
Local Authority	0	0	1
EPC Contractor/O&M	2	1	0
Off taker - PPA	1	1	0
Contractor	2	0	1
Total	**6**	**5**	**3**

Similarly, the respondents on the study were also asked to rate the impact of the permitting process on project timelines. Table 4.17 shows that 6 out of 14 respondents stated that the impact of the permitting process was neutral, while 5 out of 14 respondents stated that the permit process was almost completely facilitated. An additional 3 respondents stated that the permitting process completely facilitated the developers and other stakeholders.

4.3.7 Qualitative Data Analysis

In order to compliment and validate quantitative findings, data triangulation was performed for both data sets. This section depicts the qualitative findings in this regard. Qualitative interview transcripts were arranged in patterns of respective themes and sub-themes, aimed at addressing the various research objectives and research questions. The Analysis is depicted as follows:

4.3.7.1 Experience in the Renewable Energy (RE) sector

Among the objectives of the research was to establish the factors that lead to the Ngonye project implementation delay. As a result, the respective technical capacity of the project team members was identified as one of the critical success factors in addressing this objective. Hence, respondents were probed on their 'years of experience' working in the 'Renewable Energy sector'.

The following responses were obtained from each respondent with regards to establishing their technical capacity:

According to the first respondent (R1), Renewable Energy is a very new space and their involvement in the Scaling Solar project at both Ngonye and West Lunga projects, was more of a learning curve for them.

The second respondent (R2) stated that he had 10 years' experience cut across the electricity sub-sector, with a partial focus on renewable energy in particular small solar systems. Past specializations included; items such as lanterns and then also on hybrid mini grids, Solar Diesel Hybrids and Power planning around large solar.

The third respondent (R3) mentioned that he had 8 years hands on experience in the renewable energy sector with a specific focus on the commercial business development aspect. This mostly involved expanding the off-taker production, its generating base and also negotiating with the independent power producers (IPPs).

The fourth respondent (R4) stated that he had 11 to 12 years average years of experience in the energy sector, with a specialization in commercial and economic aspects.

The fifth respondent (R5) indicated that he had 7 years' experience working on renewable energy projects such as solar, geo-thermal and mini-hydro.

4.3.7.2 Respondents Role on the Scaling Solar PV Project

In addition to identifying the technical capacity of the various players on the project, respondents were requested to describe the role they played in the recent Scaling Solar Project in Zambia.

It was evident from the IFC Project Developers guide that specific entities would be required to implement specialized roles in the Scaling Solar project and these were as follows:

i. Off-taker

According to R1, their general role on the Scaling Solar project was to be the Off-taker to ensure uptake of electricity produced at the Solar Plants. To ensure this, the Off-taker also facilitated successful commissioning of the plant through provision of various forms of technical assistance to the developer via sharing of system information and data to aid plant design. Other sub-roles included the supply of power at construction site, facilitation of plant integration and connection agreements, and drafting of the Power Purchase Agreement (PPA).

On the other hand, according to R2, the major roles they played on the Scaling solar project included; negotiations with the Independent Power Producers; drawing up and negotiating agreements such as the PPA; Implementation Agreement and the government support agreement and drafting of the commercial document. In addition, there was need to constantly re-draft the standard documentation and agreements in order to suit the lenders desires, and to make it acceptable to both lenders and developers. According to the sixth respondent (R6), the main role of this stakeholder was to facilitate the integration the power plants onto the national grid, and also look into power transmission and any other grid issues that may arise.

ii. Guarantor

According to R2, this stakeholder basically played the role of a guarantor, by providing a partial risk guarantee to improve the bankability of the off-taker.

iii. Developer

According to R4, the main roles that they played included being the developer and sponsor.

iv. Policy Maker

According to R5, the roles they played included the provision of process guidance, technical understanding and advice, and program monitoring and evaluation.

4.3.7.3 Risk Identification

The first objective of this research was to characterize the de-risking strategy of the scaling solar project and in doing so, the first research question attempted to explore what risks were identified for the scaling solar program. Among the objectives of the interview was to address this question and as such the respondents were asked to state the top five risks for developing and investing in the renewable energy space.

It was clear from literature review that there were various risks inherent in the scaling solar program in Zambia and as such the interview responses were grouped in highlighting such risks specific to the Ngonye scaling solar project as follows:

A) Pre - Completion Phase Risks

These are risks that the project was exposed to during the project planning and development phase. It is considered important to identify such risks and put in place mitigation measures or de-risking strategies and as such respondents were interviewed to explore this category of risks and the employed de-risking strategies.

i. Activity Planning

According to R1, there will always be limitations because of the status of the current grid network and as such, an independent study was conducted to determine the uptake capacity of the grid. The study showed that the grid can take up to 900MW by the year 2020 and up to about 1200 MW by 2022 after some grid reinforcements have been done. Further, the respondent mentioned that plans are underway to conduct another independent study to verify those findings. It can therefore, be observed that the grid impact study conducted by the developer was mitigating the risk of grid uptake capacity by confirming that the grid could uptake the power to be produced from the scaling solar projects. On the other hand, R6 stated that the off-taker engaged a consultant, who had already conducted a study dealing with grid uptake capacity.

ii. Technological Risk

According to R3, severe risks such as deemed energy, force majeure and grid failure, were constantly debated upon, and how they will affect either the plant or the grid.

The developers insisted that these risks were to be taken up by the off-taker, thus contributing to unequal allocation of risks. According to R4, off-taker risks pointed to grid availability among the major risks identified. Additionally, R5 stated that there were limits to the amount of intermittent energy that could be introduced onto the grid. There was a risk of investing in a big solar plant that produces excess energy than required during the day, and does not produce at all at night. Further R5 indicated that intermittent energy had to be produced in tandem with non-intermittent energy such as hydro hence introducing a limit of the amount of solar energy that could be introduced into the power system.

Moreover, according to R6, the standard project documents were a risk in themselves in that the risk allocation, concerning events such as force majeure, were inequitably allocated, hence forcing the off-taker to fully take up such risks by paying for the deemed energy in the event of grid failure even though caused by natural calamities such as earth quakes. Further, R6 stated that there was also a risk arising from grid availability considered at 3600 hours in a year which could culminate into further penalties for deemed energy. R6 continued to add that, another risk identified on the project was integration into the already existing substation. The substation was already constructed and as such it was designed to have a single by-pass circuit. The statutory requirement for grid interconnection is a double by-pass circuit. Hence, this involved applying for exemptions/waivers from the energy regulator in order to avoid retrofitting.

iii. Construction Risk

According to R1, various events on the project culminated into identified construction risks, such as damaged cables during installations at plant site while some other cables were eaten by caterpillars, hence unfit for use. Similarly, according to R2, various materializing risks contributed to the construction risk on the solar project. For instance, land boundaries found on the construction site created delays in construction activities;

while on the other hand, the tedious ZRA exemption applications further delayed some construction works.

B) Post Implementation Phase Risks

i. Supply Risk:

According to R6, the off-taker commissioned a study in 2015/2016 to look at intermittent energy due to the fact that solar is intermittent in that at one point you may experience high radiation and at another point you may experience cloud cover, hence the resource may go down, causing fluctuations in power generation.

ii. Operational Risk:

R1 reiterated that Zambia didn't have the required human capacity in the utility scale solar sector, hence there was need to develop capacity very quickly.

iii. Market Risk:

According to R1, the imbalanced allocation of risks in the PPA was a major challenge as the risks were taken up by the off-taker in a hurried or rushed manner. In illustrating this, the respondent alluded to unexpected events such as force majeure and the unfair allocation of penalties towards the off-taker only. On the other hand, another major risk identified was the possibility to achieve low tariff rates less than USD 0.07/kwh as compared to the GETFiT projects (USD 0.04/Kwh) that were contracted after the scaling solar projects. This would deny the off-taker the opportunity to benefit from falling tariff rates arising from reducing technology costs because PPA were secured on a 25 year tenure. R5 added that there were a lot of incentives that were provided such as land for plant construction, in order to bring down the tariffs to the attained rate. If such incentives were not provided, the project would not have achieved a low tariff of USD 0.07/Kwh. On the contrary, R6 added that the biggest risk observed on the project was an event of ending up with a higher tariff that was non-cost reflective.

C) Risks common to both phases

i. Inflation Rate Risk:

R1 emphasized that inflation rate risk would eventually affect interest rates, thus affecting funding. Moreover, according to R2, macro-economic risks were one of the major risks identified on the scaling solar project.

ii. Exchange Rate Risk:

R1 stated that the fixing of off-taker payments strictly in United States Dollars (USD) currency fully exposed the off-taker to exchange rate risks while protecting the developer because the off-taker would constantly deal with the fluctuating 'Zambian Kwacha', as it is the standard currency of receivables for the Off-taker.

iii. Interest Rate Risk:

R1 emphasized that inflation rate risk would eventually affect interest rates, thus affecting loan repayments.

iv. Environmental Risk:

According to R4, the environmental risk was evident on the scaling solar project as issues of land surveys indicated presence of sinkholes on the construction site, with reference to earlier feasibility studies conducted.

v. Legal/Regulatory Risk:

According to R1, the lack of a policy framework that channels the passive cost of macro-economic fluctuations to the end-users, created a major risk for the off-taker. This is because the projected gains are eroded over time. On the other hand, R3 identified a risk in which the regulator may decide to blow up prices or to sale or make changes to the operations of the off-taker, hence impacting the project negatively. Furthermore, R4 added that there was the risk of dealing with the tedious license issuance process with the respective regulator which contributed to a delay in project timelines. Finally R6 stated that, risks arising from change in law, were supposed to be borne by the off-taker, specifically for items directly affecting the project.

4.3.7.4 Risk Mitigation Strategies

In order to further address the first specific objective of characterizing the de-risking strategies, the study delved further into the various de-risking strategies that were employed on the project. This involved probing respondents on whether they mitigated and managed the identified risks or any risks specifically related to utility scale solar PV power plants.

The following de-risking strategies were identified by respondents as having been implemented on the project:

i. Power Purchase Agreement (PPA):

According to R1, a PPA was among the various de-risking strategies that was used on the project. R3 added that, mitigation strategies involved the drawing up and negotiating of agreements such as the PPA. There was need to constantly re-draft the standard documentation and agreements in order to suit the lenders desires, and to make it acceptable to both lenders and developers. Similarly, according to R4, risk mitigation strategies were leveraged on the PPA, which provided for payment security through a letter of credit issued by the off-taker. R6 also added that, the project involved the use of various risk mitigation strategies through standard documents such as the PPA which incorporated an Interconnection Agreement.

ii. Partial Risk Guarantee:

According to R1, the Partial Risk Guarantee (PRG) was used as a fall back measure to providing repayment security needed by the project lenders. Moreover, according to R2, the scaling solar project finance structure acted as a mitigatory measure on its own such that, the private sector had some consultation on standard pre-work documents. Furthermore the World Bank was able to step in with a guarantee. According to R3, other risk mitigation strategies included drafting of commercial project documents, such as the PRG, which was basically a payment insurance provided for between the Guarantor and the Financier. Other similar agreements included the Implementation Agreement, and the government support agreement.

According to R4, the collaborative agreement between the Guarantor and the Lenders provided strong payment security for the project lenders. Similarly, respondent R5 mentioned that the PRG was a critical risk mitigation tool which provided comfort to the lenders.

Finally R6 also added that, the scaling solar de-risking strategy was primarily designed around the use of a Partial Risk Guarantee as a key mitigation strategy.

iii. Grid Interconnection Agreement:

Respondent R1 alluded to the implementation of a Grid Interconnection Agreement (GIA) to facilitate the process of the Solar PV Power plant integration onto the national grid. However the GIA was part of the PPA and stipulated all technical requirements for integrating the PV power plant onto the grid. According to R3, other mitigation strategies involved assessing historical statistical performance of grid availability in order to facilitate assessments for deemed energy penalty projections.

iv. Environmental and Social Impact Assessments:

R1 stated that the technical feasibility study referred to as the Environmental and Social Impact Assessment report (ESIA) was carried out in order to identify the various environmental issues and propose how to mitigate such risks.

v. Specialty Training:

According to R6, the project involved implementation of specialty trainings for 20 project members from the off-taker, conducted by a consultant from abroad on solar and wind energy.

vi. Engineering Procurement and Construction (EPC) Agreement:

According to R2, construction sites were identified prior to any physical work being done. Additionally, the specific design was handled by the EPC contractor who also happened to be the private developer. According to R4, the EPC contractor sub-contracted an experienced company to undertake some of the construction works, thus mitigating some of the plant and construction related risks.

R6 added that, the project company owned the interconnection facility, thus transferring part of the risk of payment for deemed energy caused by faulty cables away from the off-taker.

vii. Letter of Credit:

According to R6, another mitigation strategy that was employed on the project was the use of a Letter of Credit issued by a commercial bank to provide payment security for the off-taker.

viii. Incentives and Grants:

According to R5, there were a lot of incentives that were provided such as land for plant construction, in order to bring down the tariffs, such that if the incentives were not provided, the tariffs would have been higher than what was achieved. Additionally, R6 stated that in order to curb possible high tariff rates, site selection of the Lusaka South-MFEZ strategically provided various incentives such as available land, tax exemptions, aimed at bringing down the tariff rate for the project. There was also a grant received for the project that was intended to cushion development costs related to feasibilities studies.

ix. Legislation Amendments:

R1 reiterated that various legislation amendment to the ERB act and the Electricity act, were kick-started so that it allows for these passive costs to go to the consumer, thus mitigating the off-taker’s risk load.

x. Reverse Auction Procurement Process:

According to R6, there was a reverse auction that was undertaken which involved a comparison of the developers in order to end up with one with the lowest tariff. R1 stated that the respective reverse auction tender by the public developer resulted in a fairly low tariff at USD 7.2 cents per Kwh, though the project could have achieved even lower in comparison to the GETFiT project.

On the other hand, according to R2, the project remains a success in terms of procurement of competitive tariffs and completion and seeing that the tariffs were lower, this shows that the private sector was put to the fore.

However, according to R5, the provision of a variety of incentives for the project helped bring down the tariff rate to a low of USD 7.2 cents per Kwh, below the anticipated average of USD 8 cents per Kwh. R6 also added that, the scaling solar project resulted in successful plant setup at a low tariff.

4.3.7.5 Project Implementation Constraining Factors

The second specific objective of this study was to assess the influence of the de-risking strategies on the factors that led to delayed project implementation timelines. In doing so, various questions were asked during interviews, specifically probing respondents to explain on how the employed de-risking strategies impacted the project. The following insights were obtained from the respondents:

i. Biased Risk Allocation:

Mostly, R1 mainly attested to the aspect of biased risk allocation with regards to the off-taker, and made constant reference to the imbalanced risk allocation that was observed in project documents such as the PPA, in which vital, unplanned events such as a 'Force Majeure' would be the responsibility of the off-taker. The off-taker was required to pay for power even in the case of grid unavailability due to natural disasters.

Similarly, R1 further illustrated how the off-taker was exposed to the exchange rate risk arising from the US dollar currency based contract for power purchase payments. In this case, the off-taker was left exposed to the unstable Zambian Kwacha currency owing to the fact that it is their base trading currency which could lose value at any time.

ii. Delayed Financial Close:

According to R1, various aspects such as inadequate human capacity and lengthy negotiations, contributed to delays in reaching financial close, which further affected construction timelines and subsequently affected reaching commercial operations date.

Furthermore, R2 stated that there were notable delays in reaching financial close for the Scaling solar project. According to R3, the negotiations to re-draft the commercial project documents to meet the lender's requirements, took longer than expected, and as such contributed to a delay in reaching financial close.

iii. Delayed Commissioning:

According to R4, there was a delay in commissioning the Solar PV power plant due to delayed issuance of a power generation license and as such this affected the target to reach commercial operations.

iv. Delayed Grid Integration:

R1 stated that the plant was successfully integrated onto the grid as observed. However, according to R6, despite the project being successfully integrated onto the sub-transmission power-line of Lusaka, there was delay due to issues to deal with statutory requirements for grid integration. On the other hand, R1 further reiterated that there were inadequate studies done to assess the grid uptake capacity, and the only study done was by the developer. As a result, this caused a challenge of uncertainty on the project with regards to the capacity of the grid to integrate solar energy.

Owing to the fact that the substation was already constructed before the power plant, there was need to consider retrofitting the interconnecting switch gear in order to comply with the double bus bar requirement and as such this contributed to the delay. In order to harmonize this situation a waiver had to be secured with the energy regulator. R6 further stated that the project company was exposed to an interconnection facility risk as they took up ownership of interconnecting underground cables and switch gear.

v. Delayed Plant construction:

According to R1, various events contributed to construction delay. Specifically, there were certain cables that got damaged during installation as such the plant could not be commissioned within the specified time frame. R2 also reiterated that there were delays in construction of the PV Power Plant as this took slightly longer than the projected 8 months.

R4 added that, the presence of land sinkholes on the construction site contributed to construction delay in the initial phase of the project. However R2 concluded that the project remains a success in terms of construction completion.

vi. Delayed Negotiations of Agreements:

According to R3, the most notable critical success factor included securing the cover of the lenders which provided payment guarantee. Delayed negotiations and drafting of the PPA and other commercial project documents contributed to the delay in securing a payment guarantee which in turn contributed to the delay in reaching financial close. R6 added that the inclusion of various other documents into the PPA to come up with a holistic document caused a delay of about 1 month to finalize the PPA.

4.3.7.6 Scaling Solar Project Timelines

The third specific objective of the study was to establish the factors that lead to project implementation delay in the Ngonye Scaling Solar project. As a result, respondents were asked as to whether the scaling solar projects (round one) were conducted within the stipulated timelines. If not, respondents were further probed to mention the major reasons for the discrepancy in timelines. The following responses were obtained from the respondents:

According to R1, there were delays in reaching financial close, thus impacting construction and commercial operation dates. On the other hand, R2 alluded to a possible delay in construction timelines due to construction challenges on site such as the existence of sinkholes on site, and delays in reaching financial close. According to R3, agreement negotiations took longer than expected, and the construction itself took longer too. Due to a delay to reach financial close, the construction was delayed and as such power plant commissioning was also delayed. "*The scaling solar program was commissioned to deal with an immediate power crisis but still delayed by 2 more years to complete".* R3 further stated that the process of negotiating through the whole PPA took over a year. The projected financial close timeline was supposed to be eight months, but ended up taking 1 year on average.

According to R4, the project delayed by more than 12 months to reach financial close, mainly due to the long process of negotiating the PPA. The power generation license also took more than 3 months to be issued. The overall scaling solar project timeline was delayed by 2 years on average (R4). On the other hand, according to R5, the consultation processes between the developers and the government, led to project timeline delays by slightly over a year.

CHAPTER 5: DISCUSSION OF RESULTS

5.0 Introduction

The previous chapter presented an analysis of the results to highlight specific results patterns. This chapter is a discussion of the general objective of the study as outlined in section 1.3. The discussion therefore, focuses on highlighting the research findings that address the specific objectives and the research questions that have been specified in section 1.4 and 1.5. The quantitative and qualitative findings of the study are compared and contrasted with regards to literature review in order to establish correlating data patterns from which the conclusion and recommendations are drawn.

5.1 The Impact of Risks and De-Risking Strategies for the Ngonye Scaling Solar Project

The first specific objective of the study was to characterize the de-risking strategy of the Ngonye Solar project. The second objective was to assess the influence of the de-risking strategy on implementation timelines while the third objective was to establish factors that lead to project implementation delay.

In order to address the above objectives, the study attempted to answer research questions stipulated in section 1.5 which delved on identifying the risks and de-risking strategies thereof; assessing how the de-risking strategies were implemented by the concerned parties and assessing to what extent the de-risking strategy has affected project implementation timeline.

It can be observed from table 4.1 that a majority of stakeholders on the project had reasonable experience ranging between 5 to 10 years. Furthermore, stakeholders had specialized in a particular role and stage of the project as can be observed from tables 4.2 and 4.3. Additionally, a majority of stakeholders engaged professionals with a wide range of technical skills as can be observed from table 4.4. Specific training for each specific role was fair as can be observed from table 4.5. This implies that a majority were aware of specific project risks prevalent to each respective role.

Risks were identified based on the risk identification and allocation model (Gatti, 2013). In this model, risks are categorised into pre-completion risks, post completion risks and risks common to pre-completion and post completion. The following sections present a discussion of the results in line with the three specific objectives of the study.

5.1.1 Pre - Completion Risks

Pre-completion risk, are risks that are prevalent from project inception through to project commissioning. These risks include Activity planning risks, Technological risks and Construction risks. This risk category was cardinal in evaluating project implementation timeline and as such the discussion will review the risk awareness levels in line with the findings of the effects on implementation timelines for each respective risk profile.

i. Activity Planning Risk

Activity planning is the first stage of a project development process. This stage involved the identification of the need to implement the project which further culminated into feasibility studies to ascertain whether the project was viable or not. Literature review suggests that, the stage involved selection of a private developer through a competitive tender process. Activity planning was further characterized with approvals and permitting processes. All these activities exposed the project to Activity planning risks which are discussed in the following section.

According to figure 4.1 Activity planning risk had an awareness rank of 50 percent which ranks as third from the highest. Table 4.6 shows that the missing response rate for this particular risk was 5 out of 17. Out of this, 7 respondents were aware of this particular risk while 5 respondents were not aware implying that the responses are moderately representative to some extent.

Based on table 4.1, the various stakeholders engaged on the project had reasonable experience ranging between 5 to 10 years with regards to similar projects. Tables 4.2, 4.3, 4.4 and 4.5 further show that the project team members had relevant training and expertise to handle the planning activities.

Lack of experience and formal training would have affected comprehension of project information thereby compromising project implementation. Additionally qualitative findings indicate that activity planning was adequately addressed and that there were well-designed long term strategies and government programs to diversify the national energy mix. The permitting process too, was easily facilitated by government as observed from table 4.17.

To supplement the above effort, the majority of planning activities were facilitated by the private developer who was also the EPC contractor.

According to table 4.7, the EPC contract was secured within 3 to 6 months which was within the anticipated time frame. The private developer who was selected during this process became the EPC contractor as well.

Table 4.6 shows a mean score of the impact of allocating Activity planning risks to the EPC contractor as 3.92 out of a scale of 5. This implies that this de-risking strategy had a favourable outcome and it almost completely addressed this respective risk. Additionally figure 4.2 is in harmony with this aspect based on the results that show that a majority 8 out of 12 stakeholders indicated that this de-risking strategy had a positive impact on the project.

The key aspect of activity planning was to timely secure permits and approvals. This is in harmony with the observation that de-risking the permits process had a moderate impact on the cost of finance in the development of utility scale wind energy project, in South Africa (UNDP, 2013). Conversely, the impact of the scaling solar permitting process was therefore measured to ascertain the perception of the respondents. Quantitative results (table 4.17) show that the permitting and approvals process was easily facilitated. This aspect can be alluded to the fact that the project had the support of government and as such permitting and approvals were streamlined. On the contrary, qualitative findings reveal that activity planning was delayed due to limited stakeholder capacity and that the project was not properly aligned within the Public Private Partnership (PPP) framework.

These findings are in harmony with the findings of Stritzke (2018) who illustrated that alignment of government stakeholders and institutional capacity are among the central critical success factors (CSFs) which impacted the roll-out of the program in Zambia.

Based on the above, it can be established that Activity planning risk and the de-risking strategy employed thereof, contributed to project implementation delay as suggested by literature review and confirmed by Stritzke (2018) who associated Activity planning with CSFs which are driven by Institutional capacity and public stakeholder allignment.

ii. Technological Risk

Literature review suggests that technology risk is the risk that the proposed service or product may not deliver desired results due to technical challenges. In this regard, technological risk implies that either the whole or part of solar PV power plant fails to deliver the expected results. The key equipment that is subject to technological risk in a solar PV power plant includes;

solar PV modules that generate electricity; the conversion units (CU) that convert the direct current (DC) from the PV modules to alternating current (AC); the controllers that control the generation of power; and the switch gear that interconnect the PV power plant to the main grid.

According to figure 4.1 Technological risk had a risk awareness rank of 43 percent which ranks as fourth from the highest. The missing response rate for this specific risk is 6 out of 17. Table 4.6 shows that 6 respondents were aware about this risk while 5 respondents were not aware. This implies that the responses are moderately representative to some extent.

Qualitative results indicate that technological risk was allocated to the EPC contractor who ensured that equipment was sourced from reliable manufactures with a proven track record. The contractor and subcontractors had a proven track record with regards to the construction of solar PV power plants.

Additionally, the EPC contractor engaged qualified and experienced project team members and further provided specific training to contractors and subcontractors engaged on the project as can be seen from the results in table 4.4 and 4.5 respectively.

The above observation was confirmed by quantitative results that measured the respondents' perceptions with regards to the competency of the EPC contractor. According to figure 4.4, the EPC contracted exhibited adequate competency to deal with technological risk and as such, this risk did not contribute to project implementation delay.

iii. Construction Risk

Construction risk is the risk inherent to the project developer. This risk is characterised by the following attributes; Poor quality of works, delayed construction schedule, and budget overrun. This aspect is not desirable to the project developer and as such the risk is transferred to the EPC contractor who becomes responsible for the Engineering designs, Procurement of equipment and services, and construction works. The EPC contractor may further mitigate this risk incumbent on them by transferring some of the risks to the equipment manufacturer through equipment warranty provisions and by subcontracting some of the services to subcontractors.

The study results show that construction awareness risk on Ngonye project was high with a rank of 57 percent ranking as second from the highest. This risk was mitigated by allocating it to the EPC Contractor who was also the private developer. These findings are in harmony with findings of a case study on hydropower project development in Bujagali that identified construction risk as a high risk event (Valerio, 2015).

Table 4.6 shows that the impact of this de-risking strategy had the highest mean score ranking of 4.42 out of a scale of 5. These results imply that the EPC contract de-risking strategy positively impacted the project to a significant extent and further supports qualitative findings that indicate that construction of the PV power plant was successfully commissioned with the power plant achieving its targeted energy yield.

It can therefore, be deduced that the observed construction delays may have been due to other environmental factors other than construction risk and as such construction risk did not contribute to project implementation delay.

5.1.2 Post - Completion Risks

Post-Completion risks are predominant from construction completion through to operation until project decommissioning. The risks inherent to this phase include; Supply risk, Operational risk and Market risk. This phase of risks is critical to reaching financial close as it warrants the sustainability of the project.

i. Supply Risk

Supply risk refers to the risk associated with the availability of the input resource that guarantees production output. In the case of Ngonye project, supply resource is considered to be the risk associated with the availability of the right amount of solar radiation that warrants the production of the projected electrical energy yield. This risk is mitigated by ascertaining, through feasibility studies, that the desired amount of the solar resource is available in a particular location.

According to figure 4.1 the risk of the solar resource indicated an awareness rank of 50 percent which ranks as third from the highest identified risk. Table 4.6 shows that, the missing response rate for this specific risk is 6 out of 17, out of which 7 respondents were aware about the risk while 4 respondents were not aware. Findings show that this risk was mitigated through a feasibility study called a solar Geometry report that ascertained the availability of the solar resource in that particular location. Table 4.6 further shows that the impact of this de-risking strategy had a mean score ranking of 4.083 out of a scale of 5 which entails that this de-risking strategy significantly addressed the risk.

In addition to this aspect, it took a period of between 1 to 3 months to conclude the report as observed from table 4.8 which confirms that this particular de-risking strategy did not contribute to the delay in project implementation.

ii. Operational Risk

Literature review suggests that operating a facility over its life cycle advances the need to maintain the facility in order to preserve its life. The desired project outcome is realized by the effective operation and maintenance of a facility and if desired results are not attained, the project returns may not be realized as such. This aspect in itself subjects the project to operation and maintenance risk.

Operating a utility scale solar PV power plant entails generating the optimal capacity of electricity according to the contract requirements of the off – taker. Maintenance of the plant is managed such that down time is avoided while preserving the longevity of the plant.

In the case of the Ngonye project, findings of the study indicate that Operation and Maintenance risk was identified by a rank of 29 percent which is the lowest in ranking among all the risks. This implies that respondents did not perceive this risk to have a significant impact on the project. Furthermore, the risk was mitigated by allocating it to the EPC contractor, through an operation and maintenance agreement that was concluded within a period of 3 to 6 months.

It can therefore, be observed that to some extent, the stakeholders were comfortable with the above arrangement based on the fact that the EPC contractor, who was also the private developer had considerable experience with regards to the construction and operation of utility scale PV power plants. Moreover, the impact of this de-risking strategy indicated a mean score of 3.5 out 5 which was the least in rank. This implies that the de-risking strategy had no significant effect on the project and as such, it can be construed that Operation and Maintenance de-risking strategy did not contribute to a delay in project implementation.

iii. Market Risk

It is expected that the output from a project that has been developed under a project finance scheme is a product or service that is consumed by the market. The market drives demand for such a product or service as a function of supply.

Therefore, viability of projects developed under a project finance framework depends on market demand. This scenario presents a risk that products or services may not be uplifted by the market. This phenomenon is referred to as market risk.

The product that was produced from the Ngonye project is electricity that was generated from the solar PV power plant. This electricity had to be sold to a utility referred to as an off-taker for onward transmission and distribution to the consumers. This undertaking presented a significant risk on the project as returns were based on the ability of the off taker to uplift and consequently pay for the power that it uplifted. This observation is in harmony with the findings of a case study of hydro power in Africa (Bujagali, Uganda) that identified off-taker risk as a high risk event (Valerio, 2015).

According to figure 4.1, Market risk had an awareness rank of 50 percent which is third in rank from the highest. This risk event was mitigated by securing a market for power through a Power Purchase Agreement (PPA) that was complimented with a partial risk guarantee and a payment guarantee to safe guard the credit exposure.

Furthermore, results show that the impact of the PPA de-risking instrument indicated a mean score ranking of 4.15 out of 5. This result was with regards to providing a favourable project outcome and thee impact is high. Additionally, figure 4.6 shows the impact of the PPA on the project outcome. A majority of stakeholders were satisfied with the impact of the PPA while the off-taker indicated that they were not completely satisfied. Qualitative findings further suggested that the PPA de-risking instrument positively impacted the project all in all. However, the off-taker indicated that the terms and conditions of the PPA were not favourable from their perspective which is congruent to the findings illustrated in figure 4.6.

It can be construed therefore, that the above scenario contributed to a delay in negotiating the PPA as the concerned parties had to negotiate for an equitable allocation of risks. Table 4.11 indicates that negotiations for the PPA were concluded within a period of 3 to 6 months. On the contrary, qualitative findings review that it took between 6 to 12 months to conclude the PPA due to prolonged negotiations among the parties concerned.

From the above results it can be generalized that it took over 6 months to conclude the PPA. On the other hand, Stritzke (2018) illustrated a project implementation schedule shown in figure 2.9 which showed that the planned time frame to conclude the PPA was 6 months and that any delay would result in a delay to reach financial close.

Based on a comparison of the above results, it can be finally generalized that negotiating the PPA delayed and as such, this scenario contributed to a delay in reaching financial close. Therefore, project implementation was delayed by this aspect.

5.1.3 Risks Common to Both Pre-Completion and Post – Completion

i. Exchange Rate Risk

According to figure 4.1 the highest prevailing risk awareness rank identified by respondents was the 'exchange rate risk' which had a rank of 64 percent. This is in agreement with International Finance Corporation (2015) risk profile which indicates that macroecomic risks for the scaling solar program in Zambia ranged between moderate to high.

Table 4.5 shows that the missing response rate for this particular risk was 5 out of 17. Out of this, 9 respondents were aware of this particular risk while 3 respondents were not aware implying that the results were significantly representative to some extent.

Based on figure 4.9 which depicts the impact of exchange rate on project financial returns, the exchange rate risk did not negatively impact the project. On the contrary, according to an observation from the off-taker interview, the Power Purchase Agreement (PPA) that is based in United States Dollars (USD) currency implies that the exchange rate risk may have negatively impacted the off-taker with regards to perceived foreign currency exchange losses. However, findings of the study show that this macro-economic risk was mitigated by the use of hedging with IFC. Qualitative findings also show that, the exchange rate risk did not affect negotiation of the PPA and as such it may be construed that the exchange rate risk did not contribute to project implementation delay.

ii. Interest Rate Risk

Interest rate risk was the second highest risk to be identified with a rank of 57 percent. Equally, table 4.5 shows that the missing response rate for this particular risk was 5 out of 17. However, 8 respondents were aware of this particular risk while 4 respondents were not aware.

This implies that the results are representative to some extent. It can be further observed from figure 4.7 that the impact of Interest rate risk on project financial returns was not certain as the respondents gave divergent views with the majority indicating to be neutral about the aspect. Additionally, table 4.6 shows that the impact of the sensitivity analysis on interest rate risk with regards to project financial returns was 3.67 out of a scale of 5 which is moderate.

This scenario is in harmony with the (International Finance Corporation, 2015) Scaling Solar round one risk profile which indicated macro-economic risks as moderate to high profile risks on the project. This risk was mitigated by the use of hedging with IFC and as such, it can be inferred that Interest rate risk did not contribute to project implementation delay.

iii. Inflation Rate Risk

Inflation rate risk was the third highest risk to be identified with a rank of 50 percent. Equally, Table 4.5 shows that the missing response rate for this particular risk was 7 out of 17. Additionally, 7 respondents were aware of this particular risk while 3 respondents were not. This implies that the majority of respondents were aware about this risk. However, it can also be observed from figure 4.8 that the majority of respondents were neutral with regards to the impact of Inflation rate risk on project financial returns. Table 4.6 shows that the impact of the sensitivity analysis on inflation rate risk with regards to project financial returns was 3.58 out of a scale of 5 which is moderate. Hedging with International Finance Corporation (IFC) was used to mitigate this risk and as such, it can also be supposed that Inflation rate risk did not contribute to delayed implementation timelines.

iv. Environmental Risk

Infrastructure projects impact environmental conditions due to the effect of construction and operation activities. A project during construction degrades the environment due to clearing and excavation of the land. During operation and decommissioning, the project generates waste which pollutes the environment. These two aspects of a project significantly impact the environment thereby presenting an environmental risk.

Construction of the Ngonye power plant is one aspect in which the environment was impacted. The construction phase involved clearing of land which disturbed the ecological system. Operation and decommissioning of the power plant may generate waste that may pollute the environment due to the disposal of PV modules which are toxic in nature.

However, the general benefit of the project to the environment was positive in that solar energy does not contribute to greenhouse gases emissions that have a negative effect on the climate.

Findings of the study however, show that environmental risk was identified by a rank of 43 percent which is fourth in rank from the highest. Table 4.5 shows that, the missing response rate for this specific risk is 6 out of 17, out of which 6 respondents were aware about the risk while 5 respondents were not aware. This implies that the responses were fair. An Environmental and Social Impact Assessment report was conducted to assess the impact of environmental and social risks. The report further prescribed mitigation strategies for the identified environmental and social impacts.

Table 4.6 further shows that the impact of this de-risking strategy had a mean score ranking of 4.36 out of a scale of 5 which entails that this de-risking strategy significantly addressed the risk. This observation is further supported by figure 4.10 which shows that the effectiveness of the ESIA report was adequate to a large extent. In addition to this aspect, it took a period of between 3 to 6 months to conclude the report as observed from table 4.13 which confirms that this particular de-risking instrument did not contribute to a delay in project implementation.

v. Legal/Regulatory Risk

The energy sector is governed by a set of rules and regulations that promotes the organised development and operation of energy projects. Literature review shows that the government established the energy policy and statutory instruments to regulate the sector and ensure compliance. Furthermore, all energy undertakings have to be approved by the government prior to development and Licenced by the energy regulator for operation. Therefore, there could be instances where the project is not approved and an operating licence is not granted or is revoked due to non-compliance. This aspect presents a ‘risk’ referred to as Legal or Regulatory risk. As such, the Ngonye project was exposed to the regulatory risk despite government’s support and partnership in the project.

Findings of the study show that Legal/Regulatory risks were identified by a rank of 36 percent which is the second least in rank from the lowest. Table 4.5 shows that, the missing response rate for this specific risk was 6 out of 17, out of which 5 respondents were aware about the risk while 6 respondents were not aware. This implies that the quantitative results may not as such be representative to generalise the findings and as such, emphasis will be put on qualitative findings.

Therefore, according to qualitative findings, respondents indicated that Legal and Regulatory risks were allocated to the government and the Energy Regulator. As such the Energy Regulator had to amend regulations through waivers to accommodate project implementation. These findings are in harmony with ERB (2017) who reported that the energy sector revised and published several Zambian standards on renewable energy and for solar to be specific. This aspect presented some considerable delays as observed from the delayed processing of waivers for tax incentives and grid interconnection requirements. Qualitative findings further show that there was a delay in processing the power generation licence that in turn delayed the commercial operation date of the power plant hence affecting implementation timelines.

On the other hand, IFC (2015) explained that the procurement process of the private contractor was managed by IDC, a Government agent.

The procurement process was characterised by responding to multiple requests followed by agreements which were drafted specifically for the Scaling Solar program by the World Bank Group. This aspect presented some considerable delay as observed from the delayed negotiation of some agreements.

It can therefore be inferred that the allocation of legal and regulatory risk to the government and the energy regulator alone does not completely impact the project positively because it contributed to project implementation delay.

Therefore, streamlining the legal and regulatory framework to improve stakeholder efficiency is critical if implementation of similar projects has to improve.

vi. Credit/Counter Party Risk

The product or service from a project finance venture may be uplifted by one or several off- takers. Financial viability of the project therefore depends on the off-takers ability to make payments timely such as not to affect project cash –flows negatively. It follows therefore that if the off-taker defaults on payments, the project company may too default in making payments to its lenders. According to Avramov (2005) such undertakings therefore present a risk referred to as default risk.

In the case of the Ngonye project, evaluating the credit worthiness and mitigating the financial risk of the off-taker was a critical success factor for the project. Literature review suggests that the off-taker was not in a good financial standing at the time and as such the credit default risk had to be mitigated prior to financial close.

Further, findings of the study show that the credit/counter party default risk had an identification rank of 50 percent which is third in rank from the highest. The risk was mitigated through a Letter of Credit (LC), issued by a commercial bank and backed by a partial risk guarantee issued by the project guarantor. Furthermore, results show that the impact of the LC de-risking instrument indicated a mean score ranking of 4.36 out of a measure of 5. This result implies that the de-risking instrument positively impacted the project to a large extent. Moreover, these findings are in coherence with the results indicated in figure 4.11 that show that the influence of the LC on the Investors and lenders Comfort was completely positive.

Accordingly, qualitative findings indicate that the strategy to issue a partial risk guarantee to back the LC was in order to improve the bankability of the off-taker. This is consistent to Gervokian (2012), who suggested that de-risking the credit/counter party default risk through payment guarantees improves lenders confidence which further improves conditions to reach financial close.

With regards to the time frame to conclude the tender process to select a commercial bank to issue an LC, Table 4.15 indicates that the process was concluded within a period of 3 to 6 months which is within the timelines illustrated by Stritzke (2018).

Based on the above, it can be generalized that payment guarantee de-risking strategy that was implemented through an LC did not negatively affect the project and as such did not contribute to project implementation delay.

5.2 Factors That Affected Project Implementation

The third specific object of the study attempted to assess the influence of the de-risking strategy on project implementation timelines. In order to address this objective, the constraining factors for the project were highlighted based on qualitative findings and assessed against the de-risking strategies that were employed to address each specific factor. Among the notable constraining factors that affected project implementation include; Delayed negotiation of PPA; Delayed grid integration; and Environmental Constraints.

5.2.1 Delayed Negotiation of the Power Purchase Agreement

The PPA and the Gird Integration Agreement (GIA) had to be negotiated and redrafted several times so as to address pertinent issues that came up. Ideally the GIA is a separate document from the PPA as per legal requirement but in this case the two documents had to be integrated into one. Among the profound issues that came up during the negotiations of the PPA was the issue of equitable allocation of risks between the project company and the off-taker. According to the off-taker, they were not satisfied with the allocation of force majeure risk. The off-taker was required to pay for deemed energy even in the event that the grid was not available due to natural disasters.

5.2.2 Delayed Grid Integration

With regards to addressing grid interconnection requirements, the utility had to apply for waivers from the energy regulator to avoid retrofitting the interconnection facilities so as to accommodate the Solar PV power plant. This was necessitated by the fact that the substation was already constructed before the power plant and as such it did not accommodate double bus bar requirements for integrating the solar PV power plant. The regulatory environment did not have an adequate working framework to guide the integration of utility scale Solar PV power technology on the national grid and as such the energy regulator spent some time in amending the regulations so as to accommodate the project. The structure of the power market too is such that the off-taker of the power from the project is the grid operator and owner of the transmission and distribution network including the major power generation plants. This entailed that the project had to depend on the input of the utility before authority could be granted to connect to the grid. This dependency on the utility further exposed the project to delays owing to the bureaucratic nature of the utility.

5.2.3 Environmental Constraints

Literature review suggests that construction was delayed due to geotechnical challenges exhibited by the presence of sinkholes on site. This was confirmed by research findings and is in accord with the ESIA Report.

Qualitative findings further reveal that the land that was initially secured to construct the PV power plant was not sufficient to meet the required energy yield. As such, additional land had to be sourced from the neighbouring land borders. This feature contributed to a delay in planning activities that involved detailed feasibility studies that could only commence after securing the required size of land.

It can therefore be established that environmental constraints negatively impacted construction activities as such this aspect negatively affected project implementation timelines. This observation is in agreement with Stritzke (2018) who illustrated that geotechnical challenges at the selected construction site contributed to project implementation delay.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

The last two chapters presented a detailed analysis and discussion of results to highlight the effect of the project finance de-risking strategies on the implementation timelines of the Ngonye project. This chapter presents the conclusion drawn from the analysis and discussion of results thereof. In addition, it presents recommendations directed at improving a further rollout of other utility scale solar PV projects in Zambia and outlines opportunities for further research.

6.2 Conclusion

The objective of the research was to establish the effect of the employed Project Finance de-risking framework on the implementation timelines of the Ngonye Solar project. This was achieved by characterizing the risk profile and assessing the impact of each de-risking strategy on project implementation timelines. The financing framework was structured around a pre-designed de-risking framework whose objective was to achieve a competitive feed-in tariff while reducing project implementation timeline. Respective stakeholders implemented various risk mitigation strategies in order to address specific risks that were identified at different phases of the project. Despite de-risking the project, specific observed constraining factors to project implementation persisted.

Findings of the study reveal that the risk profile of the Ngonye project was by and large moderate. Among the notable risks that impacted the project were; Activity planning risk, Market risk and Legal/Regulatory risk. The de-risking strategies that were employed to mitigate these risks were characterised with challenges of application. Among the three, Market risk that was mitigated by securing a PPA, significantly affected project implementation. Although the PPA de-risking strategy had a favourable impact on Market risk, this respective strategy was not implemented timely due to prolonged negotiations.

It is therefore established that the project finance de-risking framework that was employed for the Ngonye Scaling Solar project contributed to project implementation delay beyond target. Some de-risking strategies were not adequately aligned to meet stakeholders' expectations thereby constraining application. Furthermore, some constraining factors were beyond the scope of the de-risking framework and therefore equally contributed to project implementation delay.

6.3 Recommendations

Having understood the effects of the de-risking strategy on the implementation timelines of the Ngonye project, recommendations are hereby provided in order to enhance implementation of other utility scale solar projects of a similar magnitude in future.

6.3.1 Enhance Institutional Capacity

The Ngonye project was implemented within an institutional environment that comprised of public and private stakeholders. Various institutions played various roles at different stages of the project. Public Institutions were involved in planning activities from inception through to commissioning of the project. Among the notable planning activities implemented by the Public Institutions were; permitting, approvals and licensing processes. On the other hand, the Private Institutions were mainly involved in professional services that involved engineering and financing activities.

Institutional capacity was therefore, critical for the successful implementation of the Ngonye project. Findings of the study point to Activity planning risk as one of the contributing aspects to project implementation delay. Although this risk was mitigated by allocating the major planning activities to the private institutions, the public institutions were responsible for permitting and approving activities. The fact that the project was the first of its kind in Zambia exposed the public institutions to a lack of technical capacity hence the permitting and approval process was characterised with delay.

It is therefore recommended to improve institutional capacity through continuous training and development of public stakeholder personnel that may be involved in similar projects. Adequate training and exposure to projects of similar magnitude and specification will improve their competency and speed of execution.

Furthermore, there is need to adequately align project implementation within the Public Private Partnership (PPP) framework so as to improve service delivery by the public stakeholders. The study observed that project activities were coordinated within a central public procurement agent that may have had limited capacity to single handedly supervise the project. Institutional capacity can be improved by identifying experts from different public institutions to form a team that will be better placed to coordinate and supervise the project.

6.3.2 Streamline Risk Allocation

Implementing the de-risking strategy for the Ngonye project was characterised with delayed negotiations for the PPA which was a key mitigating instrument for Market risk. This aspect contributed to project implementation delay.

Findings of the study have revealed that delayed negotiations were arising from the manner in which risks were allocated in the PPA between the project company and the off-taker. The off-taker was not satisfied with the fact that they were required to pay for deemed energy in the event that they could not uplift power due to grid unavailability resulting from events of force majeure. On the other hand, there was no penalty to the Project Company or incentive to the off-taker in the event that the power plant could not supply power to the grid. This scenario was therefore perceived to be unfair from the perspective of the off-taker.

It is perceived therefore that, the allocation of risks in this manner was intended to de-risk the interest rate risk by improving lenders perceptions of the project. With reduced interest rate, the cost of borrowing was subsequently reduced, which resulted into a lower cost of capital for the project. The result was that a low feed-in tariff (USD 0.072/Kwh) for the project was achieved at the expense of project implementation time frame.

With this understanding, it is recommended therefore that, project perceptions which influence interest rate are improved by allowing for feed-in tariff increments that are cost reflective other than fixing the tariffs over the project life span. The off-taker too, has to implement cost reflective tariffs to compliment feed-in tariff increments. The government should also continue to provide incentives in order to mitigate the risk of contracting projects with a high tariff rate. This scenario will allow for a fair allocation of risks in the Power Purchase Agreement (PPA) thereby reducing the time frame for negotiations. The result will be that, project implementation will be improved to timely address the overall project objective of reducing power deficit in Zambia.

6.3.3 Recommendation for further research

Although this study provided valuable insights with regards to de-risking strategies associated with project finance for the Ngonye scaling solar project, there is need to further investigate the factors that influence the allocation of risks among stakeholders and how these factors impact the lenders perceptions which significantly influence the cost of capital for similar projects.

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APPENDICES

APPENDIX I - RESPONDENT QUESTIONNAIRE

RESEARCH QUESTIONNAIRE

This questionnaire has been developed by researchers at the **University of Zambia**. All the information that you provide will be confidential, and will be used only for this research purpose.

Please kindly complete the questionnaire and share it with the researcher for reporting purpose. Your opinions are valued in assessing the impact of risk addressing measures that are used in solar PV projects in Zambia, and how best practices can further be implemented.

Thank you for your participation!

Section A: Organization's Capacity

General Information: This section is designed to address general information about the organization's capacity to deal with utility scale Solar PV development projects.

Please indicate your choice of answer by tick in the box indicating your respective range of experience.

	Less than 5 years	5-10 years	More than 10 years	Never
How long has your organization worked on the development of utility Scale Solar PV projects?				

What area of specialization did your organization provide in the utility scale solar project development?

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At what stage of the utility scale solar project development did your organization participate?

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What activities was your organisation involved in during utility scale Solar PV project development?

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What was the headcount of the project team engaged in the solar PV project development?

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What was the skill set of the project team engaged in the solar PV project development? Example, Technicians, Engineers, Project Managers, Etc.?

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Did the project team undergo any form of training relevant to the project? If so , specify the details of such kind of training.

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Section B: Project Risk Awareness

There are numerous risk categories associated with the development of a utility scale ‘Solar PV’ project. These risks translate into different probabilities of project delays at each development stage.

(Tick in the boxes next to your answer/choice)

Which of the following ‘risks’ did you identify?

	IDENTIFIED RISKS	YES	NO
1	Activity planning		
2	Technological Risk		
3	Construction Risk		
4	Operational Risk		
5	Supply Risk (Solar Resource)		
6	Market Risk		
7	Interest Rate Risk		
8	Exchange Rate Risk		
9	Inflation Rate Risk		
10	Environmental Risk		
11	Regulatory and Legal Risk		
12	Credit/Counterparty Risk		

If '**Yes**' to any of the above, please specify **'mitigation strategies**' employed for the **identified risk** or any other risk that you may have identified that is '**Not'** listed above. If '**No**' risk was identified at all, skip to the next section.

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Section C: Influence of De-risking Strategy on identified risks

In this section we request you to rate the influence of the subjects under the first column using a scale of 1 to 5 provided in the other columns as:

Not at all = 1; Almost not at all = 2; Neutral =3; Almost Completely =4; Completely = 5

(Circle the scale of influence you think is associated to the subject)

SUBJECTS	Not at all	Almost not at all	Neutral	Almost Completely	Completely
i) To what extent did the **Engineering, Procurement and Construction** contractor adequately address the **Activity Planning** risks?	1	2	3	4	5
ii) To what extent did the Interconnection **Agreement** yield favorable outcomes?	1	2	3	4	5
iii) Did the **Solar Radiation Geometry report** provide accurate estimates regarding available solar radiation resource?	1	2	3	4	5
iv) Did the **Engineering, Procurement and Construction contractor** and other **sub-contractors** exhibit full competencies during PV power plant construction?	1	2	3	4	5
v) To what extent did the **Operation and Maintenance Agreement** yield favorable outcomes?	1	2	3	4	5
vi) To what extent did the **Power Purchase Agreement** yield favorable outcomes?	1	2	3	4	5
vii) Did the **sensitivity analysis** conducted on **interest rate** accurately impact the project?	1	2	3	4	5
viii) Did the **sensitivity analysis** conducted on **inflation rate** accurately impact the project?	1	2	3	4	5
ix) Did the **sensitivity analysis** conducted on **exchange rate** accurately impact the project?	1	2	3	4	5
x) Did the **Environmental risk assessment report** accurately depict the situation on site?	1	2	3	4	5
xi) Did the **REFiT** benchmark for solar PV tariffs yield the expected positive outcome?	1	2	3	4	5
xii) To what extent did the **Letter of Credit (Payment Guarantee)** and other related guarantees influence investors and lenders comfort?	1	2	3	4	5

Section D: De-risking Strategies – Timelines

The Ngonye Solar photovoltaic plant in Zambia was planned to be installed and commissioned within a specific timeframe. Various de-risking strategies were implemented at different stages of the project to minimize on the identified risks.

By ticking under the respective timeframe, kindly indicate the duration that was taken to conclude each respective **De-risking strategy**.

.					TIME-FRAME (Months)				
Item No	**De-risk Strategy**	**Project Phase**	**Identified Risk**	**Main Action Agent**					
1	Engineering, Procurement, Contractor Agreement **(EPC Contract)**	Pre-Completion	Activity Planning	Enel Green Power	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
2	Grid Integration agreement	Pre-Completion	Technological	ZESCO	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
3	Solar Radiation Geometry report	Pre-Completion	Technological	IDC	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
4	EPC Contract	Pre-Completion	Construction Risk	Enel Green Power	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
5	O&M Agreement	Post-Completion	Operational Risk	Ngonye Project Company (SPV)	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
6	Power Purchase Agreement	Post-Completion	Market Risk	ZESCO	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
7	Project Sensitivity Analysis	Common to Pre & Post Completion	Interest Rate, Inflation Rate, Exchange Rate	IFC	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
8	Environmental Impact Assessment Report	Common to Pre & Post Completion	Environmental Risk	ZEMA	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
9	REFiT benchmark tariffs for solar PV. **Standard Licence**	Common to Pre & Post Completion	Legal/Regulatory Risk	Energy Regulation Board	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**
10	Letter of Credit – Zesco Payment Guarantee	Common to Pre & Post Completion	Credit/Counterparty Risk	Standard Chartered Bank	**1-3**	**3-6**	**6-9**	**9-12**	**More Than 12**

If there was a delay in any of the timelines above, please specify the main reasons for the delay? If there were no delays, skip to next section.

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4.1 Policy De-risking Instruments

Various policy and project design de-risking strategies were implemented in the Ngonye PV project to reduce on project risks.

On a scale of 1-5, kindly rate the impact of the following policy de-risking strategies on project timelines by circling the answer of your choice.

	Not at all	**Almost not at all**	**Neutral**	**Almost Completely**	**Completely**
i.) The long term Scaling Solar programs are well **designed** and **attainable**?	1	2	3	4	5
ii.) The '**permit process'** is easily facilitated for the project developer and other stakeholders.	1	2	3	4	5

Please give reasons for each of your responses in the above question:

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4.2 Financial De-risking Instruments

Various financial de-risking instruments were implemented in the Ngonye PV project to reduce on project risk. On a scale of 1-5, kindly rate the influence of the following de-risking instruments on project output by circling the answer of your choice.

	Not at all	**Almost not at all**	**Neutral**	**Almost Completely**	**Completely**	**Not Applicable**
i.) The **public loans** for the Scaling Solar PV project have been well designed in order to increase solar power deployment?	1	2	3	4	5	N/A
ii.) The **partial loan guarantees** for the Scaling Solar PV projects have been well designed in order to increase solar power deployment?	1	2	3	4	5	N/A
iii.) The **political risk insurances** for the Scaling Solar PV projects have been well designed in order to increase solar power deployment?	1	2	3	4	5	N/A

Please give reasons for each of your responses in the above question:

i)…………………………………………………………………………………………
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4.3 Direct Financial Incentives

Various financial incentives were implemented in the Ngonye PV project to reduce on project risks. On a scale of 1-5, kindly rate the influence of the following financial incentives on project output:

	Not at all	Almost not at all	Neutral	Almost Completely	Completely
i.) The Feed In Tariffs for the Scaling Solar PV projects are well designed to increase solar power deployment.	1	2	3	4	5
ii.) The Tax credits for the Scaling Solar PV projects are helping to facilitate solar power deployment.	1	2	3	4	5
iii.) The increase of **electricity** tariffs had a positive impact on the Scaling Solar PV projects	1	2	3	4	5

Please give reasons for each of your responses in the above question:

i)…………………………………………………………………………………………
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5. Section E: Recommendations and Suggestions

Your recommendations and suggestions will be vital in improving on any aspects that caused project delays in the initial project phase.

i.) In your own words, what were the main factors that led to project implementation delays in the **Ngonye** Scaling Solar project?

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ii.) In your own words, what factors contributed to the delayed schedules between the Ngonye and West Lunga solar projects, despite being commissioned at the same time:

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iii.) In your own words, what have been the lessons learnt and suggestions that will facilitate the utility scale solar project development in later phases/rounds.

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End of questionnaire.

Thank You!

Organization Name: ……………………………………………………………

Respondent Job Title: …………………………………………………………

Respondent Gender: ……………………………………………………………

I have read the information included in this Questionnaire and I hereby declare that i have provided responses to the best of my knowledge.

Title	Signature	Date (MM/DD/YYYY)

APPENDIX II: KEY INFORMANT INTERVIEW GUIDE

This interview guide has been developed by researchers at the University of Zambia. All the information that you provide will be confidential, and will be used only for this research purpose.

The interview is designed to gain more insight on the role that each respective stakeholder played in the Scaling Solar project in Zambia, and to gather respondent perception on various aspects of the project such as de-risking strategies, project success and challenges, and recommendations. The interview questions are very brief, so feel free to provide as much information as possible.

Organization Name:

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Respondent Job Title:

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Respondent Gender:

…………………………………………………………………………………

Date of Interview:

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1. Kindly assist me with any information regarding your experience in the Energy/Renewable Energy (RE) sector?
2. What was your role in the recent Scaling Solar PV project in Zambia?
3. What category of stakeholder would you describe yourself as? Sponsor, investor, developer, consultant, regulator, financier, insurer, professional services, O&M, etc.
4. What do you think of the Zambian Government's road map for Renewable energy development? Specifically scaling solar.
5. What is your view about the recent utility scale solar PV project in Zambia?
6. What would you state were the major risks and barriers that were identified in **developing and investing** in the renewable energy space, particularly in the utility scale solar PV projects? How would you rate each identified risk?

7. What in your view are the **top five risks** for developing and investing in the renewable energy space?
8. How did you mitigate and manage against the identified risks specifically related to leading edge solar utility PV plants under implementation?
9. Were the scaling solar utility projects (Round one) conducted within the stipulated timelines? If not, what were the major reasons for the discrepancy in timelines?
10. What are the major lessons learnt from round one of the project that will assist in implementation of round 2 and other similar projects?
11. What were the major challenges faced on this project?
12. Is there anything I have left out that you wish to add?

Thank You for your time!

End