PAN-AFRICAN UNIVERSITY
INSTITUTE FOR WATER AND ENERGY SCIENCES
(including CLIMATE CHANGE)

Master Dissertation

Submitted in partial fulfillment of the requirements for the Master degree in

Energy Policy

Presented by

Isaac CHITEDZE

ANALYSING FEED-IN TARIFF POLICY TO ACCELERATE RENEWABLE ENERGY DEPLOYMENT AND ELECTRICITY ACCESS IN MALAWI

Defended on 02/09/2018 Before the Following Committee:

Chair	Obudho Omondi	Dr.	Kenya Institute of Curriculum Dev.
Supervisor	Hassan Qudrat-Ullah	Prof.	York University
External Examiner	Justus Simiyu	Dr.	University of Nairobi
Internal Examiner	Samir Maliki	Prof.	University of Tlemcen

DECLARATION

This thesis is my personal original work, realized to the best of my knowledge and has not been submitted for a degree to any other university or to any examining board in fulfillment of any course requirement. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

Student signature	Date	Place
	05/09/2018	Tlemcen, Algeria

Supervisor signature	Date	Place
	05/09/2018	Tlemcen, Algeria

DEDICATION

This work is dedicated to my parents Mr Chitedze and Mrs Chitedze. Thanks a lot for the love and affection, a love so complete. Mum and Dad your unconditional support and words of encouragement motivates me always. My sisters and my brother you are my best cheerleaders. To my wife Miriam, thanks for your superfluous care and support, you are a blessing!

ACKNOWLEDGEMENTS

Passion and inspirations are among the main drivers in achieving a set goal. This wonderful and exciting journey was possible and inspired by many people. I owe my deepest gratitude to a large group of people and institutions. I am particularly indebted to my supervisor, Prof Hassan Qudrat-Ullah for his advice and guidance throughout the research.

This research work would not have been possible without the financial support from African Union, GIZ, KFW and Tlemcen University. I am particularly grateful to these aforementioned organizations.

Appreciation is due to a group of colleagues and friends. I am privileged and fortunate in having such a great team by my side.

ABSTRACT

Decarbonisation of the energy sector and promotion of renewable energy sources is a central goal of Malawi Government as outlined in the country's Renewable Energy Strategy essentially aimed at increasing the installed capacity of renewable energy technologies and the distributed generation of renewable electricity to accelerate electricity access within the nation boarder. In order to exploit the renewable energy, the government adopted the Feed-In Tariff (FIT) policy, the most versatile and widely implemented scheme globally accounting for a greater share of renewable power propagation than any other renewable energy policy support scheme. FIT is the highest-flying market-based economic instrument promoting renewable energy deployment and being implemented in over 110 countries worldwide. The purpose of this thesis was to analyse the poor performance of Malawi FIT and redesign the policy to attract investors. Since its inception in 2012, the FIT has neither increased renewable electricity generation capacity nor attracted any Independent Power Producers to connected to the grid or generating and selling power to a particular community as distributed generation. The research assessed FIT policy design and remuneration model in Malawi, scheme implementation and challenges faced and funding for the policy. The research explored innovative design to limit the total policy cost.

Among the notable research findings and policy design include remuneration model entailing fixed price with full or partial inflation adjustment, levelized cost-based tariff established on conservative basis, shallow approach interconnection costs and inflation tariff adjustment approach. Some of the policy implementation challenges are lack of technical expertise, lack of policy funding, low end-user tariff being charged as ratepayer, grid capacity and low tariff levels. FIT policy funding is critical as it has a bearing on the investors security and several ways to fund the Malawi FIT policy were explored namely fuel levy, electricity levy, ratepayer, maximising electronic fiscal device tax collection to ensure policy longevity and sustainability. The study also involved modelling FIT rates for KIA solar farm under six scenarios and policy options using RETScreen Expert. To turn the KIA project to profitability, the FIT has to be $ 0.51 kWh and investors will earn a 10 % internal rate of return on equity

A well-designed FIT will transform the country's energy system in profound and tangible way. An effective FIT scheme will foster more rapid renewable energy deployment, increase overall electricity generation, boost economic development and increase electricity access in the country while avoiding the greenhouse gas emissions.

RÉSUMÉ

La décarbonisation du secteur de l'énergie et la promotion des sources d'énergie renouvelables est un objectif central du gouvernement du Malawi tel que décrit dans la stratégie d'énergie renouvelable du pays visant essentiellement à augmenter la capacité installée des technologies d'énergie renouvelable et la production décentralisée d'électricité renouvelable, pensionnaire de la nation. Afin d'exploiter l'énergie renouvelable, le gouvernement a adopté la politique de tarifs de rachat garantis (FIT), le régime le plus polyvalent et le plus largement mis en œuvre au niveau mondial. La FIT est l'instrument économique basé sur le marché le plus performant qui promeut le déploiement des énergies renouvelables et qui est mis en œuvre dans plus de 110 pays à travers le monde. Le but de cette thèse était d'analyser la mauvaise performance du FIT au Malawi et de revoir la politique pour attirer les investisseurs. Depuis sa création en 2012, le FIT n'a ni augmenté la capacité de production d'électricité renouvelable ni attiré de producteurs d'électricité indépendants à se connecter au réseau ou à produire et vendre de l'électricité à une communauté donnée en tant que production décentralisée. La recherche a évalué la conception des politiques et le modèle de rémunération des FIT au Malawi, la mise en œuvre du système et les défis rencontrés et le financement de la politique. La recherche a exploré la conception innovatrice pour limiter le coût total de la politique.

Parmi les résultats de recherche notables et la conception des politiques, citons le modèle de rémunération comportant un ajustement fixe ou partiel de l'inflation, un tarif nivelé basé sur les coûts établis sur une base prudente, des coûts d'interconnexion peu élevés et une approche d'ajustement tarifaire. Certains des défis liés à la mise en œuvre des politiques sont le manque d'expertise technique, le manque de financement des politiques, le faible tarif pour les utilisateurs finals étant facturé en tant que contribuable, la capacité du réseau et les faibles tarifs. Le financement des politiques FIT est essentiel car il a une incidence sur la sécurité des investisseurs et plusieurs moyens de financer la politique FIT du Malawi ont été explorés, notamment la taxe sur les carburants, la taxe sur l'électricité, le contribuable, la maximisation de la pérennité fiscale. L'étude comprenait également la modélisation des tarifs FIT pour la ferme solaire KIA selon six scénarios et des options stratégiques à l'aide de RETScreen Expert. Pour que le projet KIA soit rentable, le FIT doit être de $ 0,51 kWh et les investisseurs bénéficieront d'un taux de rendement interne de 10 % sur les capitaux propres.

Une FIT bien conçue transformera le système énergétique du pays de manière profonde et tangible. Un système de FIT efficace favorisera un déploiement plus rapide des énergies renouvelables, augmentera la production d'électricité au Malawi, stimulera le développement économique et augmentera l'accès à l'électricité dans le pays tout en évitant les émissions de gaz à effet de serre.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

DFD	: Electronic Fiscal Device
ESCOM	: Electricity Supply Corporation of Malawi
EU	: European Union
FIT	: Feed-In Tariff
GHG	: Greenhouse Gas
GoM	: Government of Malawi
IPPs	: Independent Power Producers
IRR	: Internal Rate of Return
JICA	: Japan International Corporation Agency
kWh	: Kilowatt-hour
MBIs	: Market-based instruments
MERA	: Malawi Energy Regulatory Authority
MRES	: Malawi Renewable Energy Strategy
MRA	: Malawi Revenue Authority
MWK	: Malawi Kwacha
MW	: Mega-Watt
PPA	: Power Purchase Agreement
PV	: Photovoltaics
RE	: Renewable Energy
RETs	: Renewable Energy Technologies
RES-E	: Renewable Electricity Generation
RPS	: Renewable Energy Portfolio Standards
SDGs	: Sustainable Development Goals
SE4All	: Sustainable Energy for All
USD	: United States Dollar

Chapter 1 : INTRODUCTION

Promoting the use of Renewable Energy Technologies (RETs) and widening electricity access is a central goal of the Malawi Government, which was recently corroborated in the Malawi Renewable Energy Strategy. The Government recognises the strong two-way linkage between energy and economic development hence it has identified energy as a priority sector in order to spur development in other sectors such as agriculture and manufacturing industries. Fostering renewable energy deployment that the Government is spearheading links with regional, continental and international goals such as Agenda 2063- The Africa We Want and Sustainable Development Goals (SDGs). The Government comprehend a call to action on energy in the Agenda 2063, which stipulates that Africa must harness all African energy resources to ensure modern, efficient, reliable, cost-effective, renewable and environmentally friendly energy to all African households, businesses, industries and institutions, through building the national and regional energy pools and grids. Globally, the SDGs goal 7 is to ensure modern energy being access by all at an affordable price, is reliable and sustainable whereas goal 13 is to take imperative action to combat climate change and its impacts. Increasing electricity access and decarbonisation of the energy sector is a global concern therefore renewables are the solution, which offer this transition without emitting fossil fuels which will in the long run exacerbate the negative impacts of climate change.

1.1 Background

British environmental economists David Pierce, Anil Markandya and Edward Barbier introduced the concept of green economy in 1989 [1]. After that, making a transition towards green economy has been put on many governments' agenda and developmental goals. Initially the concept of green economy emphasized and addressed the issue of reducing greenhouse gas (GHG) emission only [1]. ECO Canada defines green economy as the "aggregate of all activity operating with the primary intention of reducing conventional levels of resource consumption, harmful emissions, and minimizing all forms of environmental impact. The green economy includes the inputs, activities, outputs and outcomes as they relate to the production of green products and services" [2]. From the above definition, it is clear that green economy is extensive in nature and has a wider breadth in its meaning. Henceforth the United Nations Environment Programme (UNEP) describe green economy as a more comprehensive and challenging kind of economy that aim to cutback GHG emission and other environmental risks and ecological scarcities along with development and social goals to improve human well-being and social equity [3]. Therefore, the issue of GHG and climate change is unequivocal.

Climate change impacts, pollution and goals to increase environmental sustainability have emerged among the most urgent area of action for the international community today. GHG levels and raising global temperatures, has led to worldwide consensus that GHG emission levels must be stabilised. Through multilateral agreements such as Kyoto Protocol and CoP21, many States pledged to drive down GHS emissions consequently many countries have introduced programmes and energy policies to accelerate electricity generation from renewable energy. Renewable energy technologies (RETs) development has taken different shapes across the global, supported by a range of policy frameworks, depending on the particular national context, including Feed-In Tariff (FIT), Renewable Energy Portfolio Standards (RPS), and Renewable Energy Obligation. FIT and RPS are the most widely implemented and beneficial programs for promoting deployment of renewable energy technologies around the world [4], [5]. Relatedly, green energy subsidies utilization has also up-surged in recent years. For instance, the World Energy Outlook 2013, reported that the total subsidies for renewable energy was “101 billion USD in 2012, an increase by 11 % from 2011” [6], [7].

Instruments supporting renewable electricity (RES-E) generation are categorised based on whether they affect demand or supply of renewable electricity or whether they support power generation [8]. First, policies may regulate renewable electricity price or the quantity produced and second, policies may support investment in renewable energy generation or direct subsidize generation [8]. Table 1.1 provides a classification of these policy instruments.

Table 1.1 Renewable energy support instruments

		Direct		Indirect
		Price-driven	**Quantity-driven**	
Regulatory	Investment	➢ Investment subsidies ➢ Tax credits ➢ Low interest/Soft loans	➢ Tendering system for investment grant	Environmental Taxes
	Generation	➢ Fixed price feed-in tariffs ➢ Premium feed-in tariffs	➢ Renewable energy portfolio standards ➢ Tendering systems for long term contracts	Environmental Taxes
Voluntary	Investment	Shareholder programmes Contribution programmes		Voluntary agreements
	Generation	Green certificates		Voluntary agreements

Source: Haas et al., 2008

Regulatory policy instruments to promote (RETs) have taken on increasing importance in many countries and states. From table above, the widely deployed and successful policy instruments for encouraging generation of electricity from renewables in the world are feed-in tariffs (FIT) and Renewable Energy Portfolio Standards (RPS) [10]. Among the existing policy instruments to accelerate renewable energy deployment, FIT policies are the versatile, accounting for an enormous portion of renewable energy generation than all other renewable energy policy scheme [11]. According to the Renewables Global Status Report (GSR 2017), 110 states or countries have FIT policies in place while 100 states or countries have RPS policies [12].

Feed-In-Tariff is an energy supply policy that "attract investments in renewable energy by offering long-term guaranteed purchase agreements to green power producers to sell their electricity into the grid" [13]. According to European Commission, FIT is the most promising of all in RE propagation [14] and experts agree that FITs exemplify the most effective policy to promote RET [15]. FIT account for nearly "75% of worldwide solar photovoltaic (PV) and 45% of global wind energy deployment by 2008" [11], [16]. In Europe alone, FIT policy accounted for 93% of all wind onshore capacity and entirely 100% of solar photovoltaics installed by the end of 2010 [17]. FITs establishes a wholesale price for purchase of electricity generated from renewable source, normally paying generators a premium rate over the retail electricity price for each unit of electricity fed into the grid. FITs typically oblige utilities to buy every kilowatt of electricity generated by producers at this premium rate, over a long period of about 15-20 years at a fixed guaranteed price, which covers the high generating costs of renewable electricity. FIT is described as a "truly revolutionary tool" in the power sector [15]. The policy aims to substantially increase the production of renewable electricity by giving investors economic incentives and levelling the playing field. FIT policies are designed to encourage a wide-range of RET and make them more competitive through economies of scale and technological innovation [18].

The Policy Action on Climate Toolkit (PACT) describes FIT policy as centred on serving dualistic purposes: an access objective and a price objective. Firstly, the access objective entail the utility company that generate electricity and the grid to grant parallel grid connections and wholesale electricity prices [19]. This provide an assurance to investors in RET that they can actually sell all the power they produce and in case of a temporary oversupply, the renewable power is not turned off. Instead, conventional power plants have to be stopped, a process that can be costly and sumptuous for certain technologies [18]. The price objective put emphasis on establishing a reasonable price, offering a surety on the price for fixed period, and earning a fair return on investment. The system focuses on a price or tariff, a wholesale period and a wholesale rate, and tariff digression [19].

Mendonça [20] stipulates three fundamental issues or policy designs that successful FITs usually constitutes: (i) guaranteed access to the grid; (ii) stable, long-term purchase agreements typically, 15-20 years; and (iii) payment levels based on the costs of renewable energy generation. To begin with, FIT provide a warrant that all renewable electricity will be purchased and be handed priority grid access. Secondly, FIT warrant the renewable electricity power generation a stable, long-term price for electricity produced, generally 15 to 25. The purchase price paid to producers is put at a higher rate than the existing electricity market price. Therefore, FIT policy throw out two key investment risks that is purchase risk, and price risk [21]. Thirdly, successful FIT is set at a rate that reflects investment capital in renewable power generation hence the FIT mechanism creates an eye-catching finance and investment opportunity in the power sector [21].

1.2 Malawi Electricity Landscape

Malawi has rich renewable resources endowment nevertheless hydropower is the most utilized resource for power generation from renewable energy resource in Malawi. In the economic region of Southern Africa Development Community (SADC), Malawi ranks as one of the least electrified country [22] with only 10% of the population having access to electricity [23]. According to United Nations, the population growth rate is around 3% every year hence it is unquestionably that Malawi is facing increasing electricity demand [24]. The electricity sector largely depends on hydropower and thermal for power generation and there is one government-owned national grid. The state-owned institution known as Electricity Supply Corporation of Malawi (ESCOM), is the grid operator. Previously, ESCOM was the main electricity generator, distributor and retailer but in 2016 the Government disbanded ESCOM to form a new state-owned company, the Electricity Generation Company (Egenco), which took over generation assets from ESCOM while ESCOM retained the responsibility for transmission and distribution as well as the trading of electricity across the nation.

The nation total installed capacity as of 2017 was 363.1 MW, with 96.6 % generated from hydropower and 3.4 % from thermal against the current estimated demand of over 700 MW [25]. Nearly all hydropower stations were built along Shire River in the south as such during dry season, power outages are the order of the day due to low water levels in Shire River. The electricity network infrastructure is marked with inadequate transmission capacity and aging infrastructure, resulting in substantial electrical losses of an estimated 20%-25% of the generated electricity [26]. Electricity supply is erratic characterised by frequent power outages and it is projected that Malawi loses around USD 16 million yearly due to endless blackouts [27]. Table 1,2 below shows the total installed capacity by the utility as of October 2017.

It is not a robust strategy to have all eggs in one basket therefore there is a need to diversify supply and increase security of supply by having several operational power generation options. Electricity generation characterised by overdependence on the Shire River poses severe risk of cataclysmic reduction of electric power even more the loss of energy in times of drought as evidenced by frequent blackout during dry seasons. The GoM recognised the need for diversification of hydro energy resources instead of overly depending of one river and other energy sources especially renewable sources such as solar, wind and geothermal. Feasibility studies for additional renewables generation in the form of new hydro schemes and expanding existing hydro schemes was done and table 1.3 shows potential or untapped sites and expected range of power generation capacity. One of the key priority area in the draft National Energy Policy is electricity generation and a policy statement by the GoM states the plan to diversify power generation sources for security of supply and expand generation capacity to meet the growing demand for electricity [28].

Table 1.2 Total installed capacity

Power Station	Installed Capacity	Year Commissioned
Nkula Falls A (Shire River)	24	1966
Nkula Falls B (Shire River)	60	1980
	20	1986
	20	1992
Tedzani Falls I (Shire River)	20	1973
Tedzani Falls II (Shire River)	20	1977
Tedzani Falls III (Shire River)	52.7	1996
Wovwe Mini Hydro (Wovwe River)	4.35	1995
Kapichira Falls Phase I (Shire River)	64.8	2000
Kapichira Falls Phase II (Shire River)	64.8	2013
Mzuzu Diesel	1.1	2017
Likoma Island Diesels	1.05	2003
Kanengo Diesel Plant	10	2016
Chizumulu Island Diesels	0.3	2003
Total Installed Capacity in 2017	**363.1**	

Source: Malawi Government [25]

Table 1.3 Untapped hydropower potential sites

Site Name	Name of River	Potential Electricity Generation (MW)
North		
Manolo	Songwe River	60-130
Low Fufu	South Rukuru River	75-140
Low Fufu and Transfer	South Rukuru River	90-180
High Fufu	South Rukuru River	90-175
Henga Valley	South Rukuru River	20-40
Rumphi	North Rukuru River	3-13
Central		
Chasombo	Bua River	25-50
Chizuma	Bua River	25-50
Malenga	Bua River	30-60
Mbongozi	Bua River	20-50
Chimgonda	Dwambazi River	20-50
South		
Kholombozi	Shire River	140-280
Mpatamanga	Shire River	135-300
Zoa Falls	Shire River	20-45

Source: Modified from Gamula et al [27]

Electricity from Solar Photovoltaic (PV) technology is still low, but it is increasing in utilization, finding applications in telecommunications, refrigeration, water pumping and at some government institutions like hospitals, schools, as well as some solar home systems. The largest Solar PV installation currently is the 830 kW solar farm at Kamuzu International Airport in Lilongwe and is the first-ever solar power project with a connection to the national grid. The GoM recognizes the need to promote and provide reliable, affordable, quality electricity to meet the needs of low income customers, particularly those in the rural areas. As such the Government initiated solar villages to serve rurally isolated communities through off-grid renewable electricity generation. The PV systems were installed as a community resource, being used among others in water pumping, lighting, and refrigeration in schools and health posts. These solar villages are Elunyeni in Mzimba, Mdyaka in Nkhatabay, Chigunda in Nkhotakota, Kadambwe in Ntcheu, Kadzuwa in Thyolo and Chitawo Village in Chiradzulo districts [29]. Solar resource in Malawi is superb with an average solar irradiation on a horizontal surface of “5.8 kWh/m^2 per day and the potential solar energy on a horizontal surface ranges from 1642.5 to 2555 kWh/m^2 per annum” [30]. With this good solar resource, at “15 % PV module efficiency, the available irradiation in Malawi can yield over 6000 GWh per annum from less than 2 % (18 km^2) of the country's land area” [31].

Wind power generation has not materialised but through Wind Energy Preparation Programme (WEPP) a feasibility analysis was completed and the study provided key insight for wind power development in Malawi. The government has installed small wind turbines of 10 kW capacity as part of hybrid systems with solar PV for rural electrification projects particularly for Mdyaka and Elunyeni solar villages. In terms of geothermal energy development, geothermal resource of Malawi has been investigated and is estimated at 200MW. There are over 50 known hot springs with 18 hot springs having an average surface temperature above 50 °C however, most of the hotter springs occur in the northern part of the Malawi [32]. Planning for a 30 MW geothermal plant in Nkhotakota started in 2012 and it was envisaged that the 30 MW plant would be upgraded to 100 MW [32]. To date the plant has not been constructed. GoM identified geothermal potential areas in excess of 20 sites where detailed explorations will be performed. Some selected geothermal sites are presented in table below;

Table 1.4 Potential geothermal sites

Site Name	District of Location	Average surface-water temperature (°C)
Mphizi	Rumphi	82
Chiwi	Nkhotakota	76
Mtomdoro	Nkhatabay	72
Mawira 1	Nkhotakota	67
Mawira 3	Nkhotakota	65
Mawira 4	Nkhotakota	64
Chombo	Nkhotakota	64
Mawira 5	Nkhotakota	63
Lingóna	Nkhotakota	61
Ngara 1	Karonga	59
Ngara 2	Karonga	55
July village	Chinkwawa	55
Chipwidzi	Nkhotakota	54
Mukungwi	Karonga	52
Mwankenja 2	Karonga	51
Mwankenja 1	Karonga	50
Mawira 2	Nkhotakota	50
Sitima	Balaka	50

Source: Zalengera et al [31]

The GoM has put emphasis on the need to make the transition away from current practices into a sustainable energy trilemma such that a modern, affordable, reliable, sustainable electricity meets the needs of the people, drive economic growth, and protect environment. Only electricity generated from renewable sources can achieve all of these aims simultaneously [25].

1.3 Malawi Feed-in Tariff Policy

Malawi Energy Regulatory Authority (MERA), in 2012, introduced feed-in tariffs as an efficient policy tool to drive the development of renewable power generation in Malawi. The FIT tool has three objectives; (i) facilitate renewable energy resource mobilization by providing investment security and market stability for investors in electricity generation from renewable energy sources (ii) reduce transaction and administrative costs and delays by eliminating the conventional bidding processes (iii) encourage private investors to operate their power plants prudently and efficiently so as to maximize returns [33]. As a commitment to encourage Independent Power Producers (IPPs) to invest in renewable power generation, the designed feed-in prices was based on the cost of various technologies since generation costs vary for different renewable energy technologies. The FIT designed by MERA provides tariffs for different technologies considering the generation costs and a fair return on equity based on the social- economic condition of the country and the regional experience. The feed-in prices were calculated on firm and non-firm power, incorporate the cost of connecting to the grid and the FIT policy undergo periodic review every five years [33].

MERA selected six renewable generation technologies for FIT policy tool namely small scale hydro, solar Photovoltaic, biomass cogeneration, biogas wind and geothermal energy. The feed-in tariffs for the aforementioned technologies were set as shown in table 1.5.

Table 1.5 Malawi Feed-In Tariff rates

Renewable Fuel	Project Size Tranche	Firm Power Tariff (¢/kWh)	Non-Firm Power Tariff (¢/kWh)	Duration
Hydropower	500kW-1 MW	14.0	13.0	20 yrs.
	1-5 MW	12.0	10.0	20 yrs.
	5-10 MW	10.0	8.0	20 yrs.
Solar	500kW-10 MW	20.0	10.0	20 yrs.
Biomass	500kW-100 MW	10.0	8.0	20 yrs.
Biogas	500kW-50 MW	10.0	8.0	20 yrs.
Wind	500kW-50 MW	13.0	13.0	20 yrs.
Geothermal	0-50 MW	10.5	10.5	20 yrs.

Source: Author

MERA introduced various caps as a way of control market saturation or unprecedented growth of RE and to limit the costs of the policy. The condition for hydropower tariffs is applicable to first 150 MW of small hydro, firm power generating stations whereas the non-firm power rate is valid to first 50 MW of small hydro non-firm power generating stations developed in Malawi. Secondly, for solar, the firm power price pertain to the first 100 MW while the non-firm power price applies to the first 50 MW of non-firm power generating, solar based power plants developed in the country. In addition, biomass firm power rate is applicable to the first 200 MW while non-firm power rate is applicable to the first 50 MW of biomass based power plants developed in the country. In contrast, the firm power price for biogas is applicable to the first 100 MW whereas the non-firm power price is applicable to the first 50 MW biogas based power plants. Last but one is the wind power tariff that is valid for the first cumulative 200 MW capacity. Lastly, the condition for geothermal energy tariff effect the first 200 MW installed in the country [33]. According to MERA, the grid operator, ESCOM, shall connect all renewable power plants, guarantee priority purchase and dispatch.

1.4 Problem Analysis and Statement

Over the last few years, endless Government effort has been fostering the deployment and utilization of RE. Different initiatives to increase RETs uptake have been pursued in Malawi such as the National Sustainable and Renewable Energy Program (NSREP), Barrier Removal to Renewable Energy in Malawi (BARREM), Program for Biomass Energy Conservation (ProBEC), the Promotion of Alternative Energy Sources Project (PAESP) and the Malawi Renewable Energy Acceleration Programme (MREAP). In 2012, GoM introduced FITs as an economic incentive for IPP to invest in renewable power generation by offering long-term power purchase agreements for the sale of RE electricity.

In relation to RE power generation, a growing body of evidence concludes that FIT scheme as market-based instruments is the most effective and efficient tool for deploying RE electricity and account for the greatest propagation of renewable electricity generation that any other RE support scheme [13], [34], [35]. In many countries, FIT schemes are considered the main contributor to the success of RE markets [36] but for Malawi, it is a contrary case FIT policy has not increased the share of RE in total energy supply. Since its inception in 2012, there is only one grid-connected power plant at Kamuzu International Airport (KIA). The 830 kW solar farm was a grant project entitled "Introduction of Clean Energy by Solar Electricity Generation System" funded by the Japanese Government through Japan International Corporation Agency (JICA) Malawi. This is the first-ever power project connected to the national grid. The project concept intended power KIA premises, neighbouring staff houses with the surplus electricity fed into the nation grid. To date, there is no IPP in the country generating and selling power to the grid.

According to Malawi Renewable Energy Strategy (MRES) there are over 40 Independent Power Producers (IPPs) who have expressed interest in the RE market by signing a memorandums of agreement with the Government of Malawi. MRES enunciates that these agreements are non-binding, but they just highlight the scale of interest. As for the large-scale power sector, the GoM hopes that the first Power Purchase Agreement will be signed with an independent investor in 2018 and that the first new renewables development will be operational by 2020 [25]. A key question for policymakers: Why the FIT policy in Malawi has actually not increased renewable electricity generation capacity? This research sought to analyse the FIT policy for Malawi as the tool has not achieved its objective of either attracting and encouraging private investors to operate their power plants or spread of decentralized production of RE and the deployment of RETs. Among notable things stated in the FIT policy document, the government hoped that the feed-in tariffs would eventually displace the existing very expensive diesel operated generator used for electricity production on Likoma and Chizumulo Islands that has not happened to date [33].

Additionally, the second inspiration for this research is the commitment expressed by the Government to promote grid-scale renewable electricity. MRES action number 1 for 2018 under renewable electricity articulates that Government is seeking partners to “assess the need for and viability of a renewable energy Feed-in Tariff in Malawi” [25]. Among other things, the GoM acknowledge the potential and constant interest of IPPs to invest in the power sector as such the IPPs are key to bridging the gap between electricity demand and supply [25].

Finally, yet importantly, Malawi is facing energy crisis, the existing generation capacity cannot meet the growing demand for electricity. Electricity blackouts are the order of the day. According to Millennium Challenge Corporation (MCC), the country is faced with serious energy supply problems notably, insufficient electricity generation capacity, insufficient attention on alternative energy sources and lack of investment in new electricity generation units. There are high transmission and distribution losses transpired by low voltage transmission at 33 kV and 66 kV to long distances, heavily subsidized electricity price, and lack of access to modern electricity for a big section of the population [37]. It is urgent that the IPPs enter the electricity market. An effective FIT policy that is well designed and implemented can quickly stimulate IPPs to invest in large amounts of RE electricity generation to alleviate the supply problem and address the electricity access gap in Malawi. As seen, FITs have accelerated RE utilization, helping bring the countries that have implemented them successfully to the limelight in the RE industry and to secure their nation’s energy supply. FITs can be more than just guaranteed payments for electricity generated from RE in Malawi. They can promote rural electrification, increase electricity generation capacity, provide greater power reliability and contribute to meeting national energy policy objectives of improving security of supply, and diversify supply. Government noble actions are many, but one of the most noble among them is to uplift the masses who are deep in energy poverty and enable them to pursue a decent life.

1.5 Objectives of the Study

1.5.1 General objective of the study

The overall objective of the study was to analyse the feed-in tariff policy as mechanism to accelerate renewable energy deployment and electricity access in Malawi.

1.5.2 Specific objectives of the study

i. To assess feed-in tariff policy design and remuneration model in Malawi.
ii. To investigate the feed-in tariff policy implementation and the challenges encountered in Malawi.
iii. To examine the funding for feed-in tariff policy in Malawi

1.5.3 Research questions

This research aims to answer the following research questions:

i. What is the best feed-in tariff payment design and remuneration model to employ in order to make the policy effective in Malawi?
ii. What are the challenges in FIT implementation and changes to implement in order to make the FIT scheme effective in Malawi?
iii. How to fund the feed-in tariff policy in Malawi?
iv. Which innovative design to limit the total cost of the FIT policy should be implemented in Malawi?

1.6 Significance of the Study

The Malawi FIT policy is subject for review as the five years' duration has elapsed. This study will develop new information on how design an effective FIT policy that will attract IPP into the electricity market in the next five years. The research findings and recommendations will be fed back into further rounds of policymaking process as this study shall supply policy makers with reliable policy-relevant knowledge about FIT designs options. Well-designed FIT will transform the country's energy system in profound and tangible way. An effective FIT scheme will foster more rapid RE deployment, increase overall electricity generation, boost economic development and improve access to modern energy for all while avoiding the GHG emissions.

Additionally, the GoM has come up with an Action Agenda in line with SE4All, which present an energy sector-wide vision covering the period of 15 years from 2015 to 2030 as a way of achieving the SE4All goals of universal access to modern energy services and increasing the share of renewable energy in Malawi energy mix by 2030. Electricity from renewable energy sources has been set at 11 % in 2020, 16 % in 2025 and 22 % in 2030 [28]. As of 2015, less than 1% of rural areas population had electricity access but the Action Agenda is targeting 31.6

% of rural people to access electricity [38]. The renewable energy targets are shown in table 1.6 with a projected total installed capacity of 2,170.35 MW by 2030.

Table 1.6 Renewable energy 2030 targets

RE source	2016 capacity	2030 target	Target Percentage
Large hydro	281.5 MW	1,471 MW	Percent of generation: 56
Small hydro	4.35 MW	103.35 MW	Percent of generation: 4
Solar	.8	550 MW	Percent of generation: 21
Bagasse	18 MW	46 MW	Percent of generation:1.8
TOTAL	303.85	2,170 MW	Percent of generation: 83

Source: Malawi Government [38]

To attain these RE targets outlined in the table above, FIT scheme is one of the most viable and versatile strategy for the country. The FIT scheme strategy will enable RETs to become the backbone of the energy system and achieve the targets. Perfectly and expertly designed FIT shall bring untold benefits to electricity customers and meet the country's renewable energy 2030 targets. Therefore, a robust discussion about FIT policy is instrumental given the energy crisis at hand, as the existing generation capacity cannot meet the growing demand for electricity. Unquestionably, the research findings will contribute to attainment of these targets through an effective FIT scheme, which is a revolutionary tool and sustainable investment plan for the Malawi's power sector to save the climate and accelerate power production from RE sources. For example, FITs are key to Germany's goal of generating 35 percent of its electricity from renewable sources by 2020 while in Thailand's FIT policies are central to the target to increase RE generation from about 9 percent of total energy consumption in 2011 to 25 percent by 2021 [39].

1.7 Scope of the Study

1.7.1 Geographical scope

The study was carried out in Malawi as the policy is implemented countrywide and applies to all four regions. The stakeholder relevant to the instrument is the central government particularly Malawi Energy Regulatory Authority (MERA). The study area was accessible to the researcher and the FIT policy for the country is due for review.

1.7.2 Time scope

The study covered a period from January 2018 to July 2018. The researcher considered this period bearing in mind the approved time to do master's thesis in line with PAUWES academic calendar.

1.7.3 Subject scope

The research analysed robust FIT policy design, implementation and funding to accelerate renewable energy deployment and widening electricity access in Malawi. An innovative FIT designs to limit the policy costs was explored. A detailed analysis of FIT scheme design and implementation was carried out to identify a set of best practices that can be effective to rapidly encourage and increase the share of RE electricity in the total energy supply.

1.7.4 Target audience

This research targeted policy makers and regulators and influential stakeholders of the energy sector. The nature of analysis of this research targeted the Ministry of Energy, Department of Energy Affairs, Malawi Energy Regulatory Authority, academia and energy researchers.

Chapter 2 : LITERATURE REVIEW

2.0 Introduction

This chapter presents literature on policy instruments supporting renewable energy deployment, feed-in tariffs policy design and the key elements in the design and policy considerations. The chapter outlines empirical evidence on successful and effective FIT policy implementation in the European Union (EU) and African context.

2.1 Theoretical Background on Environmental Policy Instruments

Environmental policy theory integrates a broader range of disciplines for better understanding of the linkages between human and natural systems. Modern environmental policy dates back to early seventies where it essentially focused on water quality, air pollutants, solid waste disposal and pollution control. The most notable theoretical work in the field of neoclassical environmental economics was established the seventies, which is still applied in our era to understand the theory of environmental policy instruments [40]. Among other things, environment economics seeks to establish the best way to allocate scarce resources to the various production processes and finished goods to the consumers. Environmental economics deals with the interface between economics and the surrounding life-support system of the earth. Environmental economics put emphasis on assimilating environmental commodities such as quality water, clean air into the economic system. These environmental commodities are perceived as scare and affect human well-being and the public hence they should be considered in the economic resource allocation problem. For instance, neoclassical theory uses the Pareto Criterion as the main indicator to assess the optimal allocation of resource at hand [40]. Nevertheless, some early policy instruments were deemed inefficient to solve some of environmental problems such as the command-and-control regulations have addressed point source water pollution, they have been less successful in dealing with non-point source pollution [41]. Table below presents environmental policies instruments that have been used for ages and have had different impact on the national and global scale.

Table 2.1Environmental policy instruments

Serial	Policy type	Description/Examples
1	Regulative instruments	Command and control, permits, technological prescription
2	Market-based instruments	Taxes, tariffs, subsidies, tradable permits
3	Procedural instruments	Auditing programmes, environmental impact assessment
4	Co-operative instruments	Commitments and agreements, roundtables, action plans, harmonisation, research
5	Persuasive instruments	Information , education, public campaigns, appeals, eco labels

Source: Böcher and Töller [42]

Regulative instruments such as command-and-control aim at controlling the actions of firms and encompass mandatory regulations where the government directly intervenes in the activities of individual firms by prescribing or forbidding certain activities [43]. Command-and-control regulations allow relatively little flexibility as the regulator specifies what individual firms can and cannot do enforced by penalties for non-compliance. On the other hand, they effectively limit aggregate emissions of pollutants and they typically exact high costs in the process by forcing some firms to resort to unduly expensive means of controlling pollution [44]. Some types of regulatory instrument include emission standards, controls on use of resources and toxic substances, through bans, permits, quotas and licensing; controls on the choice of technology or standards for the environmental performance of technology; compulsory environmental management standards and environmental audits [45].

Market-based instruments (MBIs) are regulations that aim at providing actors or polluters with incentives to adopt low-emission technologies and encourage behaviour change through market signals rather than through explicit directives regarding pollution control levels or methods [43], [46]. Market-based instruments alter the behaviour of producers and consumers by providing positive or negative economic incentives to change their behaviour towards more efficient use of natural resources and to consider alternative modes of action that are less harmful to the environment. MBIs include taxes or charges on emissions or products, levies, tradable permit schemes, deposit refund systems, subsidies, tax or refund schemes whereby people receive refunds on environmental taxes [47]. MBIs help in setting the right price of resources that are improperly valued at the market, such as ecosystem services, quality water, clean air, and biodiversity. By setting the right price, MBIs reflects the resource cost or externality cost and reflects the principle of full-cost recovery hence providing actors with incentives to change their behaviours and to control emission with reference to individual marginal abatement curves [47]. Some remarkable successes of MBIs include reduction of

United States sulphur dioxide emissions and the bottle deposit refund programs that increased recycling rates in municipalities throughout the United States [41].

Procedural instruments aim at assessing the environmental impact of certain production processes and determine alternative arrangements that are environment friendly. Examples are environmental impact assessment [48]. Co-operative instruments such as voluntary agreements work best where people already have some incentive to change their behaviour and they integrate with prevailing laws. Voluntary agreements are effective where behaviour change is guaranteed through the actions of a small number of market players and the scale of environmental impacts would not warrant the introduction of national regulative instruments or economic incentives [45]. A number of studies question the effectiveness of voluntary agreements citing that organizations take part in voluntary agreements as long as there is a benefit, afraid of regulations and work in a country that already have voluntary agreements in action [41], [49]. Persuasive instruments such as information provision tools work best where there is an information gap such that the missing of information is a hindrance to people to change their behaviour on how best to reduce environmental impacts. Some examples of information provision tools are information campaigns, eco labels, internet or face-to-face advice and training. The essence of information-based tools is to lessen information asymmetry, transpired by consumers' limited knowledge on the products they buy facing inept choices [41]. Environmental policy has continued to evolve into one of the strongest focus areas bringing about the adoption of a plethora of different policy instruments fostering innovation and diffusion of environmental friendly technologies that help in climate change mitigation and GHG emission reduction, especially in the field of renewable energy sources to decarbonise the energy sector [42].

2.2 Policy Instruments Encouraging the Deployment of Renewable Electricity Generation

Environmental policy as discussed above has advanced bringing about the adoption of superabundantly policy instruments profoundly used in the renewable energy field and climate change mitigation. Renewable energy plays a crucial to abate GHG emissions, provide access to modern energy, and bring about energy security by diversifying energy supply and a reducing energy import dependency. International Renewable Energy Agency (IRENA) describes four policy instruments that are used to promote renewable electricity generation namely fiscal incentives; public finance, regulations; and access policies as summarized in table below [50].

Table 2.2 Policy instruments that promote renewable electricity generation

POLICY INSTRUMENTS	DESCRIPTION
Fiscal incentives	
Rebate	One-time direct payment from the government to a private party to cover a percentage or specified amount of the investment cost of a RE system or service. Typically, offered automatically to eligible projects after completion, not requiring detailed application procedures.
Grant	Monetary assistance that does not have to be repaid and that is bestowed by a government for specified purposes to an eligible recipient. Grants (and rebates) help reduce system investment costs associated with preparation, purchase or construction of renewable energy (RE) equipment or related infrastructure.
Energy production payment	Direct payment from the government per unit of RE produced.
Tax credit (production or investment)	Provides the investor or owner of qualifying property with an annual income tax credit based on the amount of money invested in that facility or the amount of energy that it generates during the relevant year. Allows investments in RE to be partially or fully deducted from tax obligations or income.
Tax reduction or exemption	Reduction in tax—including but not limited to sales, value-added, energy or carbon tax—applicable to the purchase (or production) of RE or RE technologies
Public finance	
Investment	Financing provided in return for an equity ownership interest in a RE company or project. Usually delivered as a government-managed fund that directly invests equity in projects and companies, or as a funder of privately managed funds (fund of funds).
Guarantee	Risk-sharing mechanism aimed at mobilising domestic lending from commercial banks for RE companies and projects that have high-perceived credit (i.e., repayment) risk. Typically, a guarantee is partial, that is, it covers a portion of the outstanding loan principal with 50 - 80% being common.
Loan	Financing provided to a RE company or project in return for a debt (i.e., repayment) obligation. Provided by government, development bank or investment authority usually on concessional terms (e.g., lower interest rates or with lower security requirements).
Public procurement	Public entities preferentially purchase RE services (such as electricity) and/or RE equipment.
Regulations	
Quantity-driven	
Renewable Portfolio Standard or Quota obligation or mandate	Obligates designated parties (generators, suppliers, consumers) to meet minimum RE targets, generally expressed as percentages of total supplies or as an amount of RE capacity, with costs borne by consumers. Mandates for blending biofuels into total transportation fuel in percent or specific quantity.
Tendering or Bidding	Public authorities organise tenders for given quota of RE supplies or supply capacities, and remunerate winning bids at prices mostly above standard market levels.
Price-driven	

Fixed payment feed-in tariff (FIT)	Guarantees RE supplies with priority access and dispatch, and sets a fixed price varying by technology per unit delivered during a specified number of years.
Premium payment FIT	Guarantees RE supplies an additional payment on top of their energy market price or end-use value.
Quality-driven	
Green energy purchasing	Regulates the supply of voluntary RE purchases by consumers, beyond existing RE obligations.
Green labelling	Government-sponsored labelling (there are also some private sector labels) that guarantees that energy products meet certain sustainability criteria to facilitate voluntary green energy purchasing. Some governments require labelling on consumer bills, with full disclosure of the energy mix (or share of RE).
Access	
Net metering (also net billing)	Allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. The meter flows backwards when power is fed into the grid, with power compensated at the retail rate during the 'netting' cycle regardless of whether instantaneous customer generation exceeds customer demand.
Priority or guaranteed access to network	Provides RE supplies with unhindered access to established energy networks.
Priority dispatch	Mandates that RE supplies are integrated into energy systems before supplies from other sources.

Source: IRENA [50]

2.3 Empirical Review of Feed in Tariff Policy

The feed-in tariff is a policy mechanism used to accelerate investment in RETs and oblige power utilities to purchase from energy producers the electricity generated from renewable energy sources that is fed into the power grid at predetermined rates. FIT for renewable energies is described as a game changer and an effective stimulus package without new public borrowing [51]. The profitability level and price or tariff at which the government or state set to purchase electricity from IPPs is crucial for the success of FIT schemes. High tariffs tend to attract more investors due to high levels of profitability or returns as this makes less efficient projects financially viable. Low tariffs in turn, are not appealing to investors hence limited RE deployment, as this conservative remuneration may not be sufficient for RE market expansion [11]. FIT has several designs options and elements and payment can be differentiated by technology type, transmission access, resource quality at a particular site for instance strong wind regime versus weak wind regime. Project size in terms of total installed capacity, specific location, ownership type for example, publicly owned versus privately owned and project location to reflect the real project costs such as mainland versus island locations [52].

2.3.1 Feed-in tariff price calculation methodology

FIT payment calculation methodology is one of the fundamental design elements for policymaker to decide in establishing the actual FIT payment price awarded to IPPs for the electricity generated. There are four different approaches or methodologies used worldwide in designing and calculating price to determine the FIT payment levels. Firstly, the payment design is based on the actual levelized cost of RE generation, plus an estimated profit, which the policymakers or regulators usually decide. This approach is the most commonly used in the European Union and has been the most successful FIT option in driving rapid RE deployment. The second is based on the value of the RE generation either to society or to the utility typically expressed in terms of "avoided costs." The value to society account for the attributes of the electricity plus sustainability and climate change mitigation, health and safety impacts, energy security, supply diversity and other external costs or externalities. This approach is used common in the United States like in California in addition to British Columbia but in the United States, it has experienced more limited success. [52], [53], [54].

A third approach largely used by some utilities in the United States offers the FIT payment as a fixed-price incentive without regard to actual levelized RE generation costs or avoided costs. In this approach, a fixed-tariff is established as an arbitrarily economic incentive that offers a purchase price for renewable electricity without regard to generation costs or the notion of value to society or utility. Just like the second approach, this design option has also experienced limited success in the United States [54]. The fourth and last approach on FIT price calculation methodology is the auction-based mechanisms. Both China and India have tried out this approach. The auction mechanism is a cost-based approach and the bidding process results help in discovering the actual tariff or price that is appealing to the market [52], [55].

2.3.2 Feed-in tariff payment models

There are seven different models to structure the FIT remuneration and are mostly classified into two broad categories as market independent FIT policies and market dependent FIT policies. The four models under market-independent FIT are as follows; (i) the fixed-price model is the most basic and simplest model, which offers a fixed rate for renewable electricity for a fixed duration irrespective of the retail price of electricity as shown in figure (a). With the fixed price model, the price remains unchanged for the duration of the contract period and is independent of other variables, such as inflation and the price of fossil fuels. This model is used in more than 50 countries making it the most widely implemented of all FIT policy designs. Examples are Greece, Switzerland, Canada and Germany of which Germany has employed this model since 2000. (ii) The fixed price model with partial or full inflation adjustment as shown in figure (b). This is similar to fixed price model but the price offered tracks inflation. For example, France offers partial inflation adjustment to renewable energy projects according to a formula that adjust electricity base rate in a range of 40 % to 100 % while Ireland offers full inflation, or 100 %, adjustment. (iii) The front-end loaded tariff model offers higher payments in the early years and the price paid for RE decreases near the end of a RE projects life as shown in figure (c). A typically example is Slovenia FIT policy. (iv) Spot market gap model is the last market-independent FIT policy and a variant of this policy was executed in Netherlands. In this model, the FIT price paid to green electricity producer consists the spot price for electricity plus a subsidy, with a price ceiling on the maximum amount of remuneration that can be paid to the green electricity producer. The total price paid to green electricity producer is a fixed price defined by the summation "of the sum of the spot market price and the variable FIT premium because the actual FIT payment consists of the gap between the spot market price and the required FIT price." As shown in figure (d), spot price increases on condition that FIT premium decreases whereas if the spot price goes down the FIT premium increases. [56], [57], [58].

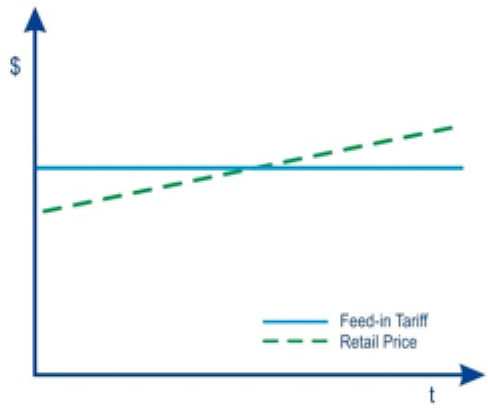


Figure a: Fixed price model [57]

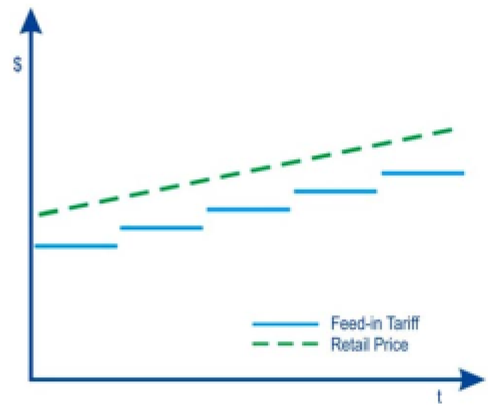


Figure b: Fixed price model with full or partial inflation adjustment [57]

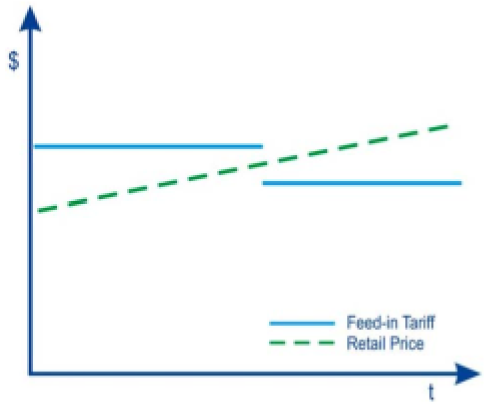


Figure c: Front-end loaded tariff model [57]

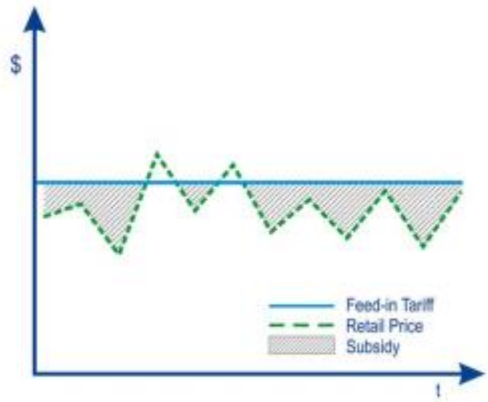


Figure d: Spot market gap model [57]

The second category is the market-dependent FIT policies, which consists the following three models: firstly, the premium price model. This model "offers a constant premium or bonus on top of the spot market electricity price". The FIT payment is the summation of the spot-market electricity tariff and an additional premium, known as an "adder". The value of the premium or the additional revenue never changes regardless of the spot market electricity price, which can fluctuate, up or down as shown in figure (e). Premium price model is usually implemented in "deregulated electricity markets" characterised by general fluctuations in the electricity retail price due to the force of demand and supply along with fuel costs. Furthermore, premium price model does not typically offer a purchase guarantee, but serves two purposes of either accounting for the environmental and societal value of RE, or approximating RE generation costs. Denmark, Netherlands, Czech Republic, Estonia and Slovenia are some countries that have implemented this model. Premium model can also offer payment differentiated on project size, technology type etc. but the generated electricity is sold on the spot electricity market, not as a guaranteed, long-term contract purchase agreements [52], [56], [57], [21], [39].

The second policy is variable premium model. This is a more complex extension of the premium model that encompass premium caps and premium floors and a variable adder that allow the premium to vary with respect to the market electricity tariff. The variable adder offers a larger subsidy when the spot market electricity price is decreases, and tapers off the subsidy when the spot-price increases as shown in figure (f). That is to say, as the spot market electricity price increase the premium tariff decrease gradually until a predetermined price; such that the premium level reaches zero and power producers receive the spot price. Large swings in the opposite direction, that is, as the spot market electricity price declines, the premium tariff increases gradually, until a predetermined price, a floor below which the price cannot exceed. For instance, a market premium scheme can be designed to provide wind power projects total compensation of $0.25 for each kilowatt-hour (kWh) of electricity sold. The wind power generator would first sell power into the wholesale market and, for this example; the project receives $0.15 per kWh. The market premium incentive scheme would then provide an additional $0.10 per kWh to the wind project in order to reach the $0.25 per kWh pre-determined price. From the above example, it can be observed that this model is designed with a 'corridor' to curtail astronomical windfall profits when the retail electricity prices rise dramatically, while minimising the investment risks for IPPs in situation where the market prices decreases to ensure that renewable projects are profitable. Spain is a typical example in implementing the variable premium model [56], [57], [21], [39], [59].

Last model is the percentage of retail price model. This model calculates the FIT as a percentage of the retail electricity price and the tariff can vary below, above or equal to the spot price. Electricity market price drives this model because if the electricity prices increase unexpectedly, power producers receives considerable windfall profits, whereas if the electricity price decrease suddenly, power producers experience a considerable loss of revenue. Previously this model was implemented in a number of countries such as Germany (90 % of retail price) and Denmark (85 % of retail price) but many countries abandoned this model, for instance Germany in 2000 and Denmark in 2001 respectively [56], [57].

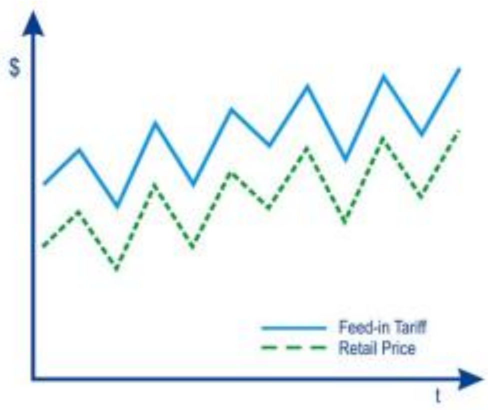


Figure e: Premium price model [57]

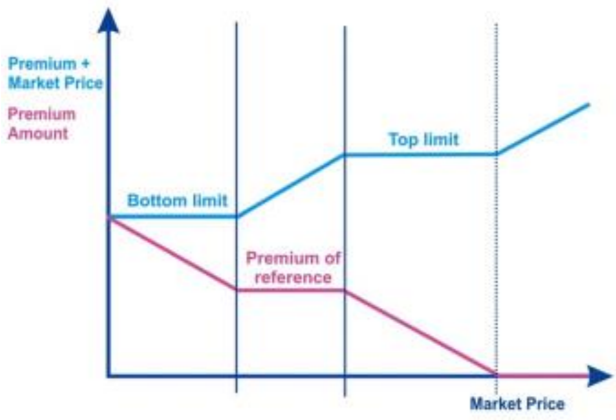


Figure f: Variable premium model [57]

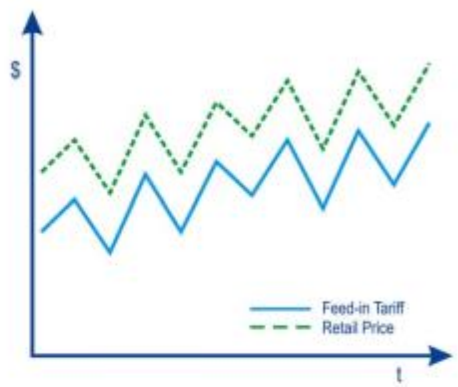


Figure g: Percentage of retail price model [57]

2.3.3 Feed-in tariff design elements and policy considerations

The FIT policy is the most popular support scheme for renewable electricity generation however; there is considerable variety in the design options and elements of individual FIT policies. The design elements of FIT scheme are as follows according to Mendonça: eligible technologies, eligible plants, tariff calculation methodology, technology-specific tariffs, size-specific tariffs, stepped tariff design, contract duration, financing mechanism, purchase obligations, priority grid access, effective administrative, procedures setting targets, progress reports, forecast obligation, tariff digression, increasing tariffs, inflation-indexed tariffs, revision of tariffs and cost-sharing methodology for grid connection [15].

The following table indicates major interactions between the design issues and policy considerations that policy makers should weigh when considering FIT policy design and implementation. The checks denote the policy design issues that are most appropriate to the underlying policy considerations, and vice versa holds.

Table 2.3 Feed-In Tariff design issues and policy considerations

	POLICY CONSIDERATIONS							
FIT DESIGN ISSUE	Investor security	Energy access	Grid stability	Policy costs	Price stabilization	Electricity portfolio diversity	Administrative complexity	Economic development
Integration with Policy Targets	√						√	
Eligibility		√	√	√		√		√
Tariff Differentiation		√		√		√	√	√
Payment Based On (Setting the Tariff Rate)	√			√	√	√	√	
Payment Duration	√			√	√			
Payment Structure	√			√	√		√	
Inflation	√				√			
Cost Recovery	√			√				
Interconnection Guarantee	√		√					
Interconnection Costs	√		√	√				
Purchase and Dispatch Requirements	√			√				
Amount Purchased	√						√	
Purchasing Entity	√						√	
Commodities Purchased	√			√			√	
Triggers & Adjustments	√		√	√	√		√	
Contract Issues	√							
Payment Currency	√			√				
Interaction with Other Incentives	√			√				

Source: UNEP [3]

To highlight some design issues and policy consideration from table above, different countries have different renewable electricity targets as such integrating FIT with national policy targets has implications for investor security and on the administrative complexity. Linking FITs into energy targets increases investor confidence in renewable energy markets on the other hand, it creates additional administrative complexity for policy makers, regulators and staff since progress toward the target has to be tracked and reported. Germany and South Africa are typical example of countries that linked FITs to renewable energy policy targets. Policy makers must decide RETs that must be supported and technologies eligible for tariff payment. Determining eligible technology enables the attainment of other policy objectives, for example increasing energy access, diversifying electricity supply mix, grid stability, limiting policy costs, and fosters economic development through limiting eligibility to those technologies that can create more job creation in the society in so doing it supports industrial policy as well. Uganda, Kenya, Canada and Thailand are some examples of countries that defined eligible technologies in their FIT policy [15], [3].

Policy makers need to consider inflation to ensure that the investors earn sufficient and targeted rate of return. For a well-designed FIT scheme, the time for full cost recovery and loan repaying usually takes 15–20 years. Long-term investment projects are very sensitive to inflation and an approach to account for inflation impacts investor security and price stabilization. Adjusting the FIT rate annually for inflation lower the risk that inflation will reduce future revenues and improves investor security. Inflation risk is a concern in developing countries and policy makers need a decision either to implement fully or partly inflation adjustment to protect tariffs against inflation rate. Ireland has implemented full inflation indexation while Spain, implemented partly adjust tariffs to inflation. Prior to December 2012, the tariffs were adjusted annually to the inflation index minus 25 per cent but from 2013, the tariffs are adjusted to the national inflation index minus 50 per cent [15], [3].

Triggers and adjustments just like other design issues have impacts on grid stability, investor security, price stabilization, policy costs, and administrative complexity. Triggers are described as a threshold that necessitate an adjustment when the level is reached or crossed. Examples of triggers include the elapse of a specified duration of time, attainment of targeted installation capacity (MW) or total policy cost. Adjustments are defined as policy modifications or changes that happen when a trigger is attained. Examples include automatic price adjustment, which can be increased or decreased in the rate due to inflation indexing and tariff digression, a hard stop, or commencement of rounds of policy review. Reviews are official regulatory evaluation to determine if any adjustments are required. The evaluation aims at monitoring and determining how the FIT policy has fared during implementation and the effects caused in practice. If the FIT policy is not adjusted, it impacts investors security because the FIT scheme may not keep pace with changing market conditions as well as the methodology to adjusting the rate, can bring risks and uncertainties which may affect the investor security. Adjustments are also need to control policy costs that may impact ratepayers and consumers. Likewise, adjustments can be used to stabilise the price as adjustments may reflect cost reductions or to encourage cost reductions whereas tariff digression can be an incentive to foster technology improvements. Conversely, unadjusted FIT scheme requires low regulatory supervision while adjusted FIT scheme requires high regulatory supervision and more administrative resources [3], [60]. Spain introduced automatic price adjustments for photovoltaics technologies if more than 75% of the capacity target is reached in the previous call, according to formula below:

Percentage adjustment to actual FIT payment (if triggered)

$$= [(1-0.9^{1/m}) \times (P_0 - P) / (0.25 \times P_0) + 0.9^{1/m}]$$

where P_0 is the PV targeted capacity for a given call, P is the pre-registered capacity recorded during the previous call, and m is the number of annual calls. If the capacity of a given call reaches between 75 % and 100 % there is a downward revision to the FIT payment level by 2.6 %. If the capacity of a given call is less than 75 % there are no changes or adjustments to the FIT payment level. Contrariwise, if less than 50 % of the capacity call is reached in two consecutive calls there is an upward revision to the FIT payment level by 2.6 % [52], [61].

2.4 European Union Feed-In Tariff Experience at Glance

Feed-in tariffs is a proven solution on how to accelerate RE deployment and the policy has been implemented in many countries worldwide. The case of EU has been chosen because it acknowledged that FIT policies in EU member states have been the most successful in promoting renewable energy worldwide with Germany FIT policy leading seconded by Spain then the UK considered having the most effective schemes in promoting renewable electricity generation [62]. For instance, in the European Union alone, over 15,000 MW of photovoltaic electricity have been generated between 2000 and 2009 as a result of feed-in tariffs [63] and 78% of new renewable electricity generation added between 1999 and 2009 was achieved by countries with FIT policies [64]. Figure below shows the contribution of FIT to EU total installed capacity and presents a comparison of FIT contribution to installed capacities (in GW) of biomass electricity, wind onshore and photovoltaics (PV) in the EU-27 and in countries using feed-in tariffs.

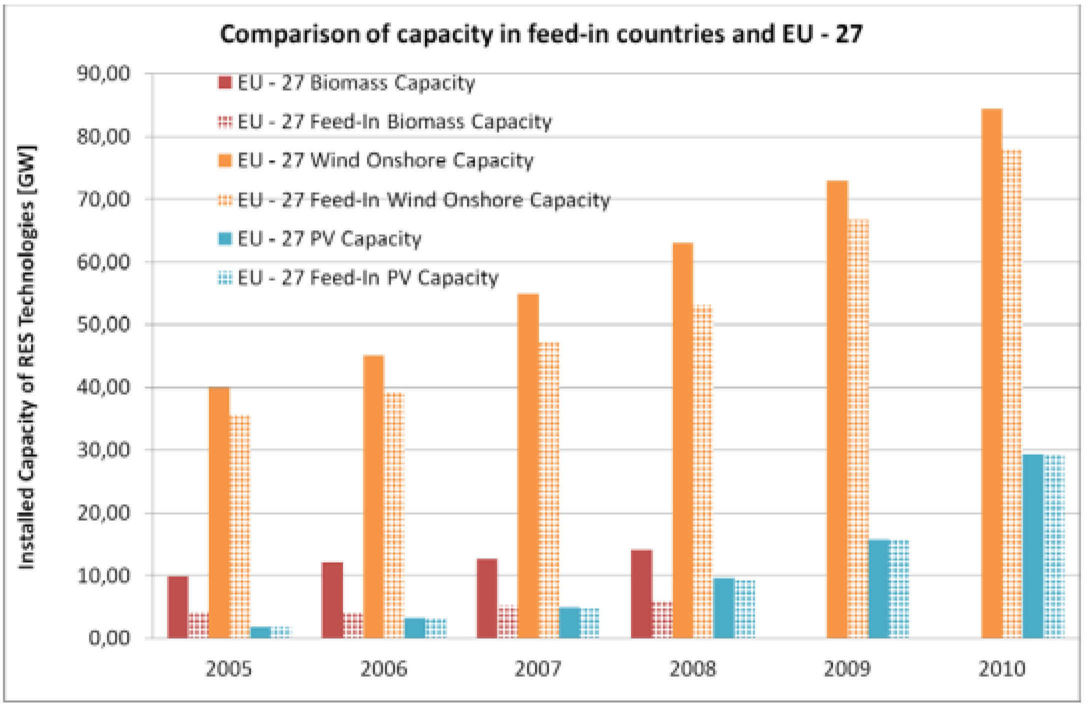


Figure 2.1 Comparison of FIT contribution to installed capacities in the EU-27 and in countries using feed-in tariffs
Source: Ragwitz et al [64]

From figure 2.1, wind energy deployment dominates and it is attributed to FIT scheme. Germany wind installed capacity rose from 18415 W in 2005 to 27214 MW in 2010 accounting for 9.3% of German electricity production while Spain wind energy accounts for 14.4% of the electricity supply. Correspondingly, PV installations in EU reached 29327.7 MW in 2010, which was a remarkable increase of almost 120% compared to 2009. For example, the Germany's installed PV capacity rose from 1910 MW in 2005 to 17370 MW in 2010. The UK is the most recent example with an increase in PV capacity as depicted below.

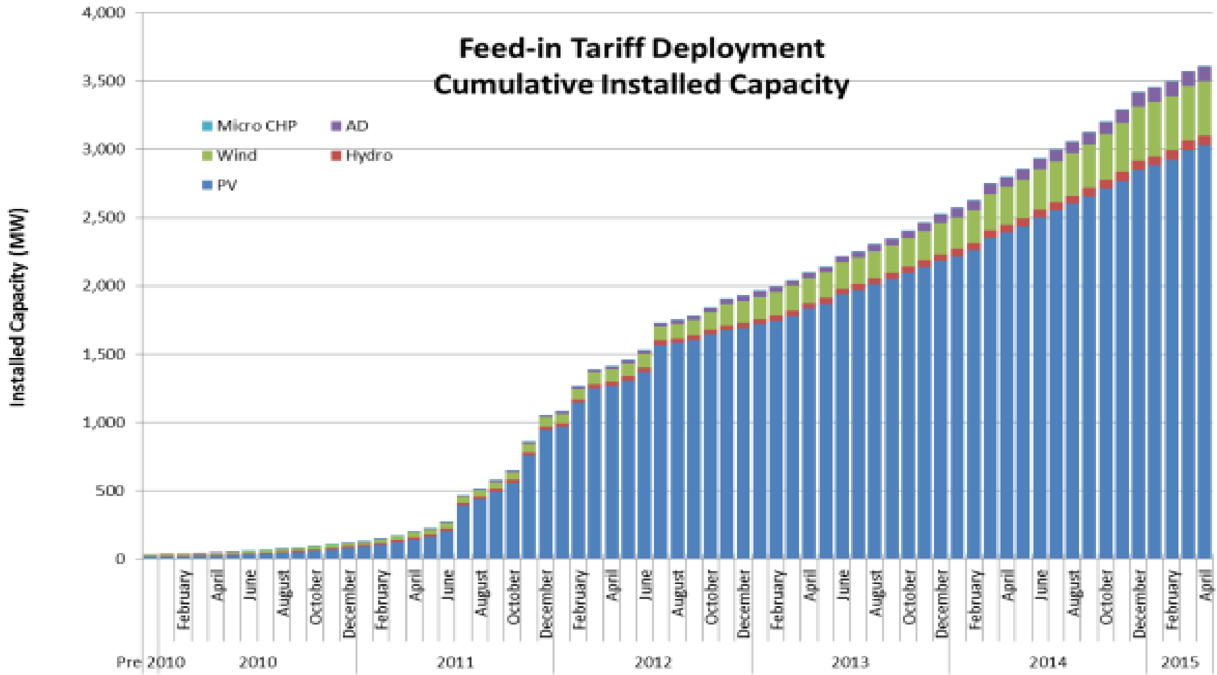


Figure 2.2 Installed capacity of renewable energy based on FITs in the UK
Source: Department of Energy and Climate Change [65]

As shown in figure 2.2, FIT enabled the UK to reach installation of 2000 MW by 2013 three years after FIT was introduced, with more installation from from solar energy [65]. The UK feed-in tariff scheme was introduced in April 2010, under the Energy Act 2008 linking it with the UK 2050 decarbonisation targets. From the graph as of 2015 and according to the 'Department of Energy and Climate Change', there were 682,511 installations with a cumulative capacity of 3,567MW installed five years after FIT adoption [65]. Table below presents the FIT remuneration levels and the duration of payment for RE electricity generation in the EU countries and the tariffs are valid for renewable generation plants commissioned from the year 2009 [60].

Table 2.4 Tariff levels in EU

		Tariff level in 2009 [€ Cents/kWh] and duration of support for different technologies						
Country		**Small hydro**	**Wind onshore**	**Wind offshore**	**Solid biomass**	**Biogas**	**PV**	**Geothermal**
Austria (fixed)		3.29 – 6.23 15 yrs.	7.53 10–12 yrs.	–	11.1 – 15.6 10–12 yrs.	11.3 – 16.9 10–12 yrs.	30.0 – 46.0 10–12 yrs.	7.28 10–12 yrs.
Bulgaria (fixed)		5.4 15 yrs.	7.4 – 9.7 15yrs	– –	8.5 – 11.1 15yrs	8.5 – 10.0 15yrs	38.6 – 42.1 25yrs	– –
Cyprus (fixed)		- -	16.6 15– 20yrs.	16.6 15–20yrs.	13.5 15–20yrs.	11.5 15–20yrs.	20.5 – 38.3 15-20 yrs.	–
Czech Republic	**(fixed)**	10.0 30 yrs.	8.6 20 yrs.	–	9.5 – 16.6 20 yrs.	13.1 – 15.2 20 yrs.	47.2 – 47.5 20 yrs.	16.6 20 yrs.
	(premium)	4.7 30 yrs.	6.0 20 yrs.	–	3.8 – 10.9 20 yrs.	7.4 – 9.5 20 yrs.	43.6 – 43.9 20 yrs.	11.6 20 yrs.
Estonia	**(fixed)**	7.35 12 yrs.	7.35 12 yrs.	7.35 12 yrs.	7.35 12 yrs.	7.35 12 yrs.	7.35 12 yrs.	7.35 12 yrs.
	(premium)	5.37 12 yrs.	5.37 12 yrs.	5.37 12 yrs.	5.37 12 yrs.	5.37 12 yrs.	5.37 12 yrs.	5.37 12 yrs.
France (fixed)		6.1 – 10.3 20 yrs.	8.2 15 yrs.	13.0 20 yrs.	12.8 20 yrs.	7.5 – 14.0 15 yrs.	32.8 – 60.1 20 yrs.	12.0 – 15.0 15 yrs.
Germany (fixed)		3.5 – 12.67 20 yrs.	5.0 - 9.2 20 yrs.	13.0 –15.0 20 yrs.	7.79 –29.67 20 yrs.	4.16 –11.0 20 yrs.	31.94 – 43.01 20 yrs.	10.5 – 23.0 20 yrs.
Greece (fixed)		8.0 – 9.2 10 yrs.	8.0 – 9.2 10 yrs.	9.7 10 yrs.	8.0 – 9.2 10 yrs.	8.0 – 9.2 10 yrs.	40.7 – 50.7 20 yrs.	8.0 – 9.2 10 yrs.
Hungary (fixed)		9.5 no limit	9.5 no limit	–	3.9 - 10.7 no limit	3.9 - 10.7 no limit	9.5 no limit	3.9 - 10.7 no limit
Ireland (fixed)		8.4 15 yrs.	6.6 – 6.9 15 yrs.	14.0 15 yrs.	8.4 15 yrs.	8.1 15 yrs.	–	–
Italy	**(fixed)**	22.0 15 yrs.	22.0 15 yrs.	-	28.0 15 yrs.	28.0 15 yrs.	-	20.0 15 yrs.
	(premium)	-	-	-	-	-	35.3 – 48.0 20 yrs.	-
Latvia (fixed)		10.8 – 13.9 10 yrs.	6.7 – 12.8 10 yrs.	–	6.0 – 17.7 10 yrs.	13.0 – 16.7 10 yrs.	33.0 10 yrs.	–
Lithuania (fixed)		7.53 10 yrs.	8.7 10 yrs.	8.7 10 yrs.	8.7 10 yrs.	8.7 10 yrs.	43.7-47.2 10 yrs.	–
Luxembourg (fixed)		8.5 – 10.5 15 yrs.	8.2 15 yrs.	–	14.5 15 yrs.	12.0 – 15.0 20 yrs.	35.9 – 40.7 15 yrs.	–
Netherlands (fixed)		8.1 15 years	6.9 15 years	–	7.1 - 13.3 15 years	1.5 12 years	32.4 – 40.6 15 years	–
Portugal (fixed)		7.5 – 7.7 20 - 25 yrs.	7.4 – 7.5 15 yrs.	7.4 – 7.5 15 yrs.	10.2 – 10.9 25 yrs.	10.2 – 11.7 15 yrs.	35.5 – 47 15 yrs.	–
Slovakia (fixed)		8.4 – 13.4 12 yrs.	8.5 – 10.2 12 yrs.	–	10.7 – 13.0 12 yrs.	10.4 – 17.9 12 yrs.	40.0 - 45.0 12 yrs.	19.7 12 yrs.
	(fixed)	8.2 – 10.5 15 yrs.	8.7 – 9.5 15 yrs.	–	16.7 – 22.4 15 yrs.	6.2 – 16.0 15 yrs.	26.9 – 41.5 15 yrs.	15.2 15 yrs.

Slovenia	**(premium)**	3.7 – 5.0 15 yrs.	3.1 – 4.3 15 yrs.	–	10.8 – 16.5 15 yrs.	0.7 – 10.3 15 yrs.	20.4 – 35.8 15 yrs.	9.3 – 15.2 15 yrs.
Spain	**(fixed)**	8.25 25 yrs.	7.65 20 yrs.	[6,60 + 1,20 x [(50 - P) /40]] x 1,0605, P = Power of the plant 25 yrs.	8.97 – 16.81 15 yrs.	6.88 – 8.45 15 yrs.	19.44 – 46.0 25 yrs.	7.29 20 yrs.
	(premium)	6.9 – 9.01 no limit	7.54–8.99 no limit	17.35 no limit	10.98 –17.6 no limit	7.47-9.48 no limit	–	–
United Kingdom	**(fixed)**	17.8 – 18.9 20 yrs.	4.5 – 34.5 20 yrs.	4.5 –34.5 20 yrs.	9.0 – 11.5 20 yrs.	9.0 – 11.5 20 yrs.	29.3 – 36.1 25 yrs.	-

Source: Klein et al [60]

2.4.1 The Germany feed-in tariff

Germany introduced FIT policy for the first time in Europe in December 1990 and utilities were obliged to purchase power from IPPs using the percentage of retail price model which was a fixed percentage. The "percentage ranged from 65-90% of the retail electricity price depending on the technology type and the project size" hence the system was effective at deploying coastal wind as well as hydropower electricity, but it had less effect on solar power. To foster the investment in more cutting-edge RE technologies specifically solar energy, a transition was necessary therefore; Germany shifted the payment model to the RE actual costs power generation instead of the market-based electricity price. This cost-based model offered a competitive advantage to a variety of renewable technologies with varying generation capacities, and remains the key element of successful FIT policies to date [52], [39].

The cost-based model drove the rapid increase of renewable from 3.1 % in 1990, to 6.4 % in 2000 and to 22.9 % in 2012. The contribution of solar photovoltaic in Germany increased sharply, from only 64 GWh in 2000 to 28 000 GWh by the end of 2012. The country was ranked first in the world in terms of solar PV capacity though the country is considered not to be rich in solar resources. As of end, 2012 Germany had 32 % of the world's installed PV capacity [66], [67]. Figure below shows the cumulative installed capacity of renewable power, by source, 2000-2014 with the contribution of FIT policy.

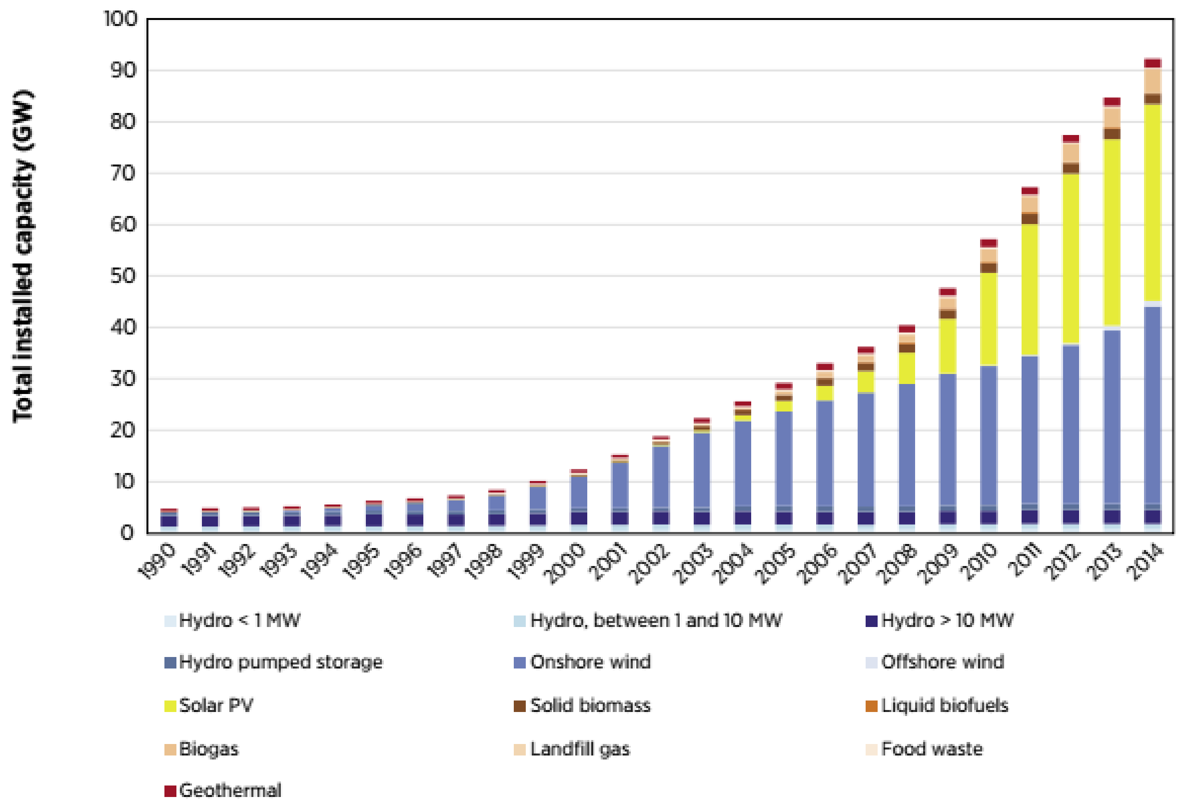


Figure 2.3 Germany Installed capacity of renewable power, by source, 2000-2014
Source: IRENA [68]

From figure above, Germany's total installed renewable power capacity increased by a factor of 7 between 2000 and 2013, from 12.3 GW to 85 GW. Onshore wind and solar PV dominate the renewable market, followed by various forms of bioenergy [68]. In the German system, tariffs are differentiated by source and plant size and contract duration is 20 years. The FIT scheme design has stepped tariff, purchase obligation, burden sharing and tariff digression. The Renewable Energy Act (Erneuerbare-Energien-Gesetz, or EEG) emphasize priority grid access for RES-E and renewable electricity has priority in transmission and distribution. Power producers are responsible to cover the costs associated with connecting their plants and metering devices to the appropriate grid connection point while utility grid operators are responsible for the costs of grid reinforcement and upgrading grid system. On financing the FIT policy, the scheme is independent of government budgets and subsidies. The grid operators pay the power producers directly for their power and pass on the costs of the tariffs to their electricity consumers in the electricity bill via a surcharge on electricity bills [39], [66], [68], [69].

2.5 Feed-In Tariff Schemes in Some African Countries at Glance

African countries have adopted various policy mechanisms to promote renewable energy deployment, increase power supply capacities and to diversify supply resource base. The most prevailing policies in Africa are fiscal incentives and tax reductions is the most widespread incentive in Africa as it requires no additional budget allocation from government coffers, fewer administrative procedures and low regulatory supervision [70]. FIT is the most prominent economic instrument promoting renewable energy technologies in the power sector thus several countries have adopted FITs like Algeria, Nigeria, Kenya, Mauritius, Rwanda, Uganda, South Africa, Ghana, Tanzania, Botswana, Zambia and Zimbabwe.

2.5.1 Algeria

Algeria was the pioneer country in Africa to adopt FIT and the first scheme was passed in 2004 after "power shortages and rationing of electricity" in mid-2003. The 2004 FIT scheme had no detailed RE targets but in 2011, Algeria adopted the Renewable Energy and Energy Efficiency Program targeting 22 000 MW of RE power between 2011 and 2030 [71]. The tariff is differentiated by technology and the power plant capacity cap is less than or equal to 50MW. The country offers premium remunerations and the eligible technologies are gas with steam/hot water cogeneration, solar thermal/gas hybrid, waste-to-energy, hydropower, wind power, concentrated solar power and solar PV technology. The FIT is dependent on government coffers; there is National Renewable Energy and Cogeneration Fund that earn 1% fee on petroleum royalties and other contributions. The FIT policy does not incorporate inflation indexed tariffs and contract issues on PPA is negotiated on case-by-case basis with the state-owned single buyer (Sonelgaz) the sole grid operator. RE power is granted priority grid access but interconnection cost are covered by the IPP while triggers & adjustments are based on RE production quota set per project per year. As of 2013, there was no a single project that came operational under the FIT policy [72].

2.5.2 Kenya

The Government of Kenya introduced a FIT policy in 2008 to diversify supply and increase electricity generation capacity. After two years, the scheme was revised which was published in 2010 as the remuneration model of the former scheme favoured state institutions not private investors for this reason it was criticised by investors. The payment levels in the 2008 scheme excluded the investment costs such that the higher interest rates and overall higher upfront capital costs was not reflect but tariff levels were based on projects involving government institutions. The latter scheme payment levels were calculated principally based on the generation cost of renewable power plants plus return on investment (12 % post tax on equity). The FIT design (differentiation) provide technology specific tariff levels including capacity size caps both minimum and maximum caps as shown in table 2.5. The contract duration is 20 years and the tariffs are offered for firm and non-firm power [71], [72], [73].

Table 2.5 Kenya's feed-in tariff levels and caps

Technology type	Plant capacity (MW)	Maximum firm power tariff (US$/kWh) at the interconnection point	Maximum non-firm power tariff (US$/kWh) at the interconnection point	Cap for firm capacity (MW)	Cap for non-firm capacity (MW)
Geothermal	up to 70	0.085		700	
Wind	0.5–100	0.12	0.12	300	
Biomass	0.5–100	0.08	0.06	200	50
Small Hydro	0.5–0.99	0.12	0.10	150	50
	1–5.0	0.10	0.08		
	5.1–10	0.08	0.06		
Biogas	0.5–40	0.08	0.06	100	50
Solar	0.5–10	0.20	0.10	100	50

Source: Renschhausen [71]

Kenya set a price ceiling for the FIT payments, rather than a fixed rate offer and the tariff build up does not factor in inflation index price. The FIT is independent of government budget as the utility pay the power producers directly for their power and pass on the costs of the tariffs to their electricity customers as the policy states that grid operators shall recover from electricity consumers the portion of the feed-in tariff 85 % for PV and 70 % for the other technologies. Power producers are responsible for grid interconnection costs and PPA are negotiated on a case-by-case basis because the tariffs are not minimum tariffs that must be paid by the grid operator, but maximum tariffs that must not be exceeded hence the IPP and the grid operator can agree upon lower tariffs. A number of IPPs are operating under the FIT scheme such as 920 kW small hydro plant owned by the Kenya Tea Development Agency (KTDA), 5 MW geothermal wellhead generator operated by KenGen, 2.2 MW Africa's first grid-connected biogas plant by Tropical Power Kenya, and as of 2014 around 60 power projects were approved [70], [71], [72], [73].

2.5.3 Tanzania

The FIT policy in Tanzania is based on mini-hydro projects generating between 100kW and 10 MW and the country uses Standardized Power Purchase (SPP) tariffs, which were formulated in 2008. The FIT eligibility include both on-grid and mini-grid interconnected generation and eligible power projects are restricted to be at least 100 kW and export no more than 10 MW. There is no tariff differentiation based on technology type, size, location or fuel type but tariff is differentiated depending on whether the SPP is grid-connected or mini-grid. The policy payment levels use the avoided cost methodology in calculating FIT prices rather than on generation costs and payment currency is Tanzanian Shilling (TZS). For main power plants connected to the grid, the average annual tariff is 152.54 TZS/kWh but during the dry season (August to November), the rate is 183.05 TZS/kWh, and 137.29 TZS/kWh during the wet season (January to July), while mini-grid systems it is 480.50 TZS/kWh. Standardized Power Purchase (SPP) are valid for the duration of 15 years. The payment structure has a floor, which is the agreed price in the year of signing a contract, and a cap is set at 150 % of the tariff price agreed in the year in which the PPA was signed and the adjusted based on Consumer Price Index. Tanzania FIT policy has supported 24.4 MW both biomass and hydropower plants and there are an additional power projects of a combined 130 MW under construction. Recently, the FIT scheme supported the first solar PV project of 208 kW capacity supplying electricity to 45 secondary schools, civic buildings, 10 health centres, 120 dispensaries, and businesses centres across 25 village markets in the Kigoma region [72], [74], [76].

2.6 The Conceptual Framework

The core objective behind introducing FIT policy mechanism across the world is to foster the deployment of electricity generated from renewable energy sources. Nevertheless, FIT designs and remunerations levels vary significantly across the countries. In context of Malawi, the objective of FIT scheme is to grant investment security and stable market for RE investors, encourage RE investors to operate their power plants discreetly in order to maximize profits and remove power generation bidding processes. With such specific objectives, it is necessary to discuss the conceptual framework for FIT policy in Malawi.

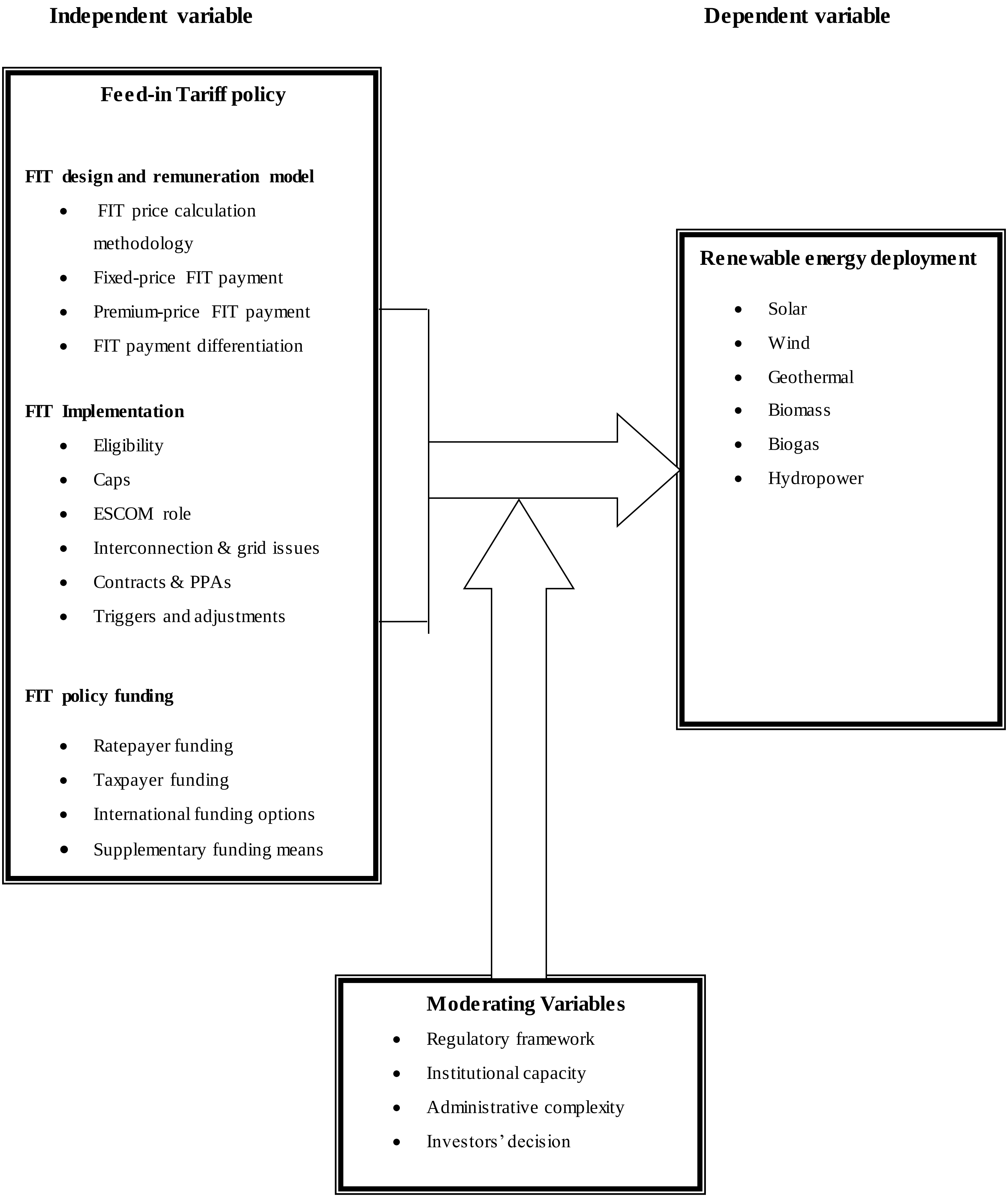


Figure 2.4 FIT policy conceptual framework

Source: Author

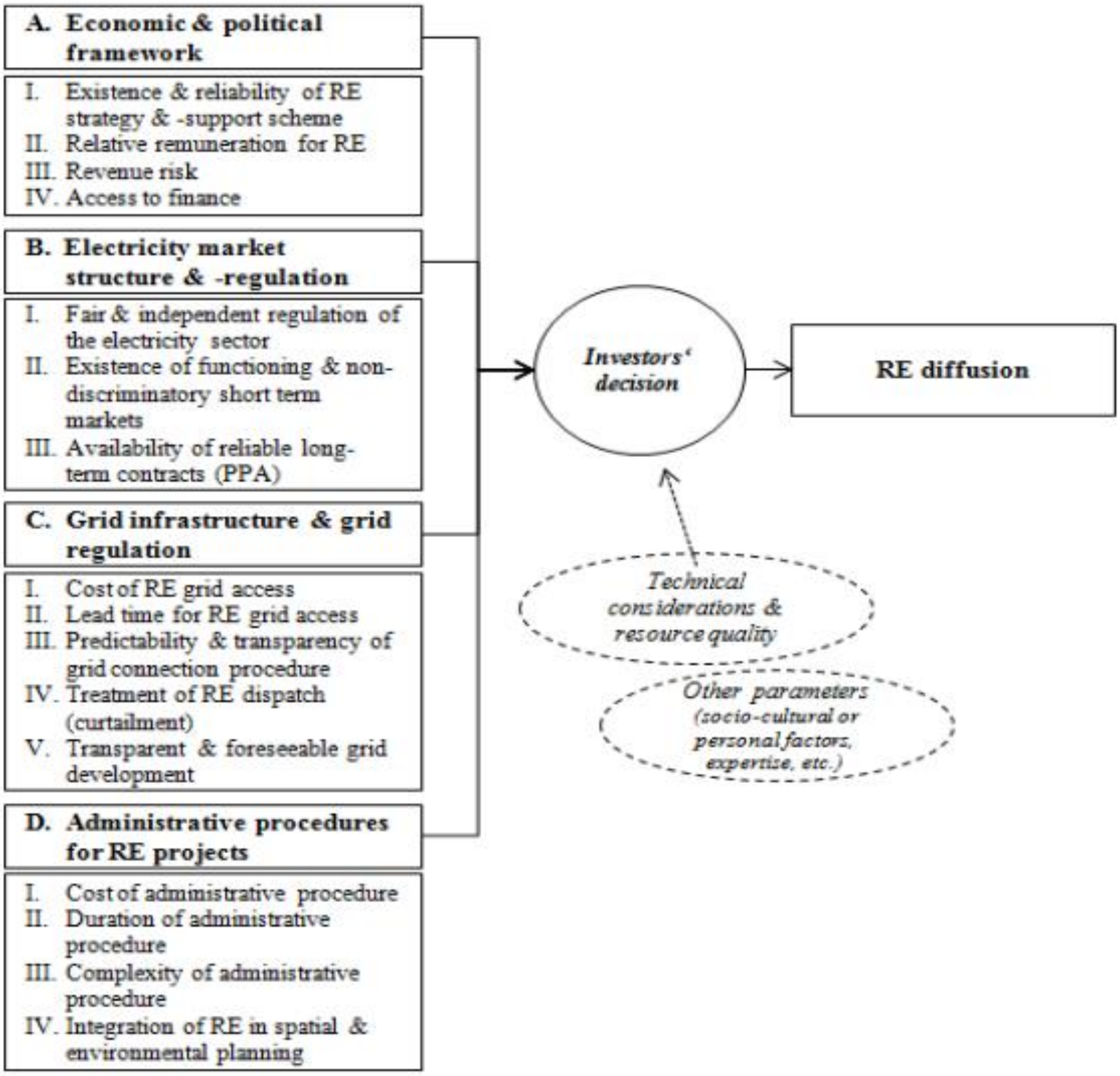


Figure 2.5 Conceptual model of the main determinants for RE diffusion from the investors' perspective
Source: Boie et al [76]

The conceptual framework provides the master plan for the research study. It helps in defining FIT policy designs options and elements to accelerate the utilization of electricity sourced from renewables in so doing increasing electricity access rate. The conceptual framework outlines the link between independent and dependent variable. To encourage RE deployment, the government set long-term tariffs paid to producers to ensure a modest return on investment that is differentiated based on each renewable technology type such as solar, wind and biomass. ESCOM has a purchase obligation to buy all electricity from RE generators and grant transmission and distribution of all RE electricity. The grid operators pay IPPs and transfer the bill to electricity consumers in the power price build up that is, the cost recovery mechanism is ratepayer based.

To incentivise RE investments, FIT policy is used to attract project developers but there are four major determinants that influence investor's decisions to invest in RE projects as it is recognised that not only supportive policy attracts investors but also the RE market structure and a stable political and regulatory framework. The first determinant is political and economic framework, which include the reliability of RE support policies that may not change completely or abandonment of the present RE targets, anticipated profits in RE investments and many more. The second is the electricity market structure and regulation such as removing barriers to IPP, non-discriminatory access of power producers to the grid, guaranteed credible long term PPAs etc. Grid infrastructure and grid regulation is the third determinant encompassing interconnection guarantee and interconnection cost, purchase and dispatch requirements. Lastly is administrative procedures for RE projects that comprise expenses to obtain permits, cumbersome and lengthy administration processes, environmental impact assessments and administrative processing fees and many more [76], [77].

The thesis addressed research gap in designing innovative FIT policy that can effectively attracting RE generators in Malawi and control policy costs. New implementation options are presented and novel policy funding means was explored as overall project development costs and lack of sustainable financing mechanisms have been identified as major constraints to power project implementation in many countries. Macro structure of the main actors, legislation, organizations and institutions that affect the successful implementation of the FIT scheme were analysed because most of the actors involved have rules, regulations, level of involvement, power and strategies. Overall, the principal aim of Malawi Energy Regulatory Authority for introducing FIT policy is to increase the installed capacity of electricity generation from renewables.

2.7 Chapter Summary

This chapter has presented various policy instruments supporting renewable energy deployment, with a focus on feed-in tariffs policy design and elements. Germany FIT policy, recognised as the most successful policy worldwide in RE deployment, has been discussed. The EU member states feed-in tariff remunerations levels and payment calculation methodologies have been outlined. The feed-in tariff policies of Algeria, Kenya and Tanzania have been described briefly to illustrate the approach being taken in other developing countries. The chapter has concluded with the major determinants that influence investor's decisions to invest in RE projects.

Chapter 3 : METHODOLOGY

3.0 Introduction

This chapter presents the research methodology employed in line with the research objectives and it indicates how data for the study was collected, analysed and interpreted in order to answer the research questions, thereby meeting the purpose of this study. The chapter comprise among other things research approach, research design, study population, determination of sample size, sampling techniques, data collection methods, data collection instruments, quality control, data collection procedures, data analysis, measurement of variables, and ethical considerations.

3.1 Research Philosophy and Approach

The thesis used the research onion concept for research process and design, which was developed by Saunders et al. [78] as it provides an excellent way to describe the stages that must be followed when formulating an effective methodology and categorise the scientific path from research philosophy to specific methods. Saunders categorised the research process onion into six stages as shown in figure below and the stages are philosophy, approach, strategy, choice, time horizon, techniques and procedures. In the outermost sixth layer, the research philosophy has to be defined and this forms the beginning of an appropriate research approach, which is utilized in the second stage. In the third stage, the research strategy is chosen and the fourth layer articulates the time horizon. The fifth stage describes data collection methodology used.

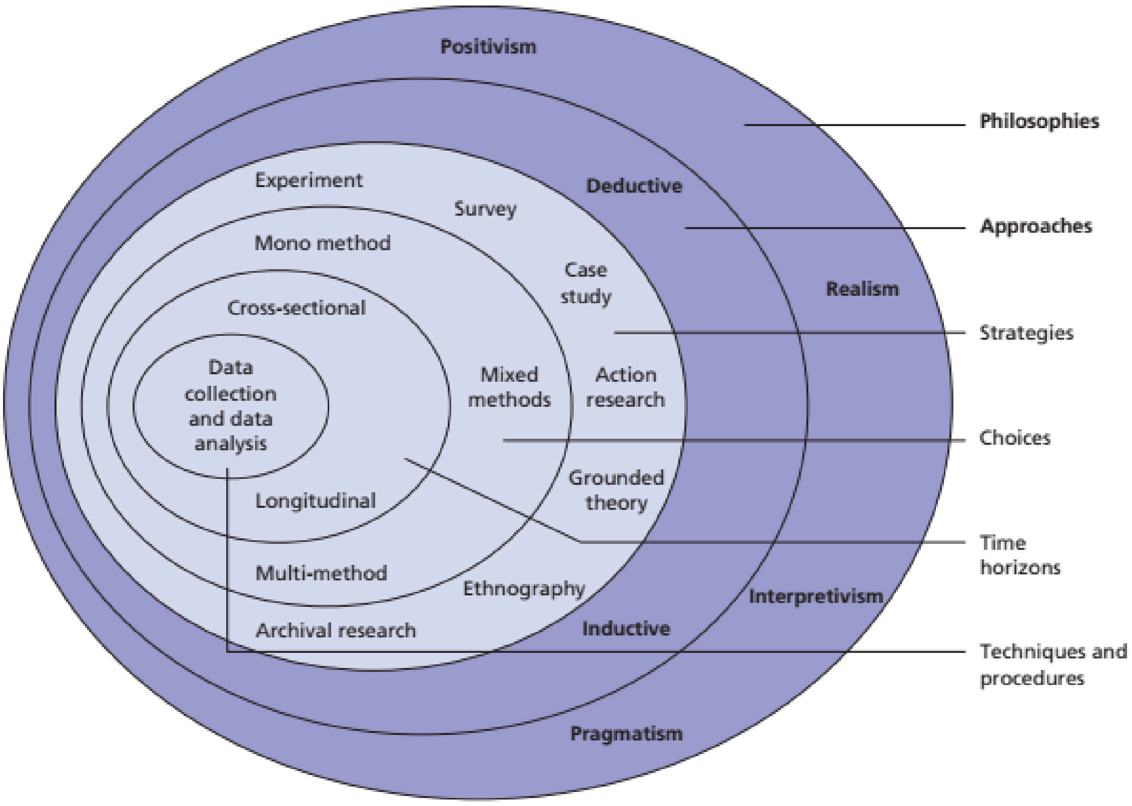


Figure 3.1 The research onion
Source: Saunders et al [78]

A research philosophy refers to the set of beliefs regarding the nature of the reality being investigated that involves the development of knowledge and the nature of that knowledge [79]. This thesis apt pragmatism research philosophy in the outermost sixth layer because it gives more freedom and focus on the method, techniques, procedures and using methods that are well suited to meeting the research purpose. This pragmatic research philosophy is not limited to a specific philosophy but pursue various approaches to collect and analyse data instead of subscribing to one-way only [80]. In the fifth layer, the research approach used in the thesis was the inductive approach as data was be collected then developed a theory after data analysis that subsequently relate to the literature [78]. New insights with respect to designing effective FIT policy for Malawi was gained and the theory developed based on those insights.

3.2 Research Design and Strategy

A research design is a plan, structure and strategy of investigation that is adopted in order to obtain answers to research questions and is conceived for the purpose of collecting and analysing evidence that makes it possible for the investigator to answer whatever questions the investigator has posed [81], [82]. The research design provides the components and the plan for carrying out the investigation and demonstrates how the major parts of the research study coordinates. There are various research designs such as correlational, exploratory, descriptive and explanatory research. This study employed the descriptive research design. According to Kumar the descriptive research design, "attempts to describe systematically a situation, problem, phenomenon, service or programme, or provides information" etc. [81] hence the research endeavoured to study and describe systematically the FIT programme and provide information about the scheme thoroughly. The research further explored policy funding mechanisms and innovative design to limit the policy costs to make the FIT scheme effective and sustainable. Thus, the research also took the form of exploratory research to some extent with the objective to explore at national level the policy funding as little is known about the subject matter and assess phenomena in a new light.

The fourth layer of the research onion describes the research strategies and there are seven research strategies notably surveys, experiments, grounded theory, case studies, ethnography, action research and archival research. The thesis used the survey as it entailed interview, discussion and administration of questionnaires and this allowed the collection of a large amount of data from a sizeable population. Moreover, the survey strategy is distinguished as authoritative, giving the researcher more control over the research process and generates findings that represent the whole study population. The survey approach enables to study large numbers of people about their attitudes, and opinions on a topic [78], [83]. In the third layer of the research onion, there are three research choices namely mono-method, multi-methods and mixed methods. The thesis employed the mixed-method because it consisted the collection of both qualitative and quantitative data and analyse both forms of data. Data analysis involved quantitative and qualitative methods, but they were no combination in the analysis procedures as each method had a specific dataset and analysed using techniques derived from quantitative and qualitative methodologies separately [84].

In the second layer, the research onion outlines the two time horizons namely, cross-sectional and longitudinal both depicts the time framework within which the research study is anticipated for completion. This thesis utilized the cross-sectional time horizon because it often used in the survey research strategy besides being time constrained. This time horizon undertakes spatial analysis and involves the study of a specific phenomenon in the case the Malawi FIT policy for a specific period of time whereas longitudinal studies takes a very long period of time such as repeated data collection to observe change over time for example every five years. The innermost first layer of the research onion brings the techniques and procedures for data collection and data analysis and methodological approach used in this thesis is outlined below [78], [85].

3.3 Area of Study and Study Population

This study was conducted in Malawi. The study population consisted respondents from the Ministry of Natural Resources, Energy and Mining; Department of Energy Affairs; Malawi Energy Regulatory Authority. From the academia, three University that offer energy courses were consulted namely Mzuzu University, The Polytechnic and Malawi University of Science and Technology. Some stakeholders from power companies that were consulted include Mulanje Energy Generation Agency (MEGA) and the grid operator ESCOM. Energy researchers and stakeholders includes National Commission of Science and Technology (NCST), Practical Action, Renewable Energy Industry Association of Malawi (REIAMA), and Malawi Institute of Management (MIM).

3.4 Sample Size and Sample Determination

The study targeted power sector players with different backgrounds including policy makers and regulators. To calculate sample size, Cochran's formula based on proportion when the population is infinite was used to determine sample size [86].

$$n_o = \frac{z^2 pq}{e^2}$$

where n_o is the sample size, z is the selected critical value of desired confidence level, p = proportion of the population having the characteristic, q = 1-p, and e is the desired level of precision or sampling error. P is also called degree of variability, which describes the distribution of attributes in the population. The more heterogeneous a population, the larger the sample size required whereas the more homogeneous a population, the smaller the sample size as large majority of the population have the attribute of interest [87]. In this thesis, the population is homogenous as respondents have the attribute of interest as all the stakeholders or respondents interviewed are experts and active players in the renewable electricity sector and influence policy decisions. As such z = 95 % confidence level, p = 90 % degree of variability and e = ± 10 % sampling error. z = 1.96, p = 0.9, q = 1- 0.9 hence q = 0.1 and e = 0.1. sampling scheme is presented below.

$$n_o = \frac{(1.96^2)(0.9)(0.1)}{(0.1)^2}$$

$$n_o = 35$$

Table 3.1 Sampling scheme

Population category	Sample size	Sampling Technique
Ministry of Energy/DEA	6	Snowball sampling
MERA	5	Purposive sampling
MZUNI	4	Purposive sampling
POLY	4	Purposive sampling
MUST	4	Purposive sampling
ESCOM	2	Snowball sampling
MEGA	1	Purposive sampling
REIAMA	4	Purposive sampling
Practical Action	1	Purposive sampling
NCST	1	Purposive sampling
MIM	1	Purposive sampling
KIA	2	Purposive sampling
Total	**35**	

Source: Author

3.5 Sampling Techniques

The study used non-probability sampling techniques due to the respondent's perceived knowledge arising out of known experience that they have in the renewable energy field. The probability sampling methods is also referred to as judgment or non-random sampling and is well suited for research intended to generate new ideas that will be systematically applied later [88]. Two types of non-probabilistic sampling technique were employed namely, purposive sampling and snowball sampling. Purposive sampling was employed to select experts in renewable energy to collect very informative data due to their vast knowledge and expertise and the respondents were approached having a prior purpose in mind. Snowball sampling also known as chain sampling is used whereby one interviewee is approached at a time and then is asked to refer the investigator to the other respondents [88]. Participants meeting the study requirements recommended others interviewee with the same characteristics to be respondents in the study. Snowball sampling is used when trying to access possible respondents that are difficult to identify, relatively rare or difficult to reach populations [89].

3.6 Data Collection Methods

The research made use of three methods to collect data from various primary and secondary sources. These are survey, interview and documentary review as shown in figure 7. The survey involved the use of a semi-structured questionnaire. The semi-structured questionnaire were deemed appropriate since part of the questionnaire offers respondents the choice of picking answers from a given set of alternatives as such there was greater precision in terms of measuring and validating the data gathered and numerous questions can be asked about a subject. This allowed a broad range of data to be collected which ensures a more accurate sample to gather targeted results from which to draw conclusions and make informed decisions while the other part of the questionnaire allows respondents to qualify their responses [90]. Similarly, interviews involved the use of a semi-structured interview guide. The method of interview using a semi-structured interview guide was deemed appropriate since most senior management, principal officers and executives have vital information yet no time to fill in questionnaires [91]. Documentary review was used to collect secondary data and relevant literature to the research topic was analysed as secondary sources of data to supplement primary data from survey and interviews.

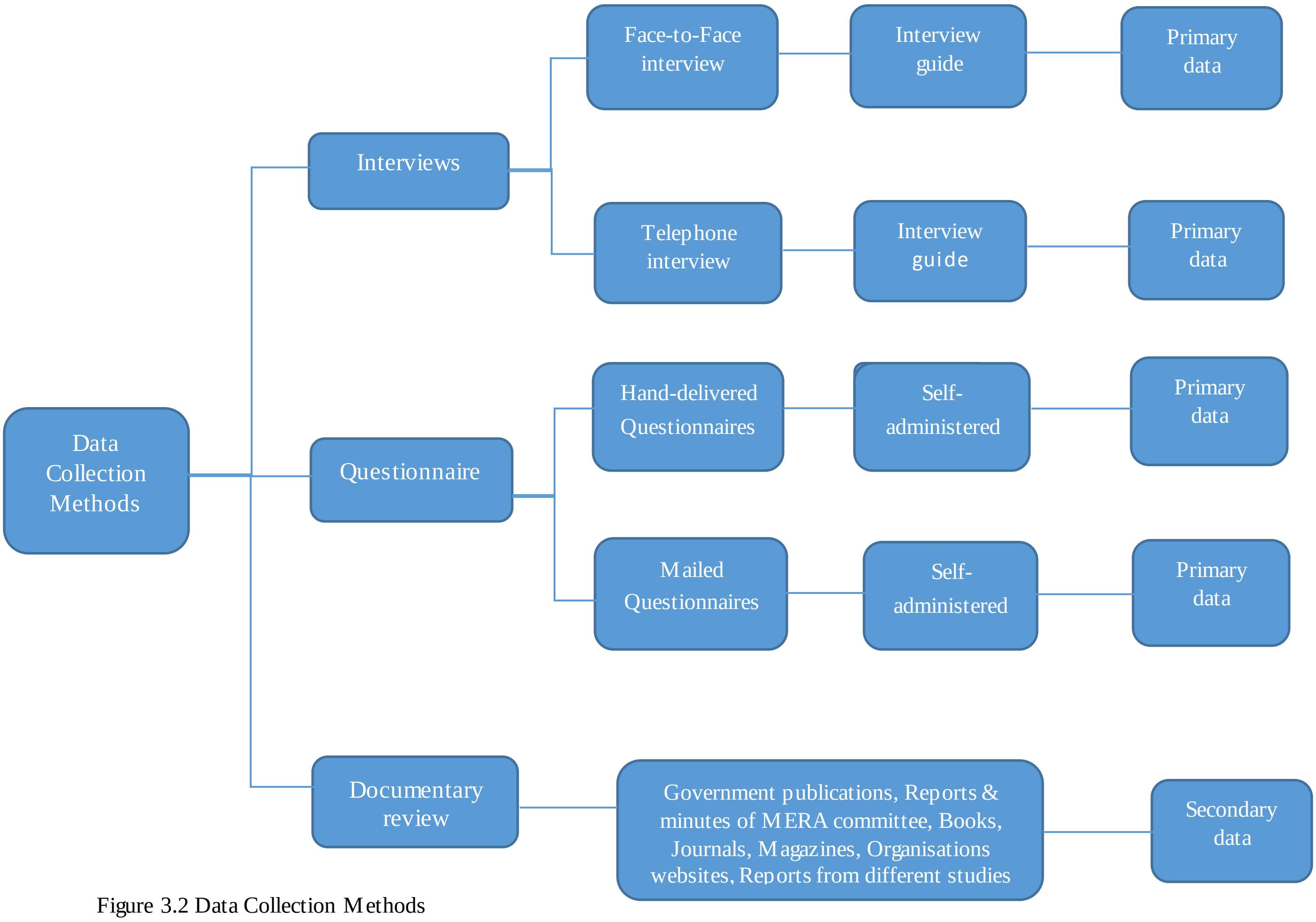


Figure 3.2 Data Collection Methods

3.7 Data Collection Instruments

3.7.1 Questionnaires

Semi-structured questionnaires were used to gather primary data from respondents. Descriptive research administering attitude, outlook and opinion questionnaires enabled the investigator to pinpoint and describe the variability in discrete phenomena [78]. Questionnaires were adaptable to objectives and respondents filled them in at their own convenience. The questionnaire was used because it has proved to be an invaluable method of collecting a wide range of information from a large number of individuals and it has greater validity of information as the responses by the subjects are available in their own language and version hence it cannot be wrongly interpreted by the investigator [91]. Additionally, questionnaires are useful method in investigating success of use, user satisfaction and needs, expectations, concepts, perspectives, priorities and preferences, values, attitudes and opinions and understand the whole picture of the research area. Sound questionnaire design principles focused on all relevant area such as question wording, question coding and how the variables are categorized, scaled, and coded after receipt of the responses, question structure and questionnaire appearance as shown below [92]. The questionnaire design used the following level of measurement and measurement of variables; nominal measurement, ordinal measurement, and Likert type rating scale.

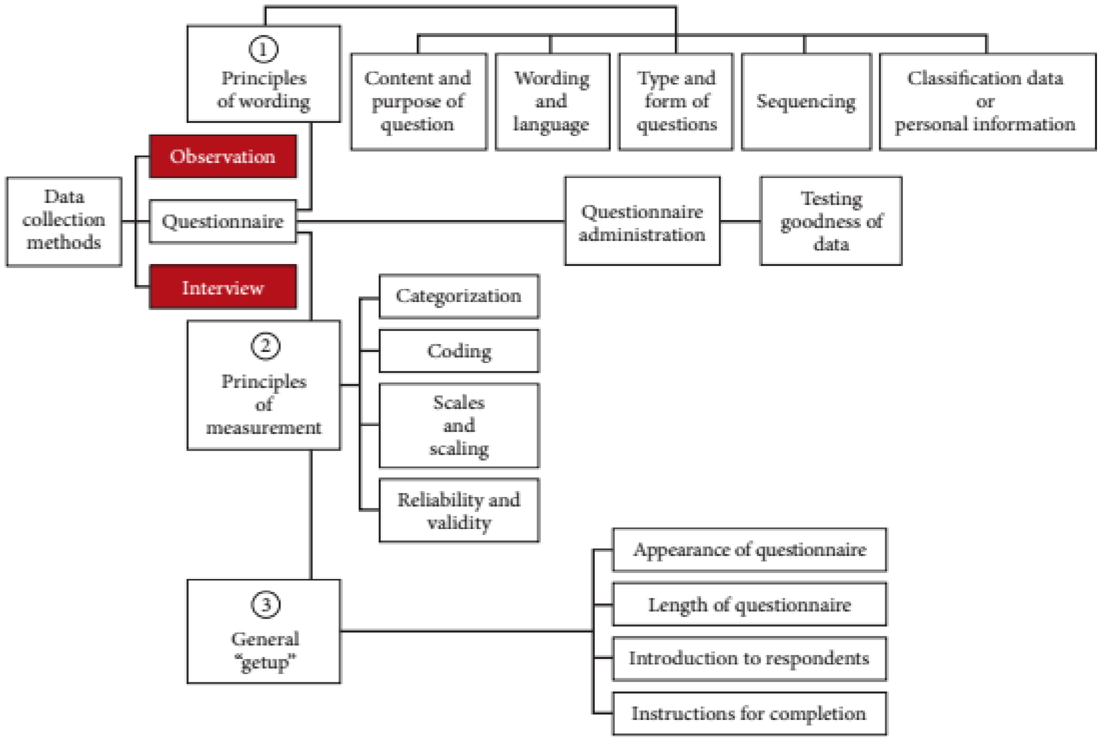


Figure 3.3 Principles of questionnaire design
Source: Sekaran et al [92]

3.7.2 Interview guide

A semi-structured interview guide was used to collect data from principal officers. Interviews were chosen because they provide in-depth information about a particular research issue or question. Still, interviews were chosen because they make it is easy to fully understand someone's impressions or experiences, or learn more about their answers. According to Sekaran, interviews are advantageous in that they provide in-depth data which is not possible to get using questionnaires and offer flexibility to probe for details or discuss issues and new factors might be identified, resulting in a deeper understanding of the important factors operating in the situation [92]. The main goal of the interview was to gain a profound understanding of policy scheme design and implementation challenges, which would also lead to a better understanding about the logic of the mechanism and perception of the performance and changes to be made including funding the policy mechanism.

3.7.3 Documentary review

This involved a list of documents that are directly relevant to the research topic and research area. In this case, the literature review encompassed government publications, reports and minutes of committee, books, journals, magazines, organisations websites, reports from different studies, conference papers, newspaper articles, internet, theses and dissertations related to the topic under investigation were reviewed. Background information about the Malawi FIT policy was collected through the review MERA publications. Scientific journal articles, reports and publications that evaluate the FIT design, implementation and the performance of FIT policy instruments to support the development of renewable energy were be reviewed.

3.8 Quality Control

3.8.1 Validity

Validity is the extent to which a construct or research instruments measure what they are intended to measure. This research used the expert judgment to validate the content the instruments. Content validity aims at providing assurance that an instrument such as interview guide or questionnaire measures the content area so that items fully reflect the research contents and objectives and to ensure that the measure possess adequate representative and comprehensiveness set of items that tap the concept [92],[93]. To assess this, the two experts or judges were consulted to evaluate the significance of each question in the instruments to the objectives. These experts' tasks were to link each objective with individual item, to measure the relevance of the respective items to the content addressed by the objectives, and to judge if the items on the research instrument adequately represent the content in the domain of interest [94]. The experts rated each question on a 4- points rating scale as: 1 – not relevant, 2 – somewhat relevant, 3 – quite relevant and 4 – very relevant. Content Validity Index (C.V.I) was used to determine validity. The C.V.I defines "proportions of items rated relevant by both judges divided by the total number of items in the questionnaire" [94].

$$\text{C.V.I} = \frac{Number\ of\ items\ rated\ relavant}{Total\ number\ of\ items}$$

As recommended by Amin [90], for the instrument to be valid, the C.V.I should be at least 0.7 while Zamanzadeh suggests the C.V.I of at least 0.80 as appropriate if it is between 0.7 and 0.79, it needs revision and it is less than 0.7 it is eliminated [95].

3.8.2 Reliability

Reliability describes dependable measurement and it is the extent to which a research instrument yields repeatable and consistent results across the various items when it is administered again at a different point in time such as from occasion to occasion or circumstance-to-circumstance [92]. To establish reliability, the research instruments was pilot-tested twice on two respondents from MZUNI, Department of Energy Studies and one respondents from Practical Action at a time interval of one weeks. The reliability coefficient obtained by this repetition method is called the test–retest reliability [92]. According to Sekaran, test-retest reliability measures the extent to which the research instrument could produce consistent and correlating scores when the instruments is administered to a set of respondents, now and again to the same respondents under the same conditions. The results from the pre-test was used to modify respective items in the research instruments but the higher the score, the better the test– retest reliability hence the stability of the consistent measure over time [92].

3.8.3 Gaining access and avoiding gatekeepers or brokers

Tracy [96] describes gatekeepers as individuals at research sites who actually has the power to grant access to the site and permit a research study to be undertaken. The gatekeepers or brokers decides whether or not to allow the researcher to undertake the research at their site on a number of reasons. These may include individual’s unwillingness due to time required, lack of ostensible research value in line with the organisation work, the topic’s nature requires sensitivity information and doubts about investigator credibility and competence [78]. Nonetheless, soundness of mind and discretion in negotiating access is required to ensure the researcher has access to the research site and preferred respondents. Law et al [97] defines negotiating access as the “process of getting permission to approach people, or indeed to use archive material or unpublished official statistics, as part of the research process.”

For this research, a meeting was held with the Senior Engineer for Renewable Energy at Malawi Energy Regulatory Authority (MERA) as the organisation is the custodian of FIT policy for Malawi. Additional strategies to help in gaining access and secure entry entailed using existing and developing new contacts such as friends; explaining clearly the purpose and type of access required and the possible benefits to the organisation. Another strategy that was used is the “known sponsor approach” whereby the researcher cited the research-funding organisation that is African Union in order to establish credibility and legitimacy when making the first approaches [98]. Furthermore, strategies like reciprocity, receptiveness to suggestions, and demonstration of professional suitability were employed [98].

3.9 Data Processing and Analysis

The data collected from respondents was coded along with assigning each question and answer codes, for data entry in SPSS. IBM SPSS Statistics version 22 was used to analyse data. Similarly, RETScreen Expert was used for modelling policy analysis to calculate FIT rates or prices. Kamuzu International Airport solar farm was modelled using RETScreen Expert under six scenarios with a 10 % targeted internal rate of return on equity. The six scenarios and policy options modelled are;

a) Is it a profitable investment if it was not a grant project?
b) How high does FIT need to be to attract investment or turn the project profitable?
c) How high does FIT need to be if tariff of $0.20/kWh escalating at 5 % annually?
d) How high does FIT need to be to attract investment if debt financing was 50% and equity financing was 50 %?
e) How high does FIT need to be to attract investment if soft loan was provided?
f) How high does FIT need to be to attract Malawian investment (local investors) if 10% capital incentive was provided, 50 % equity financing, 40 % debt financing and electricity escalation of 5 % annually?

3.10 Research Ethics

Research ethics deals primarily with the interaction between researchers and the respondents [99]. While conducting the study, principles of research ethics were strictly observed. The objectives of the study were explained to the respondents with an assurance that the data is needed for academic purpose only. Participation in the study was voluntary and subjects were not pushed to respond to questions about which they indicated some discomfort that is the principle of autonomy, informed consent and intrusiveness. Privacy, confidentiality and anonymity was firmly observed. To ensure confidentiality, data storage, access and ownership was clarified to respondents and data obtained on private matters was treated in secrecy. The risk of harm to subjects was totally avoided such as psychological stress, emotional distress, erosion of self-confidence, legal liabilities, ostracism, damaging respondent's reputation or status, or relations with others [100], [101].

3.11 Chapter Summary

The chapter has outlined the methodology that was employed in the study. It has stipulated that data was collected from both primary and secondary sources. The research onion has elaborated the research philosophy, approach, strategy, choice, time horizon, techniques and procedures. Two non-probability sampling techniques namely purposive and snowball sampling was used to select respondents. Questionnaires were used as data collection tools and for modelling KIA solar farm RETScreen Expert was used.

Chapter 4 : RESULTS AND DISCUSSION

4.0 Introduction

This chapter outlines study findings in designing an effective feed-in tariff policy for Malawi to attract investors in the electricity market. The chapter begins with explanation of the need to establish clear objectives for FIT within the nation context and how to fund the policy cost locally. The chapter conclude with modelling results for Kamuzu International Airport solar farm under different policy options.

4.1 Feed-in Tariff Policy Design and Remuneration Model in Malawi

Malawi Energy Regulatory Authority (MERA) introduced feed-in tariffs in 2012 which is to be revised every 5 years as of now it is due revision. The FIT tool has three objectives as aforesaid; (i) facilitate renewable energy resource mobilization by providing investment security and market stability for investors in electricity generation from renewable energy sources (ii) reduce transaction and administrative costs and delays by eliminating the conventional bidding processes (iii) encourage private investors to operate their power plants prudently and efficiently so as to maximize returns. An analysis of the policy was done to make it effective in attracting IPP into the Malawi electricity sector. Policy makers, regulators and stakeholders totalling to 35 who have an invaluable role in formulating and shaping policy direction were the respondents in this research and provided feedback on how effectively the policy objective can be met. To begin with, there is a need to redefine policy objectives in view of the current electricity status in the country notably power outages and low electricity access.

To drive rapid increase in the share of renewable electricity generation and accelerate electricity access, well-established FIT objectives should be put in place that reflect Malawi's situation. A multi-attribute decision making techniques was employed to select and weigh the desired set of objectives from the respondents. Five objectives that need to be incorporated in the FIT are outline below with each objective having a score of above 70%. Each objective was measured on a four-point scale as a high priority, medium priority, low priority and not an appropriate objective. Only those objectives who were chosen as high priority were selected and weighed as shown below.

Table 4.1 Policy objectives frequencies

Objective	High priority Responses		Percent of Cases
	N	Percent	
Maximize RE generation	24	13.9%	75.0%
Develop certain quantity energy in a specified time period	23	13.3%	71.9%
Increase electricity access rate	27	15.6%	84.4%
Accelerate rural electrification	26	15.0%	81.2%
Diverse mix of RE resources through technology specific incentives	23	13.3%	71.9%
Minimize rate impact to retail customers of meeting RE objectives	2	1.2%	6.2%
Support smaller projects or business	9	5.2%	28.1%
Promote projects in specific geographic locations	9	5.2%	28.1%
Promote projects that can be implemented in short to medium timeframe	7	4.0%	21.9%
Meet specific objectives in National Energy Policy (NEP) and Malawi Renewable Energy Strategy e.g. energy mix	23	13.3%	71.9%
Total	173	100.0%	540.6%

Source: author

From table above, the Malawi FIT policy has to incorporate and prioritise the following objectives in the policy design;

i. To increase electricity access rate
ii. To accelerate rural electrification
iii. To maximize RE generation
iv. To developing certain quantity energy in a specified time period in line with National Energy Policy (NEP) and Malawi Renewable Energy Strategy
v. To encourage diverse mix of RE resources through technology specific incentives

The above objectives interact with existing policies and create synergy with other policies such as the National Energy Policy as well as Renewable Energy Strategy in addressing the challenge of energy access. The FIT design elements and policy considerations that redefine the current Malawi FIT to make it effective scheme in attracting IPPs are describe below. The data collection was consultative in nature with policy makers, regulators and stakeholders and the key findings are depicted in the subsequent figure.

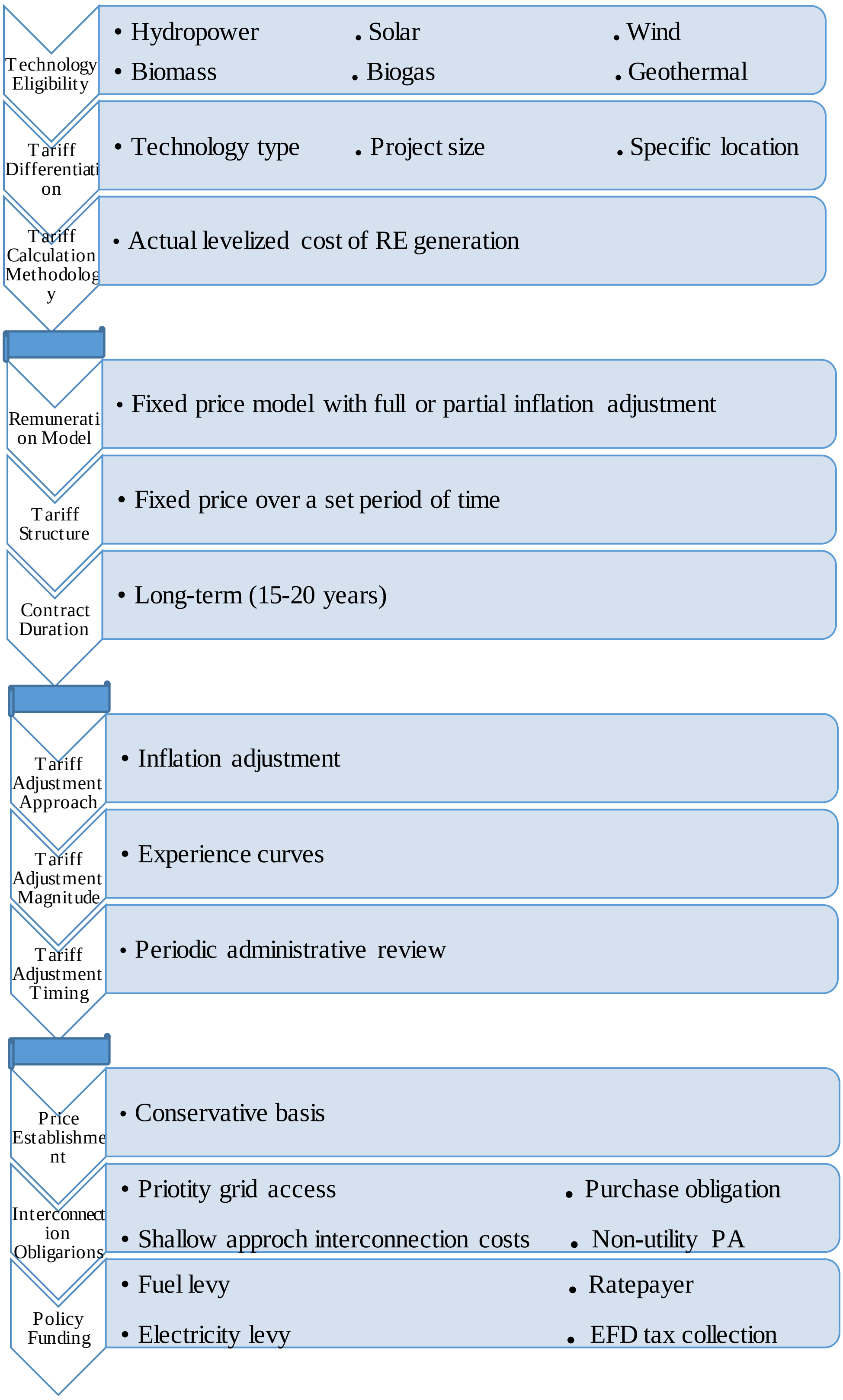


Figure 4.1 Malawi FIT policy design

Source: Author

4.1.1 Technology eligibility

The Malawi Energy Regulatory Authority decided that six renewable energy technologies should be eligible for tariff payment under the FIT mechanism depending on the resource endowment of the country. These technologies are hydropower, solar, wind, biomass, biogas and geothermal power. There is a diversification of supply by supporting a whole basket of wide-range renewable energy technologies in Malawi under the FIT mechanism which ensures necessary dispersed security of supply.

4.1.2 Tariff differentiation

There are several factors that are considered when determining the different prices offered to generators such as technology type, project size, resource quality, e.g. average wind speeds, specific location e.g. island or offshore winds, commercial operation date, ownership structure, transmission access and transmission location. The Malawi FIT differentiate the tariff payment on two factors technology type and project size. Following a consultation with policy makers, regulators and stakeholders during data collection one more factor namely specific location has been endorsed so that it should be included in the FIT policy as shown below;

Table 4.2 FIT Differentiation frequencies

FIT Differentiation		Responses		Percent of Cases
		N	Percent	
	Technology type	35	30.7%	100.0%
	Project size	27	23.7%	77.1%
	Resource quality	6	5.3%	17.1%
	Specific location	25	21.9%	71.4%
	Commercial operation date	3	2.6%	8.6%
	Ownership structure	1	0.9%	2.9%
	Transmission access	10	8.8%	28.6%
	Transmission location	7	6.1%	20.0%
Total		114	100.0%	325.7%

Source: Author

It is noteworthy that policy makers considered specific location to be added on top of technology and project size which already exist in the FIT document because of Islands such as Likoma Island which have no grid power. As mentioned earlier, among notable things stated in the FIT policy document, the government hoped that the feed-in tariffs would eventually displace the existing very expensive diesel operated generator used for electricity production on Likoma and Chizumulo Islands that has not happened to date. This is no wonder because of the physical location it is not easy to access and building power plants on these locations will require a high upfront costs compared to some other locations. Hence, to attract investors, there is a need to offering varied payments to encourage project investment in particular applications and multi-functionality. Differentiating tariffs by specific location will increase electricity access and rural electrification through mini-grids and will help the specific locations to attain higher levels of RE penetration, making it conceivably to harness resources in difficult-to-access locations [52].

4.1.3 Tariff calculation methodology

One of the central FIT design issues is the methodology used to establish the tariff or price level offered in the scheme. Chapter 2 discussed the four approaches that are used to establish the price awarded to IPPs namely the levelized cost of renewable energy generation, the value of renewable energy generation either to society, or to the utility, offered as a fixed-price incentive and lastly price offered based on the results of an auction or bidding process. Regulators, policy makers and stakeholders consulted in this thesis supported the existing tariff calculation approach to continue, that is, price be established based on the actual levelized cost of renewable energy generation.

Table 4.3 FIT calculation methodology frequencies

Payment Calculation Approach		Responses		Percent of Cases
		N	Percent	
	Actual levelized cost	29	54.7%	82.9%
	Value to society	4	7.5%	11.4%
	Fixed-price incentive	7	13.2%	20.0%
	Bidding process	13	24.5%	37.1%
Total		53	100.0%	151.4%

Source: Author

The approach of establishing price offered to generators based on the actual levelized cost of RE is the most commonly used and has been the most successful at driving RE deployment worldwide [102]. The levelized cost approach establish the FIT tariff according to the cost of renewable energy generation, plus a sufficient profitability so that a realistic costing of an investment is done to avoid under-pricing or overpricing of the services and products offered to investors. In this approach, all investment costs are to be calculated at the current year terms and takes into account such issues as capital cost, operation and maintenance cost, plant factor, fuel cost, interest rate and return on equity.

4.1.4 Remuneration model

Offering a stable remuneration to generators that reflects the country's economy ensures an efficient and a well-functioning FIT scheme that attracts investors. There are seven different remuneration model on the market around the world and the existing model in Malawi is the fixed price model which is market-independent FIT model. From this thesis work, regulators, policy makers and stakeholders considered a change from fixed price model to fixed price model with full or partial inflation adjustment because of the nation economy prone to inflation fluctuations annually. The study finding are shown in the figure 4.2 below. Considering the nation economy and the power sector status some remuneration models were deemed unviable in Malawi such as spot market gap model, front-end loaded tariff model and the variable premiums model. A market independent FIT model is deemed viable in Malawi with 62.86 % of the respondents choosing fixed price with full or partial inflation adjustment because increase in inflation reduce the real value of power generators revenue [57]. As such, with Malawi's volatile inflation, offering fixed price model does not provide added security for power generators against a decline in the real value of project income hence few investors would be attracted to invest in the power sector with the existing FIT remuneration model. Table 4.4 shows the average inflation rate for Malawi for the past 8 years.

Table 4.4 Inflation rate for Malawi from 2010

YEAR	INFLATION RATE
2010	6.3 %
2011	9.8 %
2012	21.3 %
2013	23.5 %
2014	24.5 %
2015	24.9 %
2016	20 %
2017	7.1 %
As of April 2018	9.7 %

Source: Reserve Bank of Malawi Report and Accounts for the years 2010-2018 [103]

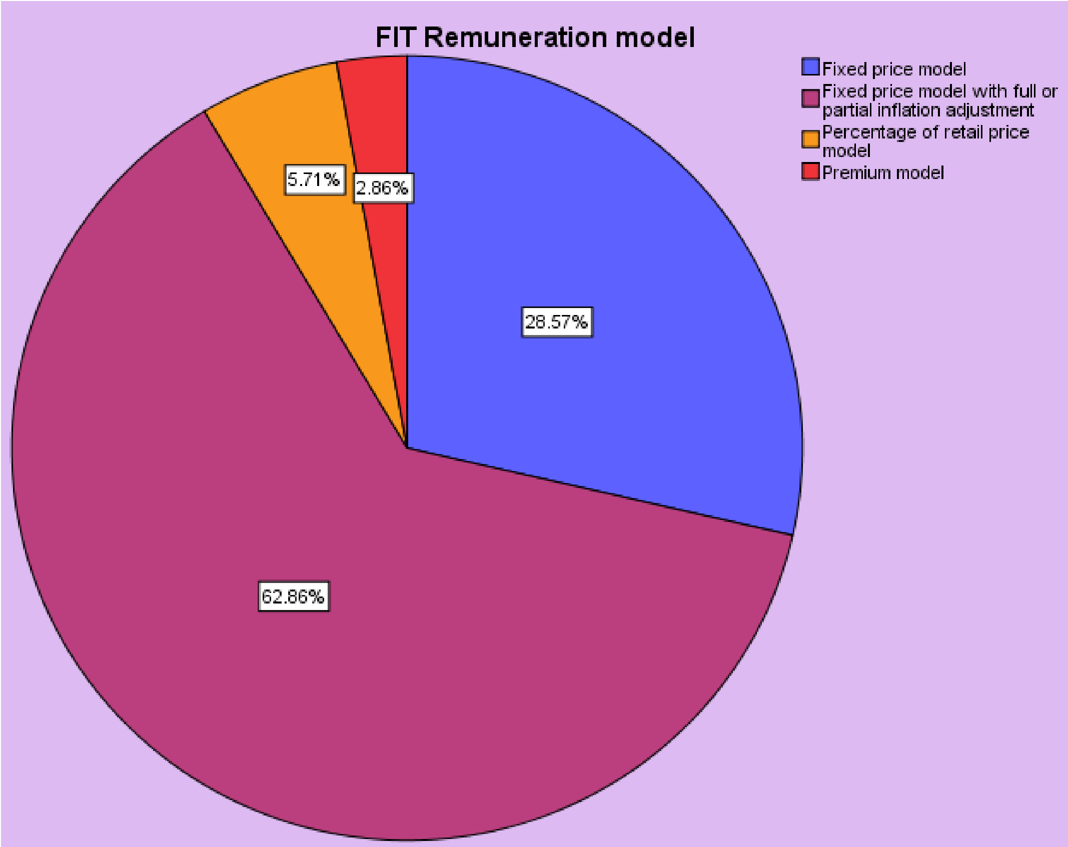


Figure 4.2 Malawi FIT remuneration model results
Source: Author

Renewable energy projects have a high-upfront costs and mostly a great percentage of the investment involves debt financing. Inflation can impact debt repayment and the other operation costs, maintenance expenses, tax payment, insurance just to mention a few. To account for inflation there is a need to set the rate using the proposed model to provide greater value for IPPs and different approaches can be employed. Firstly, the inflation can be adjustment annually for changes in the consumer price index (CPI) or inflation measured by the Reserve Bank of Malawi. Second way to account for inflation is to have a pre-established model or formula that adjusts the tariff rate to inflation and assumption about inflation which can be calculated annually should be built into the model or formula. Lastly, adjustment can be made to a percentage of the tariff rate, while a percentage of the inflation adjustment can be reflected or added on the base tariff price offered [57].

4.1.5 Tariff structure and contract duration

The tariff structure should be set up as a fixed price over pre-established period of time of which most respondents reasoned to be long term contracts of 15-20 years. This fixed price contract will offer IPPs guaranteed multi-years' revenue stream certainty that does not vary over the contract duration. This policy design and contract duration has an impact on investors security, tariff rate stability, and FIT policy costs. As described above, the tariff setting is cost based on the actual levelized RE generation which gives generators greater confidence that they will get the target return within the stipulated time period. It is no wonder that with this long-term 15-20 years' contract duration, most respondents opted that the cost-based tariff should be established on conservative basis as shown below.

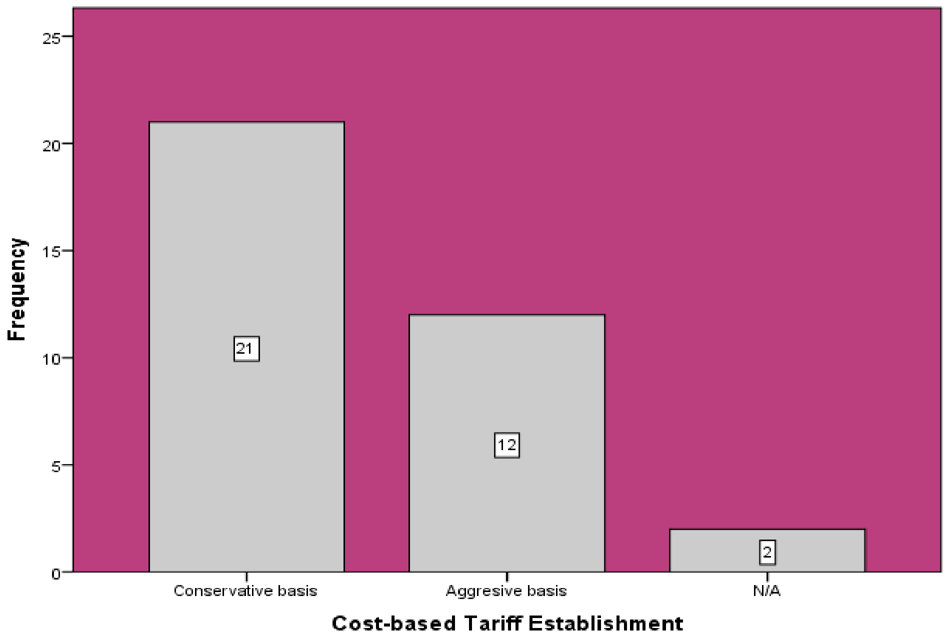


Figure 4.3 Cost-based tariff establishment
Source: Author

This fixed-long contracts offer a greater duration of time over which the IPPs revenues can be levelised and the tariff price can be correspondingly lower whereas shorter tariff payment duration translate to designing a higher tariff rate such that the $/kWh payment is higher to offer investors with the same targeted revenue within a short time frame. As such it can be deduced that this design provides price stabilization and limit the policy costs.

4.1.6 Tariff adjustment approach

There is no clause in Malawi FIT document that stipulate how the tariff can be adjusted. The document only mentions that the policy will be review every five years. The five-year term elapsed in 2017 but up to now the policy has not been review. The thesis has consolidated policy-relevant knowledge from regulators, policy-makers and stakeholders. Tariff adjustment is one of those areas which is silent in the 2012 policy document. In this thesis three tariff adjustment approaches were explored namely inflation adjustment, tariff digression and index to change in measure of value as shown below.

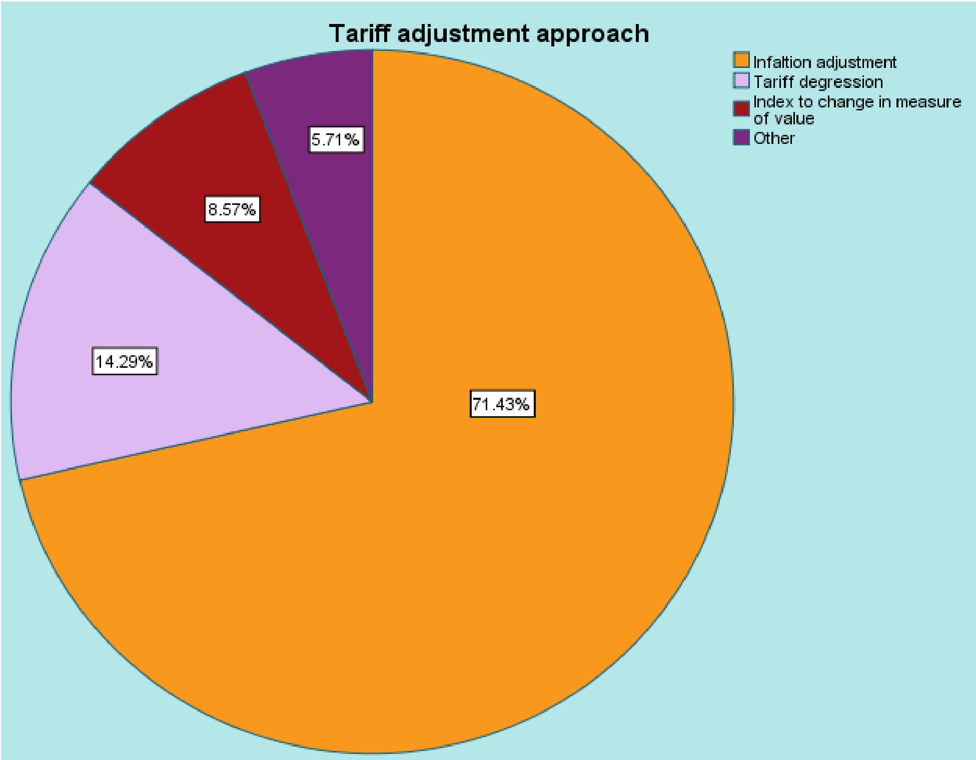


Figure 4.4 Tariff adjustment approach results
Source: Author

From the above figure, 71 % of respondents choose Malawi to use inflation adjustment approach to adjust the tariff when the five-year period elapses, as the policy is reviewed or subject to a periodic administrative review. Experiences curves should be used to determine how much price to adjust. Some respondents suggested other approaches such as using triggers to adjust the tariff rate. Triggers are threshold that can spark tariff payment adjustment once the set target is reached or surpassed such as attainment of certain capacity (MW) or policy cost. With the volatility of inflation in Malawi as aforementioned, it is no surprise that regulators, policy makers and stakeholders consulted recommended inflation adjustment approach. This is to attract investors into Malawi electricity market and to ensure that generators realize the target rate of return. Administrative reviews will provide a platform to get the price right by track changes and emerging market trends to avoid overpaying or underpaying.

4.2 Malawi Feed-in Tariff Implementation and Challenges

The FIT scheme offers an interconnection guarantee to all IPPs so that there is no delay in connecting eligible technologies. All eligible plants have a guaranteed priority grid access which mandates ESCOM to prioritize connecting all renewable electricity generation facilities into the nation grid. The policy obliges ESCOM to construct or upgrade the grid network necessary to accommodate interconnection of renewable energy power plants. This also include construction of new substations. Furthermore, this network upgrade has a cost recovery rule authorizing ESCOM to recovery the expenses from the tariffs charged on the power consumers [33]. However, the policy does not specify who will bear the expenses of interconnection cost from the power plant to the point of connection.

With ESCOM responsible for network upgrade, Malawi should implement “shallow approach” to interconnection cost whereby the IPPs will pay for expenses to connect to the grid up to the nearest point of connection, but not expenses for upgrading electricity grid network. The converse is called “deep approach” where the IPPs is required to cover for both the expenses of connecting to the grid at the point of connection and associated grid connections expenses such as electricity grid upgrades or electricity network reinforcement [60]. Since Malawi FIT rate are calculated based on the levelized cost of RE generation there is a need to factor in these shallow approach interconnection costs into the tariff rate. This policy option has an implication on policy cost as building the interconnection expenses into the tariff rate will increase total policy costs. On the other hand, it increases investor’s security because electricity consumers bear a portion of the interconnection cost to the grid and grid reinforcement.

The nation FIT policy has also the purchase obligation which oblige ESCOM to purchase, transmit and distribute all renewable electricity from IPPS. This purchase obligation guarantees investors security and reduces investment risk as ESCOM cannot decline to purchase any renewable electricity generated for sale by IPPs under the FIT policy and dispatch into the nation electricity grid network. Nevertheless, the FIT does not mention forecast obligation for intermittent renewable resources such as wind power or large-scale solar power to help match supply to demand. For renewable energy sources that are highly weather-dependent there is a need for IPPs to forecast their power generation to help ESCOM balance the total power supply on the electricity network system to facilitate reliable and uninterrupted power supply. Typical example is Spain which oblige all generators with power projects more than 10 MW to forecast their anticipated power supply 30 hours in advance before a day starts [52].

There is also another implementation option which most policy makers, regulators and stakeholders deem viable, the introduction of non-utility purchase agreements (PA) as shown in figure below. The non-utility purchase agreements option will allow generators to sell their power directly to third parties or sell through bilateral contracts with consumers.

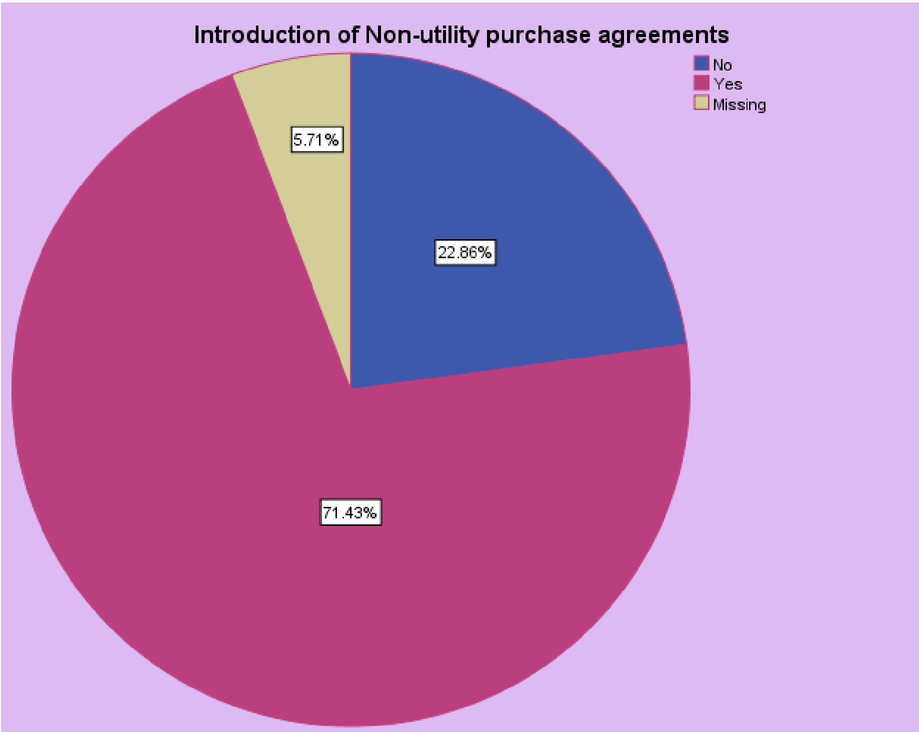


Figure 4.5 Non-utility purchase agreement results
Source: Author

These Non-utility purchase agreements (PA) can have a wide application in sugar factories, tea estates as well as in the Islands such as Likoma and Chizumulo Islands where the government has for long sought to replace the expensive diesel genset which are costly to run. Likoma Island is no connected to ESCOM nation transmission network because of the physical location being barred by Lake Malawi. In such areas, the non-utility purchase agreements will offer the generators purchase guarantee and revenue stream certainty. In addition, this option can allow IPPs to sell power directly to customers at electricity price that may be lower or at par with the retail market price offered by ESCOM and the overhead expenses will be covered under FIT.

The Malawi feed-in tariff policy has faced a number of challenges to its implementation and the challenges reported by regulators, policy makers and stakeholders are as follows;

a) No stakeholder involvement
b) Lack of technical expertise
c) Policy funding
d) Low end-user tariff being charged by ESCOM utility
e) Public willingness to pay
f) Political interference
g) Grid capacity
h) Low tariff

The first notable challenge with the Malawi FIT policy there was no stakeholder involvement during policy design or policy development process was not consultative enough. It was noted that MERA hired a consultant who developed the FIT policy but in real sense the consultant copy pasted the Kenyan 2010 FIT policy. An analysis of the two documents indicated that 95 % of the material are similar from the onset beginning with the objectives, design criteria and implementation procedures. The consultant mostly replaced the word Kenya with Malawi and in terms of tariff rate the consultant was just adding 1 or 2 cents to tariffs for different technologies to make a difference. Yet these are two different nations with different economic growth, debt financing, interest rate, inflation rate even electricity access rate is quite different hence they cannot pursue same FIT policy objectives, same policy design or expect to attract investors at the same pace or almost the same. In short, there is no "one-size-fits-all solution." It is undeniable fact that Kenya is a giant nation compared to Malawi economically as such it is no wonder that Kenya FIT attracted investors adding 69.5 MW within 4 years while in Malawi there is no even a single IPP feeding into the nation grid. The Mumias Sugar biomass plant has the installed capacity of 29 MW, O Power geothermal 40 MW while Imenti Tea Factory installed 0.5 MW small hydro totalling to 69.5 MW [104]. The Malawi FIT was design out of the nation context including the objectives set forth. This approach was short-sighted in terms of policy design and formulation.

Policy development consultation initiative should ensure openness and inclusivity of all stakeholders. FIT development should be consultative so as to design or develop solutions which will work and attract IPPs and the consultation help to determine how the policy is addressing the energy access challenge and development needs of Malawi. The second challenge mentioned is lack of technical expertise. This is in line with FIT policy design, the tariff rate calculation methodology and drafting the power purchase agreements. To address this shortage in May 2016, the government in conjunction with Power Africa hired an advisor who was embedded in ESCOM to work directly as part of the utility in facilitating private sector investment in the power sector. The advisor is funded by United States Agency for International Development (USAID) to assist ESCOM in negotiation and drafting Power Purchase Agreement with IPPs [105].

Thirdly, policy funding is another challenge. There is no practical mechanism in place detailing how to fund the policy cost for policy sustainability. The Malawi FIT policy state that ESCOM shall recover from electricity customers 70 % of the portion of the FIT on the following technologies; wind, hydropower, biomass, biogas and geothermal. For solar power, the policy lay down that ESCOM shall recover 85 % of the portion of FIT from electricity customers. The policy does not explain how the remaining 15 % or 30 % will be reclaimed. Relatedly, the rates in the FIT policy are higher than the existing end-user tariff. USAID in its publication on "Malawi Power Africa Fact Sheet" describes the electricity market price as non-cost reflective [105]. This poses a challenge as to how ESCOM will be able to pay for electricity purchased from RE generators. The question usually is who will fund the gap? This makes generators request for sovereign guarantees from government but the latter does not issue any. A sovereign guarantee "is a promise by the government to discharge the liability of a third person in case of his default." This is in-line with the fourth challenge outlined below.

Furthermore, public willingness to pay is another challenge particularly due to two major reasons. Firstly, the nation suffers frequent power outages hence when there is a proposal to hike electricity rate base most people rebuff such calls for a simple reason that ESCOM cannot increase the electricity price while there is no power. People argue that ESCOM has to supply reliable power then people will pay for the power consumed but not for blackouts. Secondly, most of the household consumers relying on the heavily subsidized electricity market price hence creating the problem of affordability since FITs are mostly subsidy free.

Political interference is another challenge. Most stakeholders described this as lack of seriousness by government or lack of political will particularly in offering sovereign guarantees requested by IPPs in accordance with the current FIT policy design. Pertinently, the marketing price of electricity is controlled by MERA which lead to ESCOM losses as the existing price is not cost-reflective. When ESCOM make a proposal to increase the electricity price MERA which is a government parastatal body most of the times disapproves the suggested new tariffs and the government opt for subsidy to cushion ESCOM in order to secure general elections votes. In fact, electricity tariffs are heavily subsidies in Malawi. For instance, domestic, prepaid customers on single phase supply the electricity unit charge per KWh is 46.30 MWK (0.06 ¢/kWh) yet the feed-in tariff price for the same hydropower source outlined in the policy document is 10.0 ¢/kWh). This means changes in inflation or forex exchange rate is covered by government without passing through to ratepayers. It is no surprise that in May 2018, ESCOM requested a bail out from government amounting to 54 billion MWK (72 million USD) but Secretary to the Treasury explained that government could not bail-out the corporation's operations for doing so would collapse the economy [106].

Additionally, another notable challenge is the nation grid capacity. A grid study undertaken by Management and Engineering Technologies International (METI) revealed that as of 2016 the electricity network infrastructure in Malawi could only accommodate an additional of 70 MW maximum integration into the grid. The study findings disclosed that the maximum solar power plant an IPP could build was 17.5 MW as an intermittent renewable resource. As such the southern and central meshed transmission system could connect multiple 17 MW maximum of solar power plants whereas the northern radial transmission network could accommodate a maximum of 15 MW multiple power plants [107]. The Millennium Challenge Account-Malawi in September 2013 began the rehabilitation, upgrading and modernisation of the Malawi electricity network and through the project Malawi will have the first ever 400 kV transmission lines by 2018. The Millennium Challenge Corporation and the World Bank's transmission and distribution network upgrade shall provide a secure and reliable transmission network which will accommodate and connect many generators. The transmission network upgrade project is expected to complete in 2022 but as of 2018 the grid capacity study indicates that IPPs connections up to 300 MW are possible in the electricity network [107].

The last challenge faced in implementing FIT policy is the low tariff level being offered to investors. Low tariff discourage private investment in the power sector as the projects are seen to be unprofitable. In measuring this variable, a Cronbach's Alpha reliability test was carried out in SPSS and the results are shown below;

Table 4.5 Low tariff reliability statistics

Item-Total Statistics

FIT Tariff	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Current hydropower tariff	13.13	14.395	.597	.814
Current solar tariff	14.07	17.582	.413	.842
Current biomass tariff	13.53	15.982	.698	.790
Current biogas tariff	13.53	15.706	.742	.782
Current wind tariff	13.47	14.809	.760	.773
Current geothermal tariff	13.77	16.599	.494	.828

Reliability Statistics

Cronbach's Alpha	N of Items
.833	6

Source: Author

Cronbach's Alpha analysis was conducted on the current feed-in tariff rate and it was found that the scale's alpha was 0.833 which surpassed the minimum threshold of 0.7 Cronbach's Alpha reliability test. The .833 indicate that the scale has an adequate level of inter-item reliability. Further analysis revealed that by deleting any item, the alpha level would still be above 0.7. The summary of respondent's statistics measuring level of satisfaction with the current FIT tariff rates is shown in the table below.

Table 4.6 Level of satisfaction with current tariff rates

		Frequency	Percent	Valid Percent
Current hydropower tariff	Strongly disagree	5	14.3	14.3
	Disagree	6	17.1	17.1
	Not sure	6	17.1	17.1
	Agree	12	34.3	34.3
	Strongly agree	6	17.1	17.1
	Total	35	100.0	100.0
Current solar tariff	Strongly disagree	8	22.9	22.9
	Disagree	15	42.9	42.9
	Not sure	7	20.0	20.0
	Agree	5	14.3	14.3
	Strongly agree	0	0	0
	Total	35	100.0	100.0
Current biomass tariff	Strongly disagree	3	8.6	9.4
	Disagree	8	22.9	25.0
	Not sure	13	37.1	40.6
	Agree	8	22.9	25.0
	Strongly agree	0	0	0
	Total	32	91.4	100.0
	No response	3	8.6	
Current biogas tariff	Strongly disagree	4	11.4	12.1
	Disagree	9	25.7	27.3
	Not sure	12	34.3	36.4
	Agree	8	22.9	24.2
	Strongly agree	0	0	0
	Total	33	94.3	100.0
	No response	2	5.7	
Current wind tariff	Strongly disagree	4	11.4	11.4
	Disagree	12	34.3	34.3
	Not sure	6	17.1	17.1
	Agree	12	34.3	34.3
	Strongly agree	1	2.9	2.9
	Total	35	100.0	100.0
Current geothermal tariff	Strongly disagree	8	22.9	23.5
	Disagree	7	20.0	20.6
	Not sure	12	34.3	35.3
	Agree	7	20.0	20.6
	Strongly agree	0	0	0
	Total	34	97.1	100.0
	No response	1	2.9	

Source: Author

From table above, it is clear that most policy makers, regulators and stakeholders disagree with the current tariff rates offered to investors which are regarded to be low to attract IPPs into the electricity market as low tariff are not appealing to investors. Even though some IPPs have shown formal interest in the electricity market, it was reported that most of the IPPs have negotiated with the government to increase the tariff rate to make their projects profitable and cost reflective. This means that if the IPPs are to invest in the power sector, they will be offered special rate that are above the existing rate outlined in the FIT policy. For instance, the Global Status of Renewable Energy 2017 and 2018 by REN 21 reveals decline in prices or rapid falling costs, particularly for solar PV modules and onshore wind power. The reports outlined the levelised cost of solar energy generation in Africa was between 0.9 to 0.26 USD/kWh in 2016 while in 2017 it ranged between 0.8 to 0.22 USD/kWh. Yet in 2012 when the FIT was adopted in Malawi, typical solar energy costs ranged between 20-37 US cents/kWh. [108], [109], [110].

The feed-in tariff price for solar generated power was chosen to model Kamauzu International Airport (KIA) solar farm using RETScreen as more respondent indicated that the solar tariff rate is very low and does not reflect the actual levelized cost of solar power generation. Furthermore, KIA solar electricity was chosen because it is the only project that is connected to the nation grid despite that the project was a grant from JICA and the solar farm is operated by KIA not IPPs but the findings reflects the truth of the investment and operations cost of solar power in Malawi.

4.3 FIT Policy Funding and Limiting Policy Cost

Policy funding is critical as it impact investors security, electricity market growth, long-term vision of the policy and sustainability. Several ways to fund the Malawi FIT was identified by policy makers, regulators and stakeholders namely:

a) Fuel levy
b) Electricity levy
c) Ratepayer
d) Maximising EFD tax collection
e) International funds

To begin with, most respondents suggested fuel levy to be the most viable option to fund the policy. Malawi has six levies built into per litre price of fuel as follows; “energy regulatory levy, charged at K10 per litre of landed petrol, diesel and paraffin; rural electrification levy charged at K37.11 for petrol, K36.71 for diesel and K29.19 for paraffin; price stabilisation fund at K22.61 for petrol, K22.21 for diesel and K21.30 for paraffin; fuel storage levy at K5 per litre of landed petrol, diesel and paraffin; Malawi Bureau of Standards (MBS) cess levy at K0.89 for petrol, K0.88 and K0.84 and road fund levy at K90.57 for petrol and K89.73 diesel" [111]. The rural electrification levy is dedicated to connecting new customers by expanding the electricity network to different trading centres as a way of increasing electricity access for people in peri-urban and rural areas.

The respondents suggested introduction of FIT levy or rethinking the rural electrification levy which funds the Malawi Rural Electrification Program (MAREP) so that the fund should be used in power generation then connect new customers as opposed to the current trend of connecting more trading centres and new customers yet the generation capacity is still the same. Similarly, the MAREP fund can be divided so that half of the amount can be used to pay IPPS and the other half connecting new customers to the grid. For instance, in June 2017, the Minister of Natural Resources, Energy and Mining announced that MAREP phase 8 will electrify 336 trading centres across the country by end 2018 to the tune of MWK 30 billion (USD 40 million) [112], [113]. According to Annual Economic Report of 2016, the initial budget was MWK 16 billion (USD 21 million) targeting 122 trading centres but the funding was increased to target many trading centres [114]. Such huge amount of money can be shared into power generation by funding FIT policy and rural electrification. Likewise, respondents suggested introduction of electricity levy in price build-up on the electricity tariff charged by ESCOM.

The third way to fund the policy is through ratepayers. This means any added cost should be factored into electricity rate base charged to all power consumers. Adjusting end-user tariffs can ensure that all costs associated with FIT are passed on to the consumers. ESCOM will pay the power producers the wholesale price directly for their power and pass on the costs to electricity consumers in the electricity bills via a surcharge on customer's electricity bills. Respondents mentioned that the existing customer differentiation should be implemented in the ratepayer funding that is domestic customers, general customers, low voltage supply for industrial users, medium voltage supply for industrial users etc. the ratepayer should not be an equivalent distribution.

Furthermore, respondents noted that most shops across the country do not have Electronic Fiscal Device (EFD) machine or have them but do not print receipts for goods purchased. To finance FIT, the government should emphasize revenue collection so that everyone who is supposed to pay tax especially Value Added Tax (VAT) has to pay and use the revenues prudently for economic development including investment in electricity generation. Maximising revenue collection will make a leeway to finance different programmes such as FIT policy cost. Some respondents cited Ethiopia as a good example worth emulating because the Ethiopian government intensified EFDs and the revenue collected is prudently used for the nation development notably investment in power generation. What's more, respondents suggested that EFD should be mandatory in Malawi in all shops with stiff punishment for tax evasion to all businesses that dodge tax net by either operating without EFD or non-issuance of tax invoices despite having the machine. Recently, the Malawi Revenue Authority (MRA) introduce a campaign called "Lisiti Langa Promotion" whereby customers won various prizes for demanding an EFD receipt every time they purchased goods. This was a good initiative even though it has loopholes that some business will continue operating without EFDs as there are no punitive measures.

Lastly, policy makers, regulators and stakeholders recommended that Malawi should take advantage of the existing international FIT policy fund to supplement locally generated funds. There are several international funding options supporting FIT policy in developing countries. These include Global Energy Transfer Feed-in Tariff (GET FiT) by Deutsche Bank, Green Power Africa, Nationally Appropriate Mitigation Actions (NAMAs) and the Green Climate Fund. These international funds encourage private sector investment in power sector as it increases investors security and de-risk IPPs investment in the power industry in developing countries.

Three ways to limit policy cost were explored these are caps, payment level adjustment and competitive bidding. An overall policy cost control mechanism from the outset is vital to balance policy benefits while bounding policy costs as FIT provide strong incentive for IPPs. Lack of policy cost containment can create an overwhelming rush of RE development resulting in either extreme profits for generators or failure to pay IPPs due to electricity oversupply or influx in RE investment. The Malawi FIT policy has individual project size caps as shown below:

Table 4.7 Malawi FIT policy caps

TECHNOLOGY	CAP (MW)	CATEGORY
Hydropower	150	Firm power
	50	Non-firm power
Solar	100	Firm power
	50	Non-firm power
Biomass	200	Firm power
	50	Non-firm power
Biogas	100	Firm power
	50	Non-firm power
Wind	200	Cumulative
Geothermal	200	Cumulative
Total	1150	

Source: Author

It was noted that investors have shown formal interest in solar, hydro and biomass which are considered to be viable in Malawi. Wind power resource feasibility study was complete under Wind Energy Preparation Programme (WEPP). Policy makers, regulators and stakeholders recommended capacity-based program size caps rather than the current individual project size caps which indicates that Malawi will not attain the target MW because some of the renewable resources are not attractive to investors such as geothermal. That being said, Malawi will fall short of the target as some RE resource under FIT will remain unexploited. Malawi should set the overall target for RE development under FIT to a known MW capacity then closely monitor so that the investment in RE generation does not surpass the envisage capacity. Once the capacity block is achieved, Malawi can employ payment level adjustment mechanism to control policy cost and benefit from technology cost reductions. Program size caps will deter creation of mass markets that can be costly to ratepayers while promising to be an effective way to limit the policy costs over a period.

4.4 Modelling Feed-In Tariff for Kamuzu International Airport Solar Farm

Kamuzu International Airport (KIA) solar farm was a grant project from Japanese government built in 2013 under the supervision of Japan International Corporation Agency (JICA) Malawi. The grant solar project costed a total amount of USD 8.3 million and generate a maximum of 830 kW. This is the first ever and only power generation facility with connection to the ESCOM grid. The system consists 3540 Panasonic solar panels with 200 panels connected in block. The panels are titled at 19 °C facing equator. The solar farm has Nissin Electric 9 inverters with each inverter having a rated output capacity of 100 kW and operating at 95 % efficiency. The solar farm has no battery bank. The solar farm has 50 panels and one invertor as spares parts and periodic costs mainly for replacing faulty components were bought in advance by JICA.

Policy makers, regulators and stakeholders were asked to suggest the percentage of Internal Rate of Return (IRR) on equity that should be paid to investors so that a reasonable level of profit is realized for their investment. The results are shown below;

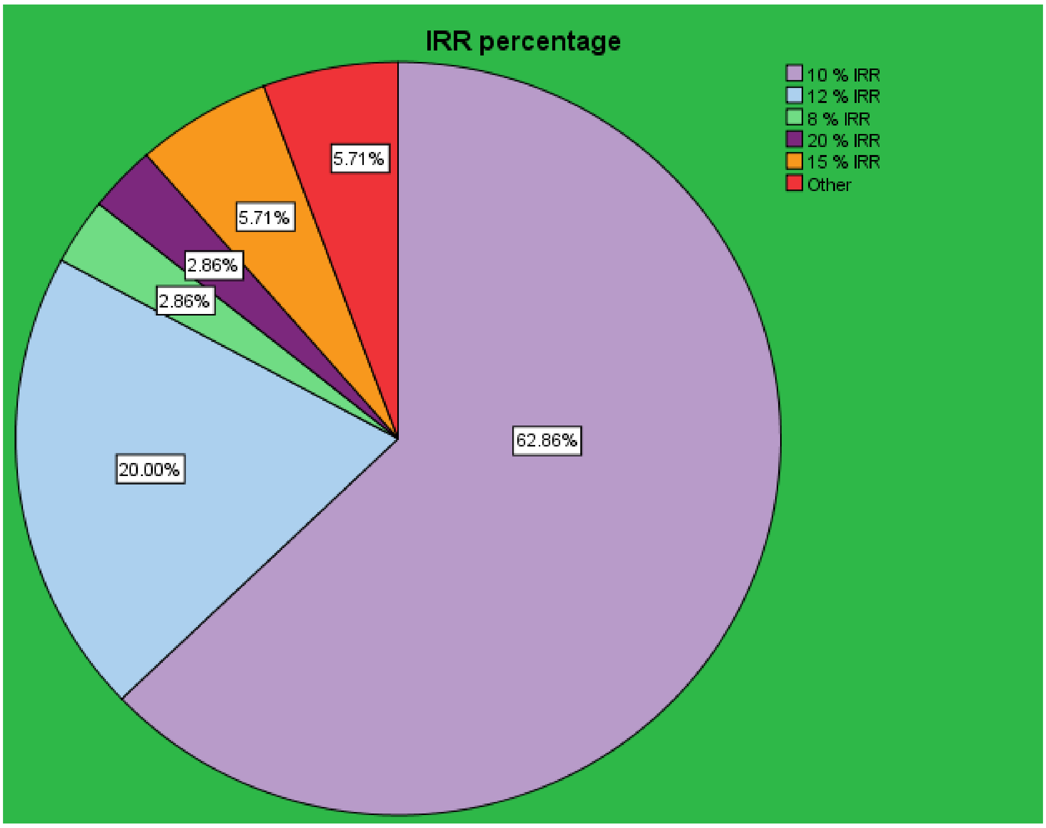


Figure 4.6 Percentage of IRR on equity
Source: Author

From figure above, 62 % of the respondents suggested a 10 % IRR on equity paying to investors. This was deemed to be sufficient incentive to attract investors into the power sector. The respondents were deliberately asked to suggest the pre-tax percentage on IRR because part of this policy analysis will involve modelling as such the percentage suggested by many respondents will be used for policy options analysis with RETScreen Expert.

KIA site information

System capacity: 830 kW

Tilt angle: 19 °C

Total system cost: USD 8.3 million

Total O&M per year: USD 1440

Inflation rate (for O&M): 10 %

Project life: 20 years

Feed-in tariff: USD $ 0.20/kWh

Inverter replacement after 12 years

No debt financing

Test scenarios and policy options (target 10 % IRR on equity)

a) Is it a profitable investment if it was not a grant project?
b) How high does FIT need to be to attract investment or turn the project profitable?
c) How high does FIT need to be if tariff of $0.20/kWh escalating at 5 % annually?
d) How high does FIT need to be to attract investment if debt financing was 50% and equity financing was 50 %?
e) How high does FIT need to be to attract investment if soft loan was provided?
f) How high does FIT need to be to attract Malawian investment (local investors) if 10% capital incentive was provided, 50 % equity financing, 40 % debt financing and electricity escalation of 5 % annually?

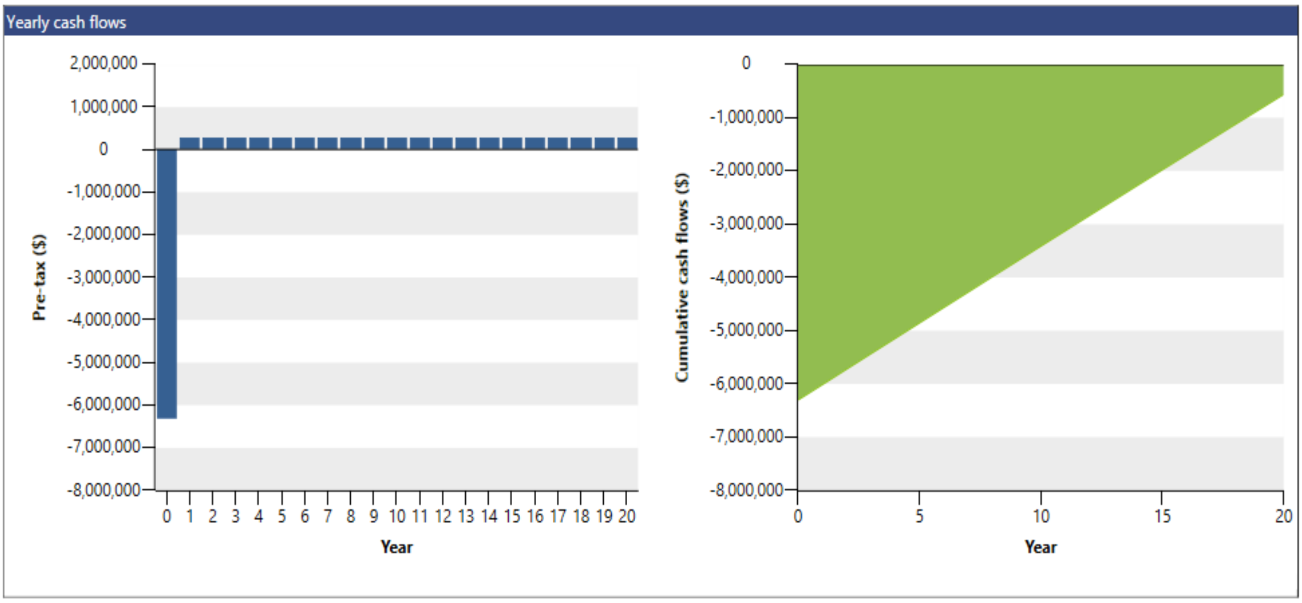
4.5 RETSCREEN Results

a) Is it a profitable investment if it was not a grant project?

Annual revenue		
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.20
Electricity export revenue	$	291,578
Electricity export escalation rate	%	0%

Financial viability		
Pre-tax IRR - equity	%	-0.87%
Pre-tax IRR - assets	%	-0.87%
Simple payback	yr	21.7
Equity payback	yr	> project
Net Present Value (NPV)	$	-3,846,434
Annual life cycle savings	$/yr	-451,801
Benefit-Cost (B-C) ratio		0.39
Debt service coverage		No debt

Yearly cash flows		
Year	**Pre-tax**	**Cumulative**
#	$	$
0	-6,300,000	-6,300,000
1	289,994	-6,010,006
2	289,835	-5,720,171
3	289,661	-5,430,510
4	289,470	-5,141,040
5	289,259	-4,851,781
6	289,027	-4,562,755
7	288,772	-4,273,983
8	288,491	-3,985,492
9	288,182	-3,697,310
10	287,843	-3,409,467
11	287,469	-3,121,998
12	287,058	-2,834,939
13	286,607	-2,548,333
14	286,109	-2,262,223
15	285,563	-1,976,661
16	284,961	-1,691,700
17	284,299	-1,407,400
18	283,572	-1,123,829
19	282,771	-841,058
20	281,890	-559,168



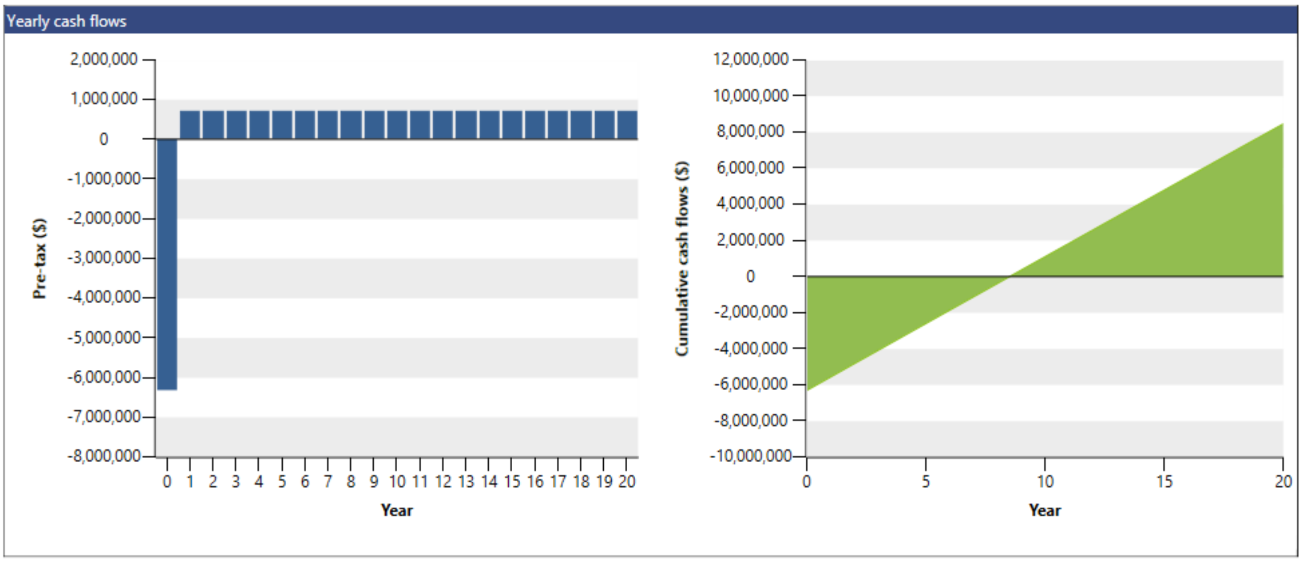
The solar farm project is not profitable as cumulative cash flow never goes past 0 and IRR on equity is -0.87 %. Simple payback is beyond the project life. The graph is linear because electricity is not escalating the FIT is fixed. In a nutshell, this is not an attractive investment for IPPs.

b) *How high does FIT need to be to attract investment or turn the project profitable?*

Annual revenue		
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.51
Electricity export revenue	$	743,349
Electricity export escalation rate	%	0%

Financial viability		
Pre-tax IRR - equity	%	10.0%
Pre-tax IRR - assets	%	10.0%
After-tax IRR - equity	%	10.0%
After-tax IRR - assets	%	10.0%
Simple payback	yr	8.5
Equity payback	yr	8.5
Net Present Value (NPV)	$	0
Annual life cycle savings	$/yr	0
Benefit-Cost (B-C) ratio		1.00

Yearly cash flows		
Year	**Pre-tax**	**Cumulative**
#	**$**	**$**
0	-6,300,000	-6,300,000
1	741,765	-5,558,235
2	741,607	-4,816,628
3	741,433	-4,075,195
4	741,241	-3,333,954
5	741,030	-2,592,923
6	740,798	-1,852,125
7	740,543	-1,111,582
8	740,263	-371,319
9	739,954	368,635
10	739,614	1,108,249
11	739,241	1,847,490
12	738,830	2,586,320
13	738,378	3,324,698
14	737,881	4,062,579
15	737,334	4,799,914
16	736,733	5,536,646
17	736,071	6,272,717
18	735,343	7,008,060
19	734,543	7,742,603
20	733,662	8,476,265



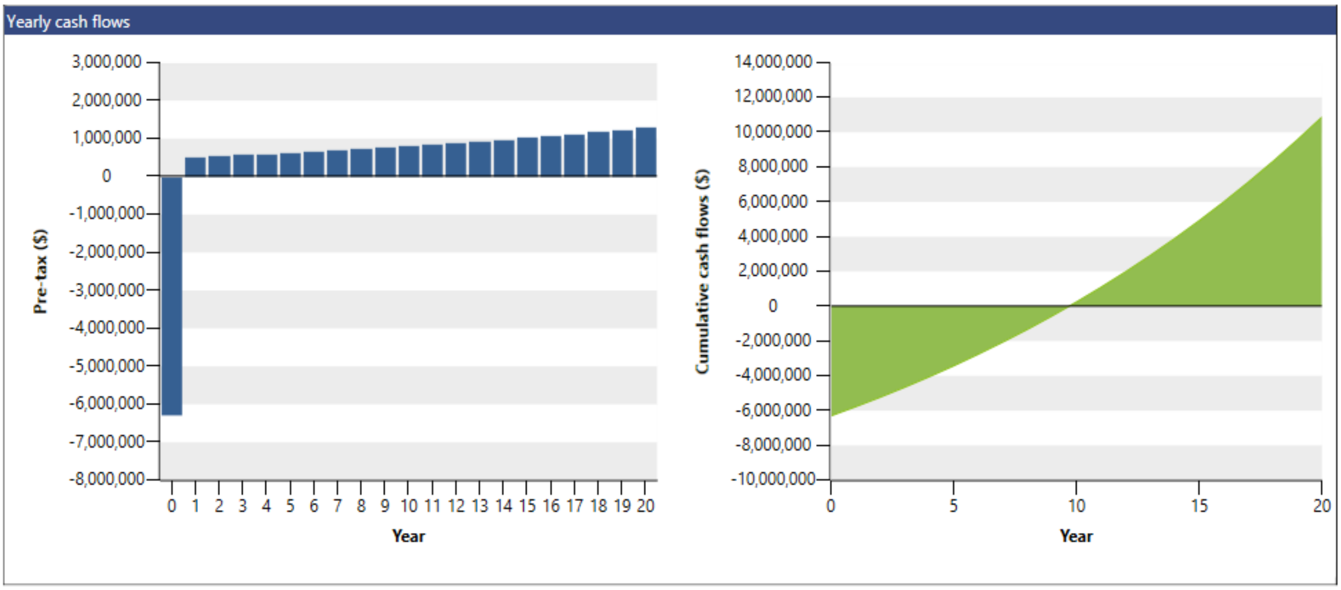
To turn the project to profitability the FIT has to be $ 0.51 kWh and investors will earn a 10 % IRR on equity. The equity payback and simple payback period of the project at this $ 0.51 kWh rate is 9 years of which IPPs would be attracted. The discount rate is 10 % and IRR on equity is also 10 % and indeed the Net Present Value is 0. Benefit-Cost ratio of 1 is an indicative of profitable of the project. The $ 0.51 kWh is high because of the overhead costs considering the nature of solar project was public and it involved bilateral aid.

c) How high does FIT need to be if tariff of $0.20/kWh escalating at 5 % annually?

Annual revenue		
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.34
Electricity export revenue	$	497,645
Electricity export escalation rate	%	5%

Financial viability		
Pre-tax IRR - equity	%	10.0%
Pre-tax IRR - assets	%	10.0%
After-tax IRR - equity	%	10.0%
After-tax IRR - assets	%	10.0%
Simple payback	yr	12.7
Equity payback	yr	9.7
Net Present Value (NPV)	$	0
Annual life cycle savings	$/yr	0
Benefit-Cost (B-C) ratio		1.00

Yearly cash flows		
Year	**Pre-tax**	**Cumulative**
#	$	$
0	-6,300,000	-6,300,000
1	520,943	-5,779,057
2	546,911	-5,232,146
3	574,170	-4,657,976
4	602,782	-4,055,194
5	632,816	-3,422,378
6	664,341	-2,758,037
7	697,430	-2,060,606
8	732,162	-1,328,445
9	768,615	-559,830
10	806,876	247,047
11	847,033	1,094,080
12	889,180	1,983,260
13	933,413	2,916,672
14	979,835	3,896,507
15	1,028,553	4,925,060
16	1,079,680	6,004,740
17	1,133,333	7,138,073
18	1,189,636	8,327,708
19	1,248,717	9,576,426
20	1,310,713	10,887,138



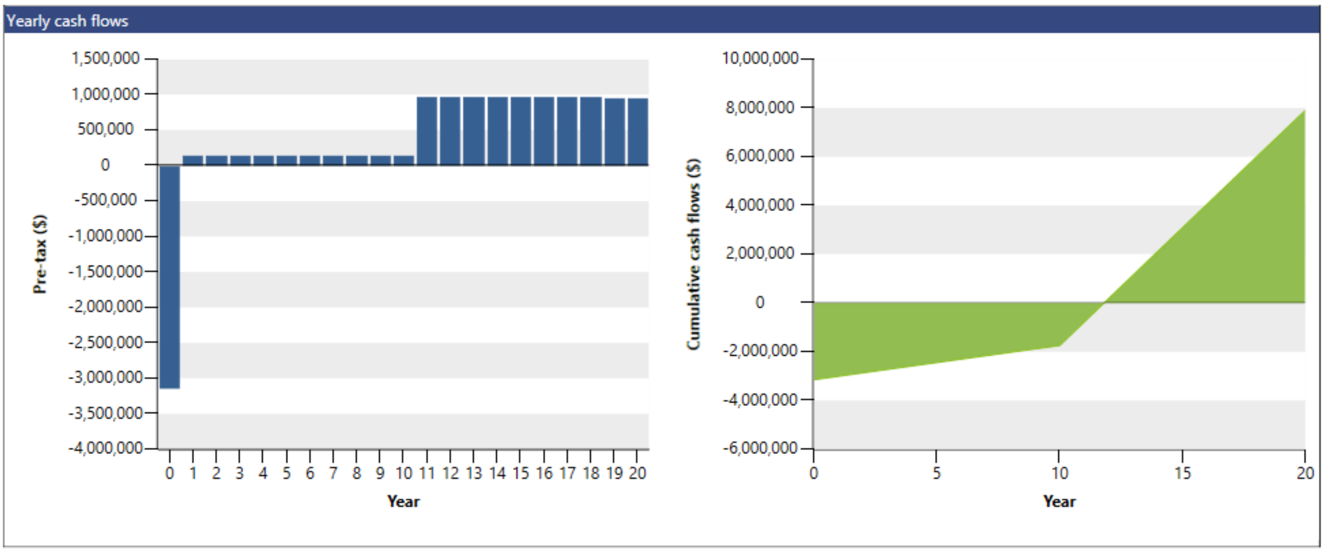
Electricity export escalation rate is the projected annual average rate of increase in electricity export rate over the life of the project and apply rate of inflation to the value of electricity export rate. At escalation rate of 5 % which is half of the inflation rate, the FIT rate has to be $ 0.34 kWh. Because the electricity rate is escalating the equity payback is 10 years while simple payback period is 13 years. Equity payback represents the length of time it takes for the IPP to recoup its own initial investment out of the project cash flows generated. If the electricity escalation rate was 10 % annually from this scenario FIT rate would be $ 0.22 kWh.

d) How high does FIT need to be to attract investment if debt financing was 50% and equity financing was 50 %?

Annual revenue		
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.67
Electricity export revenue	$	972,057
Electricity export escalation rate	%	0%

Financial viability		
Pre-tax IRR - equity	%	10.0%
Pre-tax IRR - assets	%	4.2%
After-tax IRR - equity	%	10.0%
After-tax IRR - assets	%	4.2%
Simple payback	yr	6.5
Equity payback	yr	11.8
Net Present Value (NPV)	$	0
Annual life cycle savings	$/yr	0
Benefit-Cost (B-C) ratio		1.00
Debt service coverage		1.17

Yearly cash flows		
Year	**Pre-tax**	**Cumulative**
#	$	$
0	-3,150,000	-3,150,000
1	141,367	-3,008,633
2	141,208	-2,867,425
3	141,034	-2,726,391
4	140,842	-2,585,549
5	140,632	-2,444,917
6	140,400	-2,304,518
7	140,145	-2,164,373
8	139,864	-2,024,509
9	139,555	-1,884,954
10	139,216	-1,745,738
11	967,949	-777,789
12	967,538	189,749
13	967,086	1,156,835
14	966,589	2,123,423
15	966,042	3,089,466
16	965,441	4,054,906
17	964,779	5,019,685
18	964,051	5,983,736
19	963,250	6,946,986
20	962,370	7,909,356



The project would need a FIT rate of $ 0.67 if it involved a debt financing of 50 %. The debt interest rate was 23.75 % for commercial banks in 2012 according to statistics from Reserve

Bank of Malawi when the KIA project was being initiated. The simple payback is 7 years whereas the equity payback is 12 years. The simple payback represents the length of time it takes for a proposed project to recoup its own initial cost, out of the revenue generated without taking into account debt repayment. The graph shows export income flow upsurge after 10 years because the debt financing would be repaid.

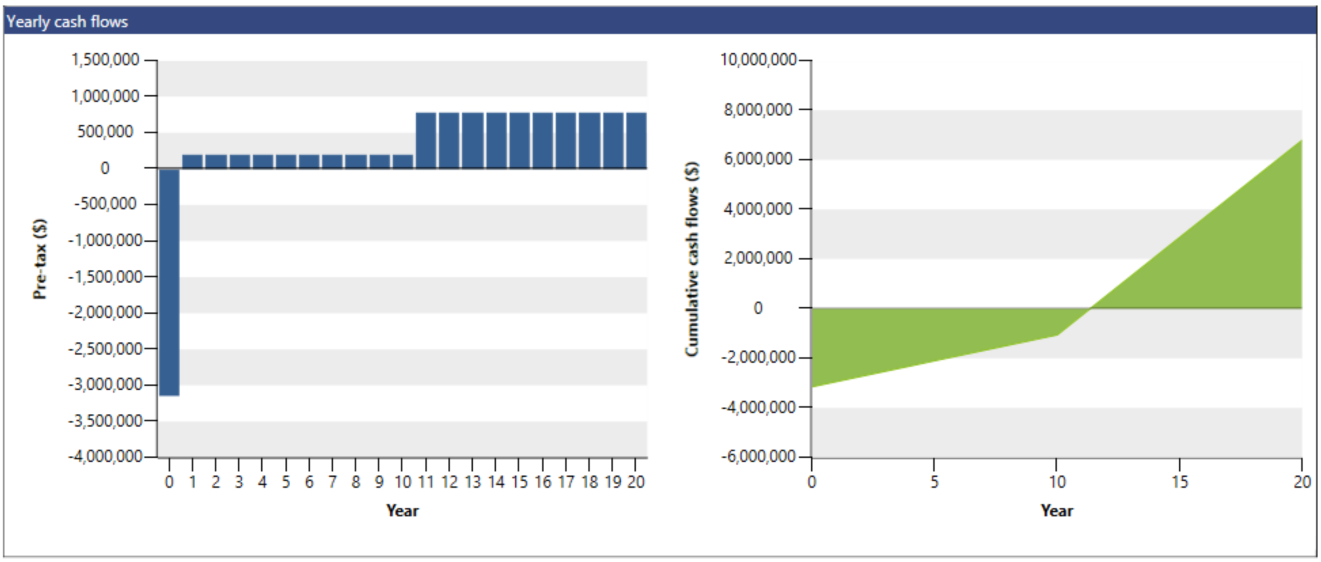
e) How high does FIT need to be to attract investment if soft loan was provided?

Annual revenue		
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.54
Electricity export revenue	$	792,283
Electricity export escalation rate	%	0%

Financial viability		
Pre-tax IRR - equity	%	10.0%
Pre-tax IRR - assets	%	3.6%
After-tax IRR - equity	%	10.0%
After-tax IRR - assets	%	3.6%
Simple payback	yr	8.0
Equity payback	yr	11.3
Net Present Value (NPV)	$	0
Annual life cycle savings	$/yr	0
Benefit-Cost (B-C) ratio		1.00
Debt service coverage		1.36

Yearly cash flows

Year	Pre-tax	Cumulative
#	$	$
0	-3,150,000	-3,150,000
1	210,187	-2,939,813
2	210,028	-2,729,785
3	209,854	-2,519,931
4	209,662	-2,310,268
5	209,452	-2,100,817
6	209,220	-1,891,597
7	208,965	-1,682,632
8	208,684	-1,473,948
9	208,375	-1,265,573
10	208,036	-1,057,537
11	788,174	-269,363
12	787,764	518,400
13	787,312	1,305,712
14	786,814	2,092,526
15	786,268	2,878,794
16	785,666	3,664,460
17	785,004	4,449,465
18	784,277	5,233,741



The soft loan means a debt interest rate of 13 % used by Reserve Bank of Malawi instead of 23.75 % used by commercial banks. If Malawi was to implement that policy option for IPPs the FIT would be $ 0.54 kWh which would allow the IPPs to earn a 10 % IRR on equity.

f) How high does FIT need to be to attract Malawian investment (local investors) if 10 % capital incentive was provided, 50 % equity financing, 40 % debt financing and electricity escalation of 5 % annually?

Annual revenue

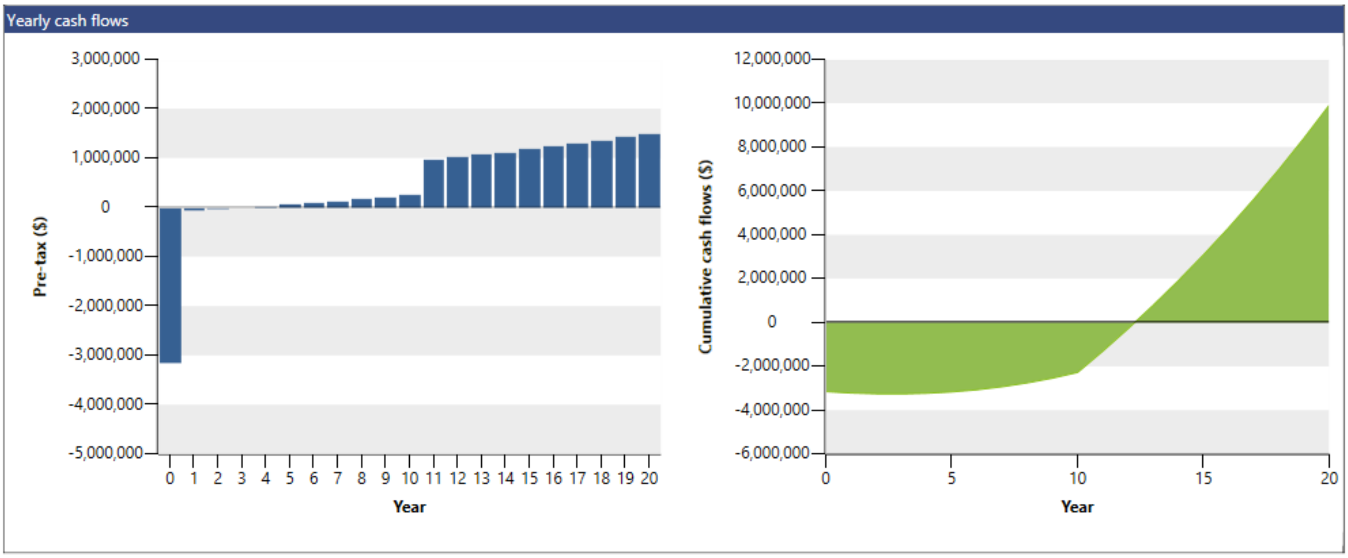
Electricity export revenue		
Electricity exported to grid	MWh	1,458
Electricity export rate	$/kWh	0.39
Electricity export revenue	$	570,236
Electricity export escalation rate	%	5%

Financial viability

Pre-tax IRR - equity	%	10.0%
Pre-tax IRR - assets	%	5.7%
After-tax IRR - equity	%	10.0%
After-tax IRR - assets	%	5.7%
Simple payback	yr	10.0
Equity payback	yr	12.3
Net Present Value (NPV)	$	0
Annual life cycle savings	$/yr	0
Benefit-Cost (B-C) ratio		1.00
Debt service coverage		0.90

Yearly cash flows

Year	Pre-tax	Cumulative
#	$	$
0	-3,150,000	-3,150,000
1	-66,121	-3,216,121
2	-36,342	-3,252,463
3	-5,082	-3,257,545
4	27,732	-3,229,813
5	62,178	-3,167,635
6	98,335	-3,069,300
7	136,288	-2,933,012
8	176,127	-2,756,885
9	217,943	-2,538,942
10	261,835	-2,277,107
11	971,189	-1,305,918
12	1,019,543	-286,374
13	1,070,295	783,920
14	1,123,561	1,907,481
15	1,179,465	3,086,946
16	1,238,138	4,325,084
17	1,299,714	5,624,798
18	1,364,336	6,989,134
19	1,432,152	8,421,286
20	1,503,319	9,924,605



Capital incentive is an option to soft loan. If the government cannot provide soft loan with interest rate equal to the lending rate offered by Reserve Bank of Malawi to commercial banks, then the government can provide capital incentives as a policy option. This capital incentive can encompass rebate, contribution, grant, subsidy in this scenario a 10 % contribution or grant on the initial cost of the project to encourage Malawi businesses to invest in the power sector. With an escalation of 5 % annually the FIT rate would be $ 0.39 kWh with a simple payback of 10 years and equity payback of 12 years. The same scenario but with an escalation of 10 % the FIT rate would be $ 0.25 kWh.

4.6 Chapter Summary

The chapter has presented FIT policy design that can attract IPPs following consultation with policy makers, regulators and stakeholders. Notable challenge with the Malawi 2012 FIT policy design there was no stakeholder consultation in Malawi the consultant copy pasted the Kenyan 2010 FIT policy as such it was design out of Malawi context. Other challenges presented include policy funding, grid capacity and low tariff offered to IPPS. To ensure investors security, fuel levy, electricity levy, ratepayer and maximising EFD tax collection have been explores as some ways to fund the FIT policy.

Chapter 5 : CONCLUSION AND RECOMMENDATIONS

Regulatory policy instruments to promote renewable electricity generation have taken on increasing importance in many countries and states. The widely deployed and successful policy instruments for encouraging generation of electricity from renewables in the world are feed-in tariffs (FIT) and Renewable Energy Portfolio Standards (RPS). Among the existing policy instruments to accelerate renewable energy deployment, FIT policies are the versatile, accounting for the worldwide greatest propagation of renewable energy generation than all other renewable energy policy scheme. Malawi is no exceptional it adopted the FIT policy in 2012 to attract more players in the power sector to generate electricity in the following eligible technologies under the Malawi FIT policy; hydropower, solar, biomass, biogas, wind and geothermal. The major challenge with the 2012 FIT policy there was no stakeholder consultation in designing the policy as such the policy missed some features of good policy making like forward looking, outward looking, evidence-based and inclusive. This is one of the challenges discussed in this study that has failed the FIT policy to attract any IPP apart from low tariff level.

Based on the study findings, the following recommendations are made;

a) The tariff rates presented in the policy document ought to be reviewed, redesigned to reflect and track the actual cost of electricity generation in Malawi, technology learning, technology change and reflect cost reductions considering recent improvements in various renewable energy technologies such as wind. Majority of the respondents disclosed that they are unsatisfied or disagree with the current level of tariff rates being offered. Relatedly, report of REN 21 on the Global Status of Renewable Energy 2017 and 2018 for instance, revealed a decline in prices or falling costs, mainly for solar PV modules and onshore wind power. The reports outlined the levelised cost of solar energy generation in Africa was between 0.9 to 0.26 USD/kWh in 2016 while in 2017 it ranged between 0.8 to 0.22 USD/kWh while for other technologies cost of generation is somewhat high.

b) The FIT policy must be gazetted. The 2012 FIT policy was not gazetted meaning it has no legal backing. By gazetting the policy, the laws will give the policy legal authority that is the laws will legitimize FIT policy and gazetting shall be an official publicising of policy.

c) Stakeholders should be involved during design and review of the policy. Policy makers, regulators and stakeholders must be involved in all the stages of policy cycle; agenda-setting, policy formulation, decision making, implementation, and evaluation. This shall increase level of public impact by getting feedback on the design, analysis, policy options and decisions and this will help MERA to design an effective FIT policy that shall attain the policy objectives, provide investors security and attract more IPPs in the electricity market. As the FIT is due for review this year after five years of its adoption in 2012, the evaluation process should involve stakeholders.

d) The objectives set in the policy document ought to be redefined to reflect real issue of energy access challenge. All the prevailing objectives are investors centred, non-reflecting the current electricity situation in Malawi. The first stage of policy formulation is agenda-setting which list problems or issues in a society or nation requiring serious attention and it gains public or elite attention. The country has 10 % electricity access rate, this is the challenge that has to be addressed and it must be a clear priority as cemented by many respondents. The objectives stipulated in the policy document such as providing investor security, minimising administrative cost, delays etc. all should be by-products or benefits of a well-designed FIT policy to IPPs. When designing the policy it has to be people-centred focusing on increasing electricity access rate, accelerating rural electrification and maximize RE generation. If these objectives are prioritized in the policy, it will make a leeway for policy-makers, regulators to design a stimulus package or tariffs that are appealing to investors and that provide investors security.

e) A stable funding mechanism should be established. This has an impact on investors security, Malawi electricity market growth and longevity of the policy. The FIT fund should not be vulnerable. Fuel levy is deemed as one of the stable options.

REFERENCES

[1] Yi Yang (2013). *Evaluation of the actual performance of China's Green Economy stimulus package. A case study of China's "Feed-in-Tariff" system for wind energy in Chang River Delta region*. (Masters Thesis). Sweden, Lund University.

[2] ECO Canada (2010). *Defining the Green Economy. Labour Market Research Study*. ECO Canada, Environmental Careers Organization. Page 3.

[3] UNEP (2011). *Towards a green economy: pathways to sustainable development and poverty eradication*. Nairobi, United Nations Environment Programme.

[4] Solangi, K.H. et al, (2011). *A review on global solar energy policy*. International Journal Renewable and Sustainable Energy Reviews. 15: 2149-2163.

[5] Palmer, K. & Burtrow D., (2005). *Cost-effectiveness of renewable electricity policies*. International Journal Energy Economics. 6:873-894.

[6] International Energy Agency (2013). *World Energy Outlook 2013: Renewable Energy Outlook*. Paris, OECD/IEA.

[7] Emanuelsson Sara, (2015). *Feed-in Tariffs for Renewable Energy and the WTO Agreement on Subsidies and Countervailing Measures- Are Feed-in Tariffs Specific Subsidies?* Goteborgs Universitet.

[8] Klein, A. et al, (2008). *Evaluation of Different Feed-in Tariff Design Options - Best Practice Paper for the International Feed-in Cooperation*. 2nd ed. Karlsruhe, Germany: Fraunhofer Institute Systems and Innovations Research.

[9] Haas, R. et al, (2008). *Promoting Electricity from Renewable Energy Sources – Lessons Learned from the EU, United States, and Japan*, in Fereidoon P. Sioshansi, ed., 'Competitive Electricity Markets', Oxford, Elsevier.

[10] Groba F, Joe Indvik J, Jenner S. (2011) *Assessing the Strength and Effectiveness of Renewable Electricity Feed-in Tariffs in European Union Countries*. DIW Berlin.

[11] Alizamir S, Véricourt F, Sun P, (2016) *Efficient Feed-In-Tariff Policies for Renewable Energy Technologies*. Operations Research 64(1):52-66.

[12] REN21, (2017). *Renewables 2017 Global Status Report*. Paris: REN21 Secretariat

[13] Klein A, (2008). *Feed-in Tariff Designs: Options to Support Electricity Generation from Renewable Energy Sources*. Germany, VDM Verlag Dr. Müeller, Saarbrücken.

[14] European Commission, (2008). *The Support of Electricity from Renewable Energy Sources*. Commission Staff Working Document.

[15] Mendonça M, Jacobs D, Sovacool B., (2010). *Powering the Green Economy: The Feed-in Tariff Handbook*. London, Earthscan.

[16] Deutsche Bank (2010). *Get FiT Program: Global Energy Transfer Feed-in Tariffs for Developing Countries.* Germany, Deutsche Bank Group.

[17] Ragwitz M et al, (2012). *Recent developments of feed-in systems in the EU – A research paper for the International Feed-In Cooperation.* Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

[18] Weibel D, (2011). *The Swiss Feed-in Tariff System: Analysis of the Swiss Policy and its Implications on the Development of Photovoltaics in Switzerland*. Energy Economics and Policy, ETH Zürich

[19] Li-Fang Chou & Liang-Feng Lin (2012). *Renewable Energy Feed-in-Tariff System Design and Experience in Taiwan, Low Carbon Policy and Development in Taiwan*. Dr. Liang-Feng Lin (Ed.), ISBN: 978-953-51-0156-7, InTech.

[20] Mendonça, M. (2007). *Feed-in Tariffs: Accelerating the Deployment of Renewable Energy*. London: EarthScan.

[21] Brown, P. (2013). *European Union Wind and Solar Electricity Policies: Overview and Considerations.* Congressional Research Service.

[22] Malawi government, (2011). *Malawi Government. Concept paper for the energy sector—public private partnerships for electricity generation for rural areas (2011–2016).* Lilongwe, Millennium Challenge Account.

[23] Overseas Development Institute, (2016). *Accelerating access to electricity in Africa with off-grid solar. Off-grid solar country briefing*: Malawi. ODI

[24] United Nations, (2017). *UN Country Profile - Malawi. Retrieved 2017, from UN DATA*: http://data.un.org/CountryProfile.aspx?crName=malawi

[25] Malawi Government, (2016). *Malawi Renewable Energy Strategy*. Lilongwe, Department of Energy Affairs.

[26] Millennium Challenge Account-Malawi, (2014). MCA-Malawi Progress Report. Presented at the Semi-Annual Review of the Millennium Challenge Compact. Lilongwe, Millennium Challenge Account.

[27] Gamula G, Hui L, Peng W, (2013). *Development of Renewable Energy Technologies in Malawi.* International Journal of Renewable Energy Technology Research Vol.2, No.2, February 2013, PP: 44 - 52, ISSN: 2325-3924

[28] Malawi Government, (2016). *Draft National Energy Policy*. Ministry of Natural Resources, Energy and Mining. Lilongwe, Department of Energy Affairs.

[29] Juma A, (2014). *The search for a sustainable strategy for the transfer of solar photovoltaic (PV) technologies to the rural areas in Malawi: Analysis of selected solar PV technology transfer strategies in Malawi*. (PhD Thesis) Lilongwe, Exploits University.

[30] Malawi Government, (2003). *National Energy Policy*. Lilongwe, Ministry of Energy and Mining.

[31] Zalengera, C., et al, (2014). *Overview of the Malawi energy situation and a PESTLE analysis for sustainable development of renewable energy*. Journal of Renewable and Sustainable Energy Reviews, 38, 335–347

[32] Gondwe K, Allen A, Georgsson L, Loga U., (2012). *Geothermal development in Malawi-a country update. Paper presented at the 4th African rift geothermal conference.* Geothermal solutions to Africa's energy needs, UN Gigiri complex,Nairobi, Kenya, Nairobi; 21–23 November 2012.

[33] Malawi Energy Regulatory Authority, (2012). *Malawi feed-in tariff: Renewable energy resource generated electricity in Malawi.* Lilongwe, Malawi Energy Regulatory Authority.

[34] IEA (2008). *Deploying Renewables: Principles for Effective Policies*. Paris, OECD/IEA.

[35] IPCC. (2011). *Special Report on Renewable Energy Sources and Climate Change Mitigation.* Prepared by Working Group III of the Intergovernmental Panel on Climate Change [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]., Cambridge, United Kingdom and New York. Cambridge University Press.

[36] Kouraki E, (2013). *Transaction Cost Analysis of Feed- in Tariff Schemes*. The case of Solar PVs in the UK. Sweden, Lund.

[37] Millennium Challenge Corporation, (2011). *Malawi Power System Project Studies – Final Feasibility Study Report*. Washington DC, Millennium Challenge Corporation.

[38] Malawi Government, (2017). *Support to SE4ALL Country Actions processes in Malawi. Action Agenda*. Lilongwe, Ministry of Energy and Mining.

[39] CCAP, (2002). *Accelerating renewable energy deployment with Feed-in-Tariffs: Germany and Thailand*. Washington, DC, Centre for Clean Air Policy.

[40] Fais B, (2015). *Modelling policy instruments in energy system models - the example of renewable electricity generation in Germany*. Institut für Energiewirtschaft und Rationelle Energieanwendung der Universität Stuttgart.

[41] Niles M. T. & Lubell M., (2012). *Integrative frontiers in environmental policy theory and research*. Policy Studies Journal, 40: 41-64

[42] Knill C. & Liefferink D., (2007). *Environmental politics in the European Union*. Manchester: Manchester University Press.

[43] Bergek A. & Berggren C., (2014). *The impact of environmental policy instruments on innovation: A review of energy and automotive industry studies.* Ecological Economics, (106), 112-123.

[44] Roth K, (2001). *Policy options for environmental pollution control including a case study: road transport alternatives.* Sustainable Energy ESD166J

[45] DEFRA, (2002). *The Government's Strategic Review of diffuse water pollution from agriculture in England: Types of Environmental Policy Instruments.* Department for Environment, Food and Rural Affairs, DWPA Project Team.

[46] Stavins R, (2001). *Experience with Market-Based Environmental Policy Instruments*. Discussion Paper 01–58. Resources for the Future 1616 P Street, NW Washington.

[47] INTOSAI, (2016). *Market-based instruments for environmental protection and management*. INTOSAI Working Group on Environmental Auditng (WGEA).

[48] Schmitt, S., Kai S., (2011). *Choosing environmental policy instruments: An assessment of the 'environmental dimension' of EU energy policy*, In: Tosun, J., and Israel S. (eds) Energy and Environment in Europe: Assessing a Complex Relationship? European Integration online Papers (EIoP), Special Mini-Issue 1, Vol. 15, Article 9

[49] Alberini, A. & Segerson K., (2002). *Assessing Voluntary Programs to Improve Environmental Quality*. Environmental and Resource Economics 22:157-84

[50] IRENA, (2012). *Evaluating policies in support of the deployment of renewable power.* IRENA policy brief. Abu Dhabi, United Arab Emirates.

[51] Fell H, (2009). *Feed-in Tariff for Renewable Energies: An Effective Stimulus Package without New Public Borrowing*. Member of the German Parliament, Berlin, Germany.

[52] Couture T. D., Kreycik C., Cory K., Williams E., (2010). *A Policymaker's Guide to Feed-in Tariff Policy Design.* Colorado. USA, National Renewable Energy Laboratory.

[53] Rickerson W. et al (2008). *Exploring Feed-in Tariffs for California. California Energy Commission*. Oakland, CA. Sacramento, CA.

[54] Couture T. & Cory K., (2009). *State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-in Tariffs in the United States.* Golden, CO. National Renewable Energy Laboratory Technical Report No. TP-6A2-45551.

[55] Han J., Mol P.J.A., Lu Y., Zhang L., (2009). *Onshore wind power development in China: Challenges behind a successful story*. Energy Policy, (37, 8); pp. 2941-2951.

[56] Stennett A., (2010). *Incentivising renewable electricity – a comparison of Renewable Obligation Certificates and Feed-in tariffs*. Northern Ireland Assembly.

[57] Couture T. & Gagnon Y., (2010). *An analysis of feed-in tariff remuneration models: Implications for renewable energy investment*. Energy Policy, (38, 2); pp. 955-965.

[58] Held, A. et al, (2007). *Feed-in Systems in Germany, Spain, Slovenia: A Comparison.* Germany, Fraunhofer Institute & Energy Economics Group, APE.

[59] Gonzalez P. & Del R., (2008). *Ten years of renewable electricity policies in Spain: an analysis of successive feed-in tariff reforms.* Energy Policy 36 (8), 2917–2929.

[60] Klein A. et al (2010). *Evaluation of Different Feed-in Tariff Design Options - Best Practice Paper for the International Feed-in Cooperation*. 3rd. Karlsruhe, Germany: Fraunhofer Institute Systems and Innovations Research.

[61] Ragwitz M., et al, (2007). *Assessment and optimization of renewable energy support schemes in the European electricity market: Final Report*. Karlsruhe, Germany: Optimization of Renewable Energy Support (OPTRES)

[62] Mendonça M., (2009). *Feed-In Tariffs: Accelerating the Deployment of Renewable Energy*. London, Sterling, VA: Earthscan

[63] Thayer R., (2013). *A Policymaker's Guide to Feed-In Tariffs: Encouraging a Responsible Transition to Renewable Electricity in California*. Pomona College.

[64] Ragwitz M., et al, (2012). *Recent developments of feed-in systems in the EU – A research paper for the International Feed-In Cooperation*. Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

[65] Nolden C., (2015). *Performance and Impact of the Feed-in Tariff Scheme: Review of Evidence*. UK, Department of Energy and Climate Change.

[66] Toit L, (2014). *Promoting renewable energy in South Africa through the inclusion of market-based instruments in South Africa's legal and policy framework with particular reference to the feed-in tariff*. University of Cape Town.

[67] REN21 (2013). *Renewables 2013: Global Status Report*. Paris: REN21 Secretariat.

[68] IRENA, (2015). *Renewable Energy Prospects: Germany, REmap 2030 analysis*. Abu Dhabi, IRENA.

[69] Fulton M., Reid C., (2012). *The German Feed-in-Tariff: Recent Policy Changes Research*. Deutsche Bank Group. DB Climate Change Advisors.

[70] IRENA, (2015). *Africa 2030: Roadmap for a Renewable Energy Future*. Abu Dhabi, IRENA.

[71] Renschhausen M., (2013). *Evaluation of feed-in tariff-schemes in African countries.* Journal of Energy in Southern Africa, vol. 24, No. 1.

[72] Renewable Energy Ventures (K) Ltd. and Meister Consultants Group Inc., (2013). *Powering Africa through Feed-in Tariffs: Advancing renewable energy to meet the continent's electricity needs.* A study for the World Future Council, the Heinrich Böll Stiftung and Friends of the Earth England, Wales & Northern Ireland (Johannesburg: February 2013)

[73] Kenya Government, (2010). *Feed-in Tariffs Policy on Wind, Biomass, Small-Hydro, Geothermal, Biogas and Solar Resource Generated Electricity.* Nairobi, Ministry of Energy.

[74] Rickerson, W., et al, (2010). *Implementing a global fund for feed-in tariffs in developing countries: A case study of Tanzania.* Paper presented at the World Renewable Energy Congress XI, September 25-30. Abu Dhabi, UAE

[75] SADC, SARDC, (2016). *SADC Energy Monitor 2016: Baseline Study of the SADC Energy Sector.* SADC, SARDC. Gaborone, Harare.

[76] Boie I., Ragwitz M., Held A., (2015). *Determinants for the Diffusion of Renewable Energy Technologies - Framework for Assessing Major Factors in Investors' Decision-Making Processes.* International Journal of Decision Support Systems 1(2):183–209

[77] Boie I., (2016). *Determinants for the market diffusion of renewable energy technologies. An analysis of the framework conditions for non-residential photovoltaic and onshore wind energy deployment in Germany, Spain and the UK.* University of Exeter.

[78] Saunders, M., Lewis, P., Thornhill, A., (2009). *Research Methods for Business Students.* 5th ed., England, Pearson Education Limited.

[79] Bryman, A. (2012). *Social research methods.* 5th ed., Oxford, Oxford University Press.

[80] Creswell J.W., (2007). *Qualitative inquiry and research design: Choosing among five approaches.* 2nd ed., London, SAGE Publications, Inc.

[81] Kumar, R, (2005). *Research Methodology: A Step-by-Step Guide for Beginners.* London, SAGE Publications.

[82] Flick U., (2007). *Designing Qualitative Research.* London, SAGE Publications Ltd.

[83] Marczyk G., DeMatteo D., Festinger D., (2005). *Essentials of Research Design and Methodology*. New Jersey, John Wiley & Sons, Inc. Hoboken.

[84] Creswell J. W., (2014). *Research design: Qualitative, Quantitative, and Mixed methods approaches.* 4th ed., London, SAGE Publications Ltd.

[85] Goddard W. & Melville S., (2004). *Research Methodology: An Introduction*. 2nd ed. Oxford, Blackwell Publishing..

[86] Kasunic., (2005). *Small sample techniques- Designing an Effective Survey. Hand book*. CMU/SEI-2005-HB-004.

[87] Sarmah H. K., Hazarika B. B., Chaudhury G., (2013). *An investigation on effect of bias on determination sample size on the basis of data related to the students of schools of Guwahati*. International Journal of Applied Mathematics And Statistical Sciences Vol. 2, Issue 1, pp. 33-48.

[88] Alvi M.H., (2016): *A Manual for Selecting Sampling Techniques in Research*. University of Karachi, Iqra University. Munich Personal RePEc Archive.

[89] Curwin J., Slater R., Eadson D., (2013). *Quantitative Methods for Business Decisions*. 7th ed. UK, Cengage Learning EMEA.

[90] Amin E. M., (2005). *Social Science Research, Conception, Methodology and Analysis*. Kampla, Makerere University Press.

[91] Sekaran, U., (2003). *Research Methods for Business: A skill-Building Approach*. 4th ed. Southern Illinois, University of Carbondale.

[92] Sekaran U. & Bougie R., (2016). *Research Methods for Business: A Skill-Building Approach.* 7th ed. West Sussex, United Kingdom. John Wiley & Sons Ltd.

[93] Goodwin C., (2009). *Research in psychology: Methods and design*. UK, Wiley.

[94] Waltz, C., Strickland, O., Lenz, E., (2010). *Measurement in nursing and health research.* 4th ed. New York, Springer Publishing Company.

[95] Greenfeld T. & Greener S., (2016). Research Methods for Postgraduates. 3rd ed. West Sussex, United Kingdom. John Wiley & Sons Ltd.

[96] Zamanzadeh V. et al, (2015). *Design and Implementation Content Validity Study: Development of an instrument for measuring Patient-Centered Communication*. Journal of Caring Sciences, 2015, 4(2), 165-178.

[97] Tracy S. J., (2013). *Qualitative Research Methods: Collecting Evidence, Crafting Analysis, Communicating Impact*. Wiley-Blackwell, John Wiley & Sons, Ltd, West Sussex, UK.

[98] Laws S., Harper C., Marcus R., (2003). *Research for development: a practical guide*. SAGE, London. Save the Children.

[99] Shenton A. K. & Hayter S., (2004). *Strategies for gaining access to organisations and informants in qualitative studies*. Education for Information 22 (2004) 223–231. IOS Press.

[100] Woodsong C., et al, (2005). *Qualitative Research Methods: A data collector's field guide*. North Carolina, USA. Family Health International.

[101] Hammersley M. & Traianou A., (2012). *Ethics in qualitative research: Controversies and contexts.* SAGE Publications Ltd, London.

[102] Klein A, (2008). *Feed-in Tariff Designs: Options to Support Electricity Generation from Renewable Energy Sources*. VDM Verlag Dr. Müeller, Saarbrücken, Germany.

[103] Reserve Bank of Malawi (2017). *Report and Accounts for the year ending 2010-2017*. Lilongwe, Malawi. RBM.

[104] COMESA, (2017). *Feed-In-Tariffs Guidelines*. http://www.comesa.int/wp-content/uploads/2017/12/FIT-Guidelines.pdf

[105] USAID, (2018). *Malawi Power Africa Fact Sheet*. https://www.usaid.gov/sites/default/files/documents/1860/MalawiPACFSDEC20175.508.pdf and https://www.usaid.gov/powerafrica/malawi

[106] Matonga G. & Nyale E., (2018, May 31). *Escom squeezed, treasury rebuffs K58bn bail-out plea*. The Nation News Paper. https://mwnation.com/escom-squeezed-treasury-rebuffs-k58bn-bail-out-plea/

[107] Management and Engineering Technologies International, (2016). *Malawi Grid Capacity Study*. 364279/PWR/PTD/1/A June 2016 Final Report.

[108] REN21, (2017). *Renewables 2017 Global Status Report*. Paris: REN21 Secretariat

[109] REN21, (2018). *Renewables 2018 Global Status Report*. Paris: REN21 Secretariat

[110] REN21, (2012). *Renewables 2012 Global Status Report*. Paris: REN21 Secretariat

[111] Phiri Grace, (2016, November 10). *MCCCI, government tussle over fuel levies*. The Nation News Paper. https://mwnation.com/mccci-government-tussle-over-fuel-levies-2/

[112] Jimu Christopher, (2017, May 11). *Businesses to benefit from K30bn Marep 8*. The Nation News Paper. https://mwnation.com/businesses-to-benefit-from-k30bn-marep-8/

[113] Malawi Government, (2017). *Annual Economic Report 2017*. Ministry of Finance, Economic Planning and Development. Department of Economic Planning and Development. Lilongwe.

[114] Malawi Government, (2016). *Annual Economic Report 2016*. Ministry of Finance, Economic Planning and Development. Lilongwe, Department of Economic Planning and Development.

APPENDICES

RETScreen Base Case Technical Information used in Policy Analysis

(a) Facility

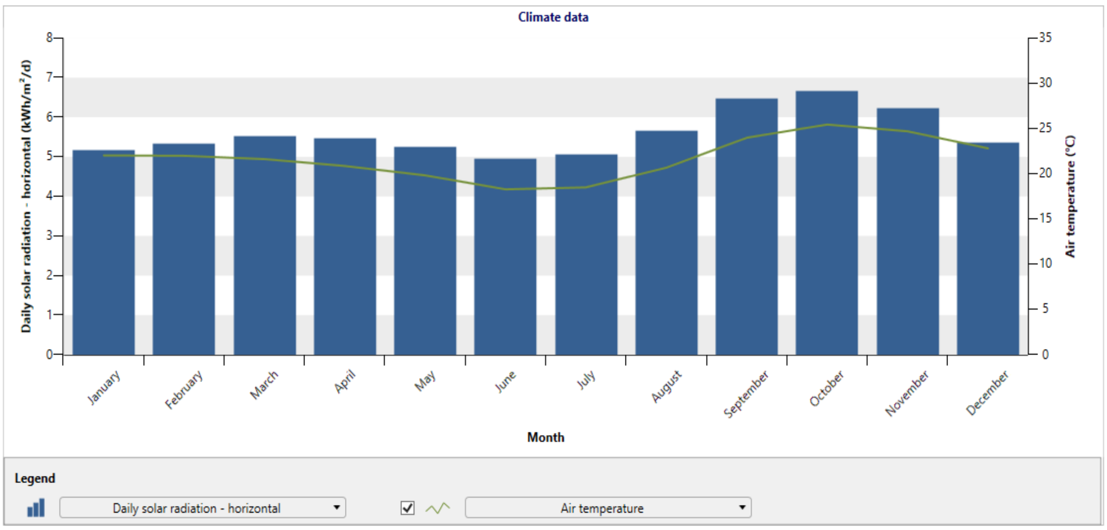
Facility information

Facility type	Power plant
Type	Photovoltaic
Description	KIA FIT Policy
Prepared for	PAUWES Thesis
Prepared by	Isaac Chitedze
Facility name	KIA Solar Farm
Address	Box 30311
City/Municipality	Lilongwe
Province/State	Central Region
Country	Malawi

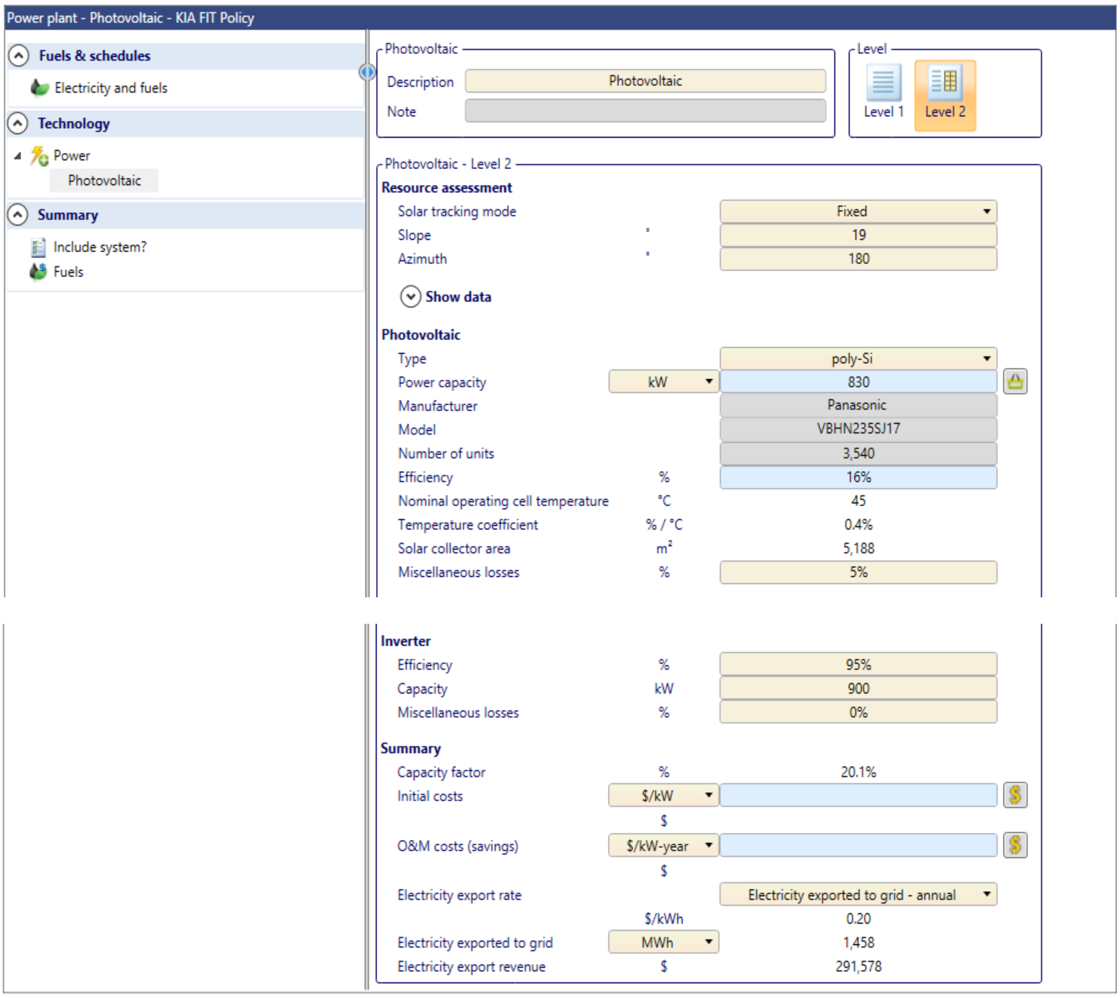
Photo - Windwärts Energie, CC BY-NC-ND 2.0

	Unit	Climate data location	Facility location	Source
Latitude		-14.0	-14.0	
Longitude		33.8	33.8	
Climate zone		2A - Hot - Humid		NASA
Elevation	m	1159	1026	NASA – NASA
Heating design temperature	°C	13.0		NASA
Cooling design temperature	°C	29.4		NASA
Earth temperature amplitude	°C	14.8		NASA

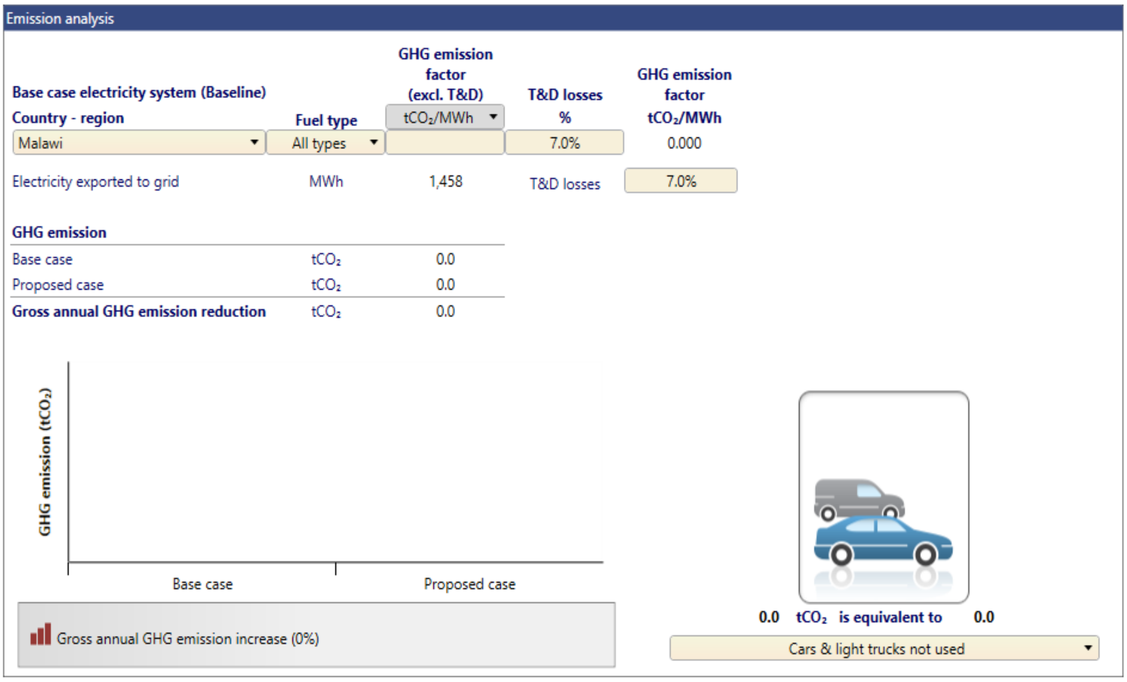
Month	Air temperature	Relative humidity	Precipitation	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days 18 °C	Cooling degree-days 10 °C
	°C	%	mm	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	22.0	80.1%	281.56	5.17	90.3	3.3	23.0	0	373
February	22.0	78.3%	208.49	5.35	90.3	3.2	22.8	0	336
March	21.6	76.1%	152.26	5.53	90.4	3.4	22.4	0	360
April	20.9	66.5%	41.52	5.48	90.6	3.3	21.9	0	326
May	19.8	55.6%	8.54	5.25	90.8	3.4	21.3	0	304
June	18.3	54.4%	2.37	4.96	91.0	3.7	20.1	0	248
July	18.5	51.6%	4.31	5.07	91.0	4.0	20.8	0	264
August	20.7	45.2%	2.60	5.67	90.9	4.3	23.7	0	331
September	24.0	39.8%	3.22	6.48	90.7	4.7	27.5	0	419
October	25.4	43.0%	10.08	6.67	90.5	4.8	29.2	0	479
November	24.7	56.3%	75.62	6.24	90.4	4.5	27.5	0	441
December	22.8	74.1%	220.64	5.38	90.4	3.7	24.3	0	397
Annual	**21.7**	**60.0%**	**1,011.22**	**5.60**	**90.6**	**3.8**	**23.7**	**0**	**4,278**
Source	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA



(b) Energy Model



(c) Emission Analysis



Research Grant Expenditure

ITEM	DESCRIPTION	QUANTITY	MWK	USD
Test–retest of research instruments	Printing (Questionnaires & Interview guides)	10	45000	61.2244898
	Telephone airtime	-	10000	13.60544218
Data collection	Printing (Questionnaires & Interview guides)	80	369000	502.0408163
	Note Books	2	3000	4.081632653
	Pen and Pencils	8	3500	4.761904762
	Ruber Eraser	1	1000	1.360544218
	Internet Modern & Start-up bundles	1	352500	479.5918367
	Telephone interviews (airtime & units)	-	96000	130.6122449
	Internet Smart Data Bundles	-	87000	118.3673469
International flight	Algeria to Malawi (return ticket)	-	127820DA	1183.519
Data analysis	RETScreen & SPSS Software training	-	120000	163.2653061
Report writing and production	Printing (4 research report and 4 internship report)	-	248400	337.9591837
Total				**3000**