Evaluation of Renewable Energy Feed In Tariff Scheme in South Africa

Master Thesis

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Abstract

The point of departure of this report is whether the *REFIT scheme* introduced by the National Energy Regulator of South Africa is effective especially with respect to PV, Wind and CSP Trough with 6 hours storage technologies. This problem is analyzed by the formulation of a research question, and four sub-questions which support the approach of the overall research question.

A theoretical context-macro perspective related to the problem field is proposed, that offers the concrete methodology to conduct the analysis. As a follow up the Financial Incentive Structure established through REFIT is evaluated by focusing on the appropriate Feed In Tariff Level and on the Feed In Tariff Scheme Considerations deemed important. In a further step "the world in which the change is taking place" is presented, including all the main legislation, actors and administrative procedures.

The overall assessment of the Financial Incentive Structure in combination with the institutional analysis in the suggested macro-context, form the basis for identifying any inefficiencies of the REFIT scheme as well as any institutional hindrances towards REFIT implementation, so that possible solutions and recommendation towards the scheme's effectiveness are provided and a conclusion is reached.

Preface

This report is written as the final Master Thesis in the Master of Science program "Sustainable Energy Planning and Management", at Aalborg University by Stavroula Petsa. The Master Thesis has been conducted during the period from 1st of February 2011 to 9th of June 2011 under the supervision of Professor Frede Hvelplund within the framework of an internship in Ea Energianalyse Company in Copenhagen, Denmark.

It is worth mentioning that the Chicago style is used for referencing.

Acknowledgment

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I would also like to thank my parents and brother for their support and guidance through my whole life. I would have never been able to make my dream a reality without them.

Last but not least, special thanks to my best friend that has been my “fellow-traveller” for the last two years.

List of Abbreviations

CIPRO	Companies and Intellectual Property Registration Office
CPI	Consumer Price Index
CSP	Concentrated Solar Power
DAE	Danish Energy Agency
DCF	Discounted Cash Flow
EPRI	Electric Power Research Institute
FIT	Feed In Tariff
IDC	Interest During Construction
IRP	Integrated Resource Plan
IRR	Internal Rate of Return
NERSA	National Energy Regulator of South Africa
NPV	Net Present Value
PPA	Power Purchase Agreement
PV	Photovoltaic
REFIT	Renewable Energy Feed In Tariff
REPA	Renewable Energy Purchasing Agency
RES	Renewable Energy Sources
RFI	Request For Information
WACC	Weighted Average Cost of Capital
WTP	Willingness To Pay

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1. Introduction

In South Africa there is stock of coal reserves so the motivation of fossil depletion, price volatility, uncertain security of supply, do not apply when considering a transition from fossil fuels to Renewable Energy Sources. Moreover, Eskom the National utility (having government as the sole shareholder), responsible for 90% of electricity generation as well as transmission and distribution of electricity in the country, has low running costs and is in a position to negotiate long term contracts with mining houses as coal is locally extracted. (Tsikata and Sebitosi 2010) This ends up in supplying a very low price for electricity; Electricity price was on average 0,33 ZAR/kWh in 2009/2010 and despite the rise to 0,42 ZAR/kWh (around 0,042 Euro/kWh) average price in 2010/2011 and the projected price rises of around 26% annually for the next two years, it is still very low compared to other countries, making it difficult for RES to compete with existing conventional generation. (Edkins, Marquard and Winkler, South Africa's renewable energy policy roadmaps 2010)

Serious supply shortages took place within 2008, indicating the fact that the under the currently installed capacity, electricity supply cannot meet the demand, especially when taking into account the possible country's economic development within the next years. New coal power plants have been planned but the supply shortfall is likely to continue, taking into account the long lead times for the construction of such plants. This fact in combination with the current bad economy of Eskom makes it urgent that some Renewable Energy Sources Independent Power Producers (IPPs) enter the market. (Department of Minerals and Energy 2008), (Edkins, Marquard and Winkler, South Africa's renewable energy policy roadmaps 2010), (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010)

At the same time, transition towards Renewable Energy Sources could serve some of the government's main goals such as increasing access to affordable energy services, improving energy governance, stimulating economic development, securing supply through diversity and managing energy related environmental and health impacts as these had been practically expressed through setting a medium-term national target of contributing 10000GWh to the country's final energy consumption from RES up to 2013. (Department of Minerals and Energy 1998), (Department of Minerals and Energy 2003)

Taking into account such driving forces, the National Energy Regulator of South Africa (NERSA) introduced in March 2009 a Renewable Energy Feed in Tariff (REFIT) scheme that included as eligible technologies Wind, CSP Trough with 6 hours of storage, Small hydro and Landfill gas (REFIT phase I). Around six months later, in October 2009, REFIT phase II was launched from NERSA, adding the RES technologies of Solar PV and Biomass, CSP Trough without storage and CSP Tower with 6hours of storage. The first and the second REFIT phases are referred in this report as REFIT 2009.

According to REFIT 2009, the Tariffs would be reviewed every year for the first five-year period of implementation and every three years thereafter, so that the approved 2009

Tariffs are adjusted to the respective up to date market terms. Within this framework new Tariffs were released in March 2011 and are currently under a consultation process from all the relevant stakeholders, formulating REFIT 2011. These Tariffs represent phase III of the REFIT program. Once approved, the REFIT 2011 will replace the REFIT 2009 Tariffs. It is worth stressing that up to now, none of these Tariffs has in practice been provided to IPPs, as no official application procedure has been launched. The Tariffs under REFIT scheme are presented below (NERSAa 2009), (NERSAc 2009).

Table 7: REFIT Scheme Feed In Tariffs (NERSA 2011)**,** (NERSAc 2009).

Technology	REFIT 2009 (ZAR/kWh)	REFIT 2011 (ZAR/kWh)
Wind ≥ 1MW	1,25	0,94
Large-scale grid-connected PV Systems ≥ 1MW	3,94	2,31
CSP Trough with 6h storage per day ≥ 1MW	2,10	1,84
CSP Trough without storage ≥ 1MW	3,14	1,94
CSP Tower with 6h storage per day ≥ 1MW	2,31	1,40
Small Hydro ≥ 1MW	0,94	0,67
Landfill Gas ≥ 1MW	0,90	0,54
Biomass Solid ≥ 1MW	1,18	1,06
Biogas ≥ 1MW	0,96	0,84

Despite the interest that several IPPs have expressed on RES projects since REFIT 2009 was established, no investments have been realized up to now. Some governmental arms express the concern that according to the existing national legislation, private investors (and consequently RES investors) should only have reasonable profits, so that the national budget is not used in favour of only some people. (Ea Energianalyse 2010)

So on the one hand there is the need for IPPs to enter the electricity market and interest has already been expressed from them. On the other hand the parameter of the possibly non cost-efficient Feed In Tariffs of the REFIT scheme in combination with other factors seem to hinder the implementation of REFIT program and the materialization of investments in RES technologies.

Within this context the cost efficiency of the “Financial Incentive Structure” established under REFIT, in combination with the lifting of possible barriers related to “Administrative and Planning Procedures” and the attitude of the “RES Market” actors, will play a key role in relation to REFIT implementation.

1.1 Problem Analysis and Statement

In the following, the problem which is approached in this report is specified. The overall reasoning behind the problem of this report is that;

- Under currently installed capacity, electricity supply in South Africa cannot meet the demand, especially when taking into account the possible country's economic development within the next years.

- There is the need to fulfill the national target of contributing 10000 GWh to the country's final energy consumption from RES up to 2013 as this has been settled by legislation.

- It is urgent that the IPPs enter the electricity market (governmental decision due to supply shortages, Eskom's bad economy).

- REFIT implementation is critical for the alleviation of the supply problem and the national target accomplishment.

- There is a need to reduce the country's CO_2 emissions resulting from the electricity sector.

- Electricity generation from RES (especially from Wind, PV and CSP technologies) has good potential in the country.

- RES exploitation and transition to a sustainable energy system could assist South Africa's economic development.

- Up to now there were problems in relation to REFIT implementation.

- The effectiveness [1] of REFIT scheme is of vital importance for its practical implementation.

In order to deeply understand the problem definition and select a suitable approach, three things need to be addressed; what is the problem, for whom is it a problem and how is it a problem.

What is the problem?

The problem is; whether the REFIT scheme introduced by the National Energy Regulator of South Africa is effective especially with respect to PV, Wind, and CSP Trough with 6h storage technologies.

[1] The term effectiveness in this report refers to the success of the REFIT scheme at encouraging RES deployment and increasing overall levels of RES electricity generation. The term cost-efficiency refers to offering Feed In Tariff Levels that are sufficient to cover project costs, while allowing for a reasonable return. (Couture, et al. 2010)

For whom is it a problem?

It is a problem for the South African government that needs to ensure that electricity supply meets the demand now and in the future.

It is also a problem for government and NERSA as they need to ensure that the incentives established through REFIT can attract investors and contribute towards achieving the targets settled without putting unnecessary burden on the end user or the national budget.

Last but not least it is a problem for the people (IPPs) that are interested in investing on the respective RES technologies now and in the future.

How is it a problem?

If the incentives for the respective technologies under REFIT prove to be insufficient, IPPs will not be attracted by the relevant investments and they will not contribute in meeting the national electricity demand.

The desired RES participation in final energy consumption will not be accomplished under the absence of an effective Feed In Tariff scheme.

The RES Market will not be created and possible socio-economic benefits will be dismissed.

1.2 Research Question

Is the REFIT scheme introduced by the National Energy Regulator of South Africa effective especially with respect to PV, Wind and CSP Trough with 6 hours storage technologies?

- What should the Feed In Tariff Level be for the technologies under consideration in South Africa?

- Which Feed In Tariff scheme design and implementation options should be considered?

- Are there any hindering factors for the REFIT implementation within the existing institutional framework?

- What changes should be implemented in order to make the REFIT program effective, in case it is not?

1.3 Project Delimitations

In this section some limitations are set in order to narrow down the scope of the project to make its structure more concrete and also make it fit with the given time frame for the completion of this report. The limitations presented below, guide the analysis that follows in all levels institutional, economical and methodological.

The main focus of attention at the present project is the assessment of the REFIT scheme's cost-efficiency while also identifying other hindering factors to its implementation but without going in depth with all of these factors. Within this framework the technical and infrastructural barriers to REFIT implementation are not analytically examined.

Furthermore the focus is on the technologies of Wind, Solar PV and CSP Trough with 6 hours of storage. The reasoning behind selecting these specific technologies is that they show the greatest potential in South Africa (Council for Scientific and Industrial Research South Africa n.d.). Behinds this, the CSP Trough with storage is selected against the CSP Trough without storage due to the fact that it could produce electricity during peak periods when the electricity has greatest value for the country.

Moreover it should be stressed that despite the different technology specific risks related to the selected technologies (e.g. each technology may have different gearing level depending on the bankability), the same WACC-Discount Rate is utilized for all the technologies, for simplicity reasons.

The calculations in order to estimate the appropriate Feed In Tariff Level are conducted in fixed 2011 prices, which means that inflation is not pre included in the assumptions as part of the calculation methodology as it is done in the German FIT model. Pre including inflation into our calculations would lead to higher interest rates for investors and in general higher Tariffs, but would provide the possibility of carrying out sensitivity analyses on inflation. On the other hand, since inflation can never be known in advance with certainty, especially in South Africa where there are currency fluctuations, the fixed price calculation provides a reliable way to calculate future project revenues if not their precise value and removes the necessity to pre define with accuracy which exact South African index is suitable to be selected for the inflation adjustment. (Couture and Yves 2009)

Not all the design and implementation options of a Feed In Tariff scheme have been considered for the supplementary evaluation of the Financial Incentive Structure (e.g. Feed In Tariffs Differentiation with Plant Size is not considered) but only the considered as the most important under current conditions in the South African context.

Last but not least the socioeconomic costs/benefits associated with the REFIT implementation have not been calculated in the context of this report as such an analysis could move us away from the main focus which is the evaluation of the REFIT scheme.

2. Screening of the Theoretical Approach Utilized

This chapter aims to give an overview of "the world in which the change is taking place". For this reason a theoretical context-macro perspective relating to the problem field, is presented. This theoretical context can offer a concrete methodology to identify possible weaknesses related to REFIT implementation in terms of the scheme's ability to accelerate deployment of large-scale grid connected RES installations (PV, Wind, CSP Trough with 6 hours Storage). In a second step the theoretical context can ease the recommendation procedure, in case it is needed (Hvelplund, Electricity Reforms, Democracy and Technological Change 2001), (Hvelplund, Renewable energy:political prices or political quantities 2005).

2.1 Macro perspective of the factors affecting REFIT implementation

The macro perspective of the factors affecting REFIT implementation and correspondingly large-scale grid- connected RES deployment under the REFIT is depicted in Figure 2.1 and has been inspired from the one presented by (Sperling, Hvelplund and Mathiesen 2010). According to Figure 2.1, there are three main coefficients that have great influence: (A) Financial Incentive Structure, (B) Administrative and Planning Procedures, (C) RES Market.

At the same time, long term national energy policy setting specific goals for RES deployment, stability in public planning policy and consistency between them, have a crucial influence as well. Therefore the three factors are embedded within the sphere of "Energy and Public Planning Policy", forming the suggested macro perspective. (Sperling, Hvelplund and Mathiesen 2010)

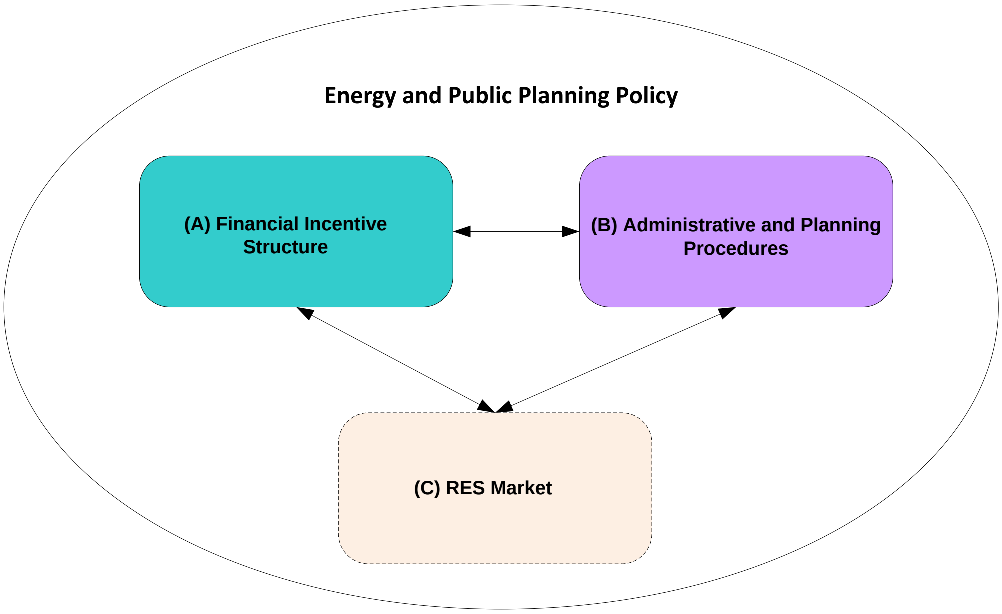

Figure 2.1: Suggested theoretical context-macro perspective of the factors affecting REFIT implementation (Sperling, Hvelplund and Mathiesen 2010).

The suggested by NERSA REFIT financial scheme or in other words the “Financial Incentive Structure” has a direct impact on large-scale RES projects’ profitability, meaning that it significantly affects the projects’ Internal Rate of Return and consequently the investors’ interest (Petsa 2011). At the same time it has impact on electricity consumers, the tax payers or the governmental budget (depending on who will have to pay for its additional costs). Thus the balance between these components defines the cost-efficiency of the “Financial Incentive Structure” (Klein, et al. 2008).

Nevertheless the attractiveness of the financial scheme to investors and its general cost-efficiency do not guarantee its implementation and are not considered enough to evaluate its effectiveness on the deployment of RES under consideration, especially in a country like South Africa with an electricity system almost absolutely reliant on coal for more than a century (Tsikata and Sebitosi 2010). A transition from the South African coal based electricity system to RES through REFIT is considered as a radical technological change and as such it involves economic redistribution and win-lose situations (Eskom’s monopoly will be broken). Thus an insight in the administrative, institutional and decision making processes surrounding the introduced “Financial Incentive Structure” constitutes an important part of the evaluation. (Hvelplund, Renewable energy governance systems 2001), (Hvelplund and Lund, Feasibility studies and public regulation in a market economy 1998)

Within this context the REFIT scheme, should also be assessed by its potential to create and develop the relevant RES market while lifting other kind of barriers (such as administrative hindrances or planning failures) (Papadopoulos and Karteris 2009). Another important point according to (Haas 2004) is the fact that investors’ willingness to pay (WTP) for RES projects is dependent on factors such as authorization procedures, competitiveness in the market and policies’ stability, among others. Finally, in the long term perspective, RES Market’s development is mainly dependent on the risk of policy changes and the existence of administrative barriers (S.Lüthi 2010).

For all these reasons underlined, “Administrative and Planning Procedures” and “RES Market[2]” are considered as integrated elements of the Energy and Public Planning Policy together with the “Financial Incentive Structure” with regard to the proposed macro perspective presented in Figure 2.1.

[2] It should be noted that the “RES Market” component in Figure 2.1 is marked with a dashed line because of the fact that it is not currently existent but its creation and development is one of the aims of REFIT scheme and is also of vital importance for RES deployment.

2.2 Analytical Macro structure

The following Figure presents a subjective approach on the main actors, legislation, organizations and institutions which affect the deployment of the considered RES technologies (PV, Wind, CSP with storage) under REFIT or in other words affect the successful implementation of the REFIT scheme.

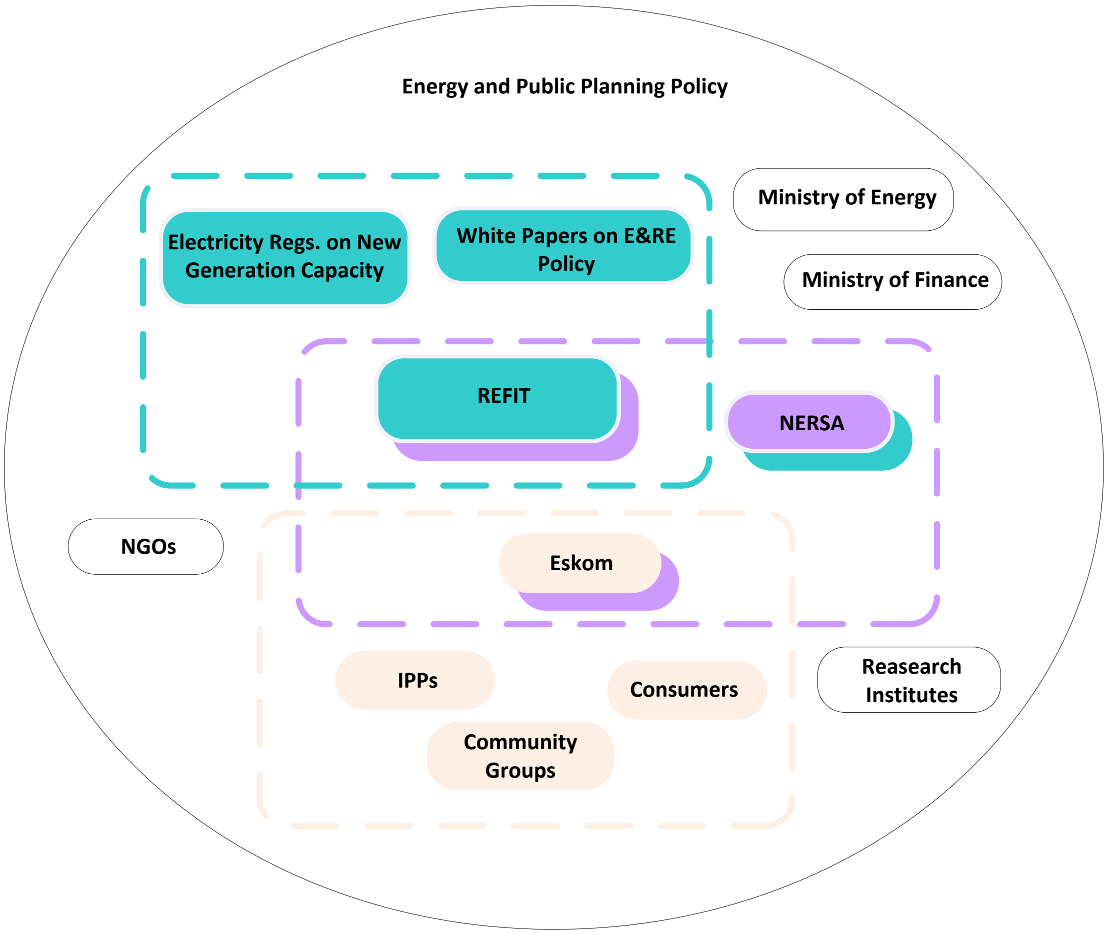

Figure 2.2: Analytical macro structure.

One could say that this is a more analytical approach of the macro perspective presented in section 2.1. The colors in the Figure express the relationship between the factors presented in Figure 2.1 and the actors – legislation presented here.

Most of the actors involved have different knowledge, rules, involvement, power, and strategy. The selected ones, which will be analytically presented on a later stage, are considered as the most important for the REFIT implementation and RES deployment. It should be kept in mind that leading an electricity system as coal based as South Africa's towards RES can be an extremely complex task considering the heavy influence of the strongest actors on the current market design. So the selection of the specific actors has been inspired from our perception that an independent innovative democracy political process is required towards REFIT implementation where new institutions are established together with the entrance of new energy market dependent (e.g. IPPs) and independent actors (e.g.NGOs) in the energy scene. (Hvelplund, Innovative Democracy and Renewable Energy Strategies: A full-scale experiment in Denmark 1976 - 2009 2009)

Of course there are many other actors and laws that have not been included in the present analysis, mostly because of the project and time delimitations.

Banks (e.g. South African Reserve Bank, Development Bank of South Africa) are excluded from this macro structure despite the fact that their willingness or reluctance to explore new fields of lending activity such as financing for RES projects may have a significant impact on RES deployment as project developers cannot precede if they cannot obtain funding. Furthermore the different risks related to RES projects are incorporated by the banks into their credit conditions, rising this way the cost of lending and affecting the long-term price stability.

RES industry (e.g. manufacturers, business associations) and other field related companies such as energy consultancy companies and organizations have also been excluded due to their negligible existence up to now. Nevertheless it should be kept in mind that in a potential later phase of RES Market development, their contribution to acceleration of RES deployment will be critical. An example of such an organization is the Africa Wind and Energy Association (AfriWEA) that aims to further the wind energy interests of Africa and developing countries in general (African Wind Energy Association 2010).

It is a reality that due to the high degree of complexity involved in such a transition of a carbon based economy to fossil fuel free economy many discussions are carried out on a political-ministerial level (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010). Such discussions could have a significant impact on REFIT implementation. Nevertheless, except from the Ministries of Energy and Finance the other Ministries of the current Government such as Ministry of Water and Environmental Affairs and Ministry of Minerals and Resources, are not included in the macro structure suggested. Other Governmental agencies such as the Central Energy Fund (CEF) are excluded as well since they are under the control of the Ministry of Energy (Clean Energy Information Portal-reegle 2011).

The White Paper on Energy Policy and the White Paper on Renewable Energy Policy have been selected together with Electricity Regulations on New Generation Capacity as the most important current policies surrounding REFIT and affecting its implementation. Of course reference to other laws-policies is necessary and will be done but the focus is mostly on REFIT since it is the policy under examination. Excluded regulations are the Free Basic Alternative Energy Policy 2003, National Energy Act 2004, Energy Security Master Plan 2007, Free Basic Electricity Policy 2007, Energy Act 2008, Electricity Pricing Policy 2008, Environmental Impact Assessment Regulations 2010. (Department of Energy, Republic of South Africa 2011)

3. Methodology

This chapter describes the methods utilized in the project for answering the research question and its sub questions. An explanation of the structure of the report and its flow comes first, followed by the description of the methods used. It is important to keep in mind that the methodology utilized in this project and presented here, is strongly related and guided by the theoretical approach defined in Chapter 2.

This is because the theoretical macro perspective has played a significant role on the selection of the aspects examined. In this way, the three factors; “Financial Incentive Structure”, “Administrative and Planning Procedures”, and “RES Market”, which are embedded in the “Energy and Public Planning Policy Sphere” are evaluated in Chapters 4 and 5 (Financial Incentives Structure) and 6 (Administrative and Planning Procedures and RES Market).

3.1 Project Structure and Description

In this section the structure of the project is presented, visually by Figure 3.1, which aims to give an overview of the relation between the chapters, the order with which they appear and their contribution towards providing an answer to the research question.

Chapter 1 (Introduction): The first chapter is an introduction to the whole project and its objective is to describe what the problem is, how is it a problem, for whom is it a problem, while also presenting the general situation, surrounding the problem field. The problem analysis, subsequently leads to the research question for the project. Lastly, the introduction contains the problem delimitation that describes which fields or problems are outside the scope of this project.

Chapter 2 (Screening of the Theoretical Approach Utilized): In this chapter an overview of “the world in which the change is taking place” is presented, through the design of a theoretical macro context, which plays a key role for the project structure and inspires the levels in which the analysis is carried out.

Chapter 3 (Methodology): This chapter refers to the research strategy utilized, including the data collection process and the methods used for analyzing and interpreting. Furthermore, there is a critical review of the methodology, the reliability of the data results, the ability to replicate the results and the validity of the results.

Chapter 4 (Feed In Tariff Level): In this chapter the evaluation of the “Financial Incentive Structure” introduced under REFIT, with focus on the Support Level for the considered technologies is carried out, by introducing a number of assumptions in a Discounted Cash Flow model designed in Excel and estimating the required Feed In Tariff Level for each technology. The challenge addressed in this Chapter is the identification of the FIT Levels that will attract potential RES investors without over-rewarding them at the expense of the actors paying or the public budget. The conclusions of this chapter answer the first sub question of the report.

Chapter 5 (Feed In Tariff Scheme Considerations): Some basic design and implementation options for REFIT scheme are discussed in order to assist in the evaluation of the established Financial Incentive Structure and provide some general information that could be used by South African policy makers in a later phase. This Chapter could be seen as supplementary to Chapter 4 and is the answer to the second sub research question.

Chapter 6 (Institutional Analysis in a Macro-context): This chapter as a follow up of the analytical macro structure defined in chapter 2, focuses on the analysis of the main legislation and actors in relation to “Administrative and Planning procedures”, “RES Market” and “Energy and Public Planning Policy Sphere”. In other words, an overall view of the current institutional framework concerning RES deployment is provided, as a mean to identify possible hindering factors to REFIT implementation, answering this way the third sub question of the project.

Chapter 7 (Conclusions and Recommendation): This final chapter consists of the concentrated results emerging from the different levels of analysis carried out in chapters 4, 5 and 6. The answer to each one of the sub questions tackles a smaller aspect of the overall research question and in this way overall conclusions are drawn. In a second step recommendation in relation with possible problems identified is provided, while finally difficulties and ideas for further research within the problem field are discussed.

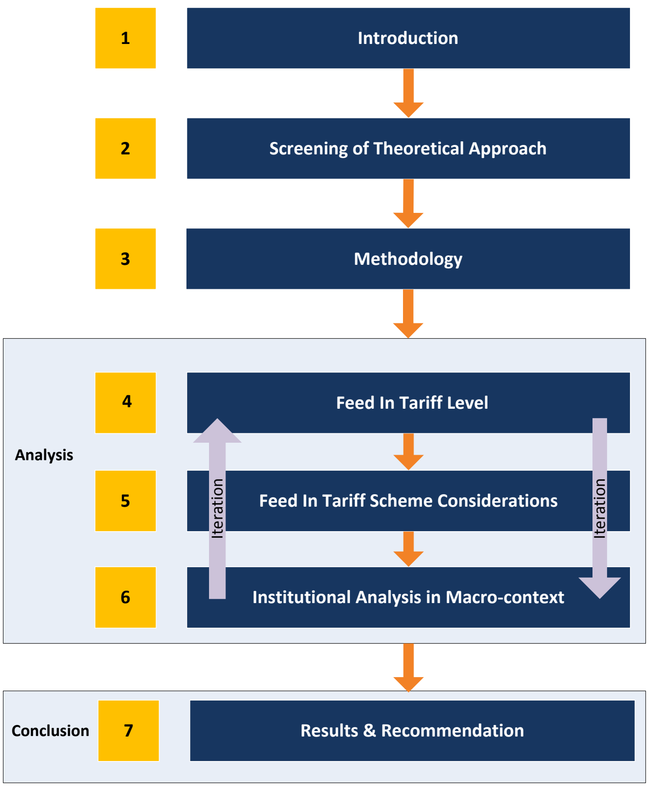

Figure 3.1: The structure of the report.

3.2 Methods for Information and Data Acquisition

Various methods and tools are used throughout the project. These methods and tools are used both separately as well as in combination where the applications supplement each other. This section will describe the methods and tools used, and the contemplation that underlie the chosen methods.

Table 3.1 shows the sub questions in the research question, what methods are used in order to answer them and in which chapter each question will be answered.

Table 3.1: Research question and sub questions.

Research question: *Is the REFIT scheme introduced by the National Energy Regulator of South Africa effective especially with respect to PV, Wind and CSP Trough with 6 hours storage technologies?*		
Sub questions	**Methods used**	**Chapters**
Sub question 1: *What should the Feed In Tariff Level be for the technologies under consideration in South Africa?*	Economic Calculations Literature studies Discussions with Ea employees	Chapter 4: Feed In Tariff Level
Sub question 2: *Which Feed In Tariff scheme design and implementation options should be considered?*	Literature studies Economic Calculations	Chapter 5: Feed In Tariff Scheme Considerations
Sub question 3: *Which are the potential hindering factors for the REFIT implementation within the existing institutional framework?*	Literature studies Discussions with Ea employees	Chapter 6: Institutional Analysis in a Macro-context
Sub question 4: *What changes should be implemented in order to make the REFIT program effective, in case it is not?*	Literature studies Economic Calculations	Chapter 7: Conclusions & Recommendation

Economic Calculations

A Discounted Cash Flow model has been designed in Excel, based on the Levelized Cost of Electricity methodology (LCOE), to estimate the appropriate Feed In Tariff Level for the different technologies. The relevant model takes into consideration the IPP perspective, meaning that aim of the model is the definition of a FIT level that also provides a certain level of return to the potential investors. The calculation methodology and the basic idea behind this model are presented in section 4.1 of Chapter 4, while more details in relation to the model and the calculations conducted are available in Appendix A.

Literature and data review

Literature studies were used in the project as a method for getting an understanding of the theoretical background, as well as of the aspects that would be important to investigate in order to assess the effectiveness of the REFIT scheme introduced by NERSA with respect to the technologies of PV, Wind and CSP Trough with 6 hours of storage. Moreover literature studies on relevant projects from other countries (such as Denmark), contributed in the process of identifying hindrances, shaping conclusions and providing recommendation.

When conducting research it is important to ensure the solidity and validity of the literature and documents that form the foundation for the project and the bases for the outcomes of it. Therefore is it necessary to uphold certain standards in consideration to the data used. There are a few criteria that are used in the project to ensure the reliability of the documents and data.

Consistency is the first criterion, a belief according to which logic and mathematical principles are used to assure truth through the use of data. In the case of this project it has been tried to transform raw data, e.g. financial data (Cost of Debt, Cost of Equity) and economical data for the costs of the technologies (Capital Costs, O&M costs etc) to valid information by means of using software tools (Excel) and an economic analysis, where logic and mathematical principles underlie. In particular, these data have served the calculation of the required FIT Level for each technology and the assessment of the Support Level established through REFIT. (Bryman 2008)

Coherency is the second criterion. Thereby, when ‘what is told is coherent to reality’ we can recall the criterion of coherency. Concerning this criterion, it is of great importance to be aware of the fact that it is impossible to acquire all the information related to a subject. This means that many times the most coherent explanation has to be accepted as the truthful one. Keeping that in mind can help to gather the necessary information - maybe just a fragment of the total amount of the information available - to proceed every time to the next step of the project. For instance, in order to identify the possible barriers in the institutional level, several documents expressing the different opinions of the actors were reviewed and some important information was derived from them. (Bryman 2008)

Evidence is another criterion implemented in the project so as to ensure its validity. According to this, truth is defined by what a person has chosen to believe or been forced to accept as the truth. The former applies for this project since facts such as the Climate Change problem and the benefits of the transition from a fossil fuel based energy system to a more sustainable system have been accepted as true without them being proven as they have been chosen to be believed. (Bryman 2008)

Discussions with employees at Ea Energianalyse Company (Unstructured Interviews)

As a qualitative method of gathering data, many discussions have been conducted with employees at Ea Energianalyse company which have been involved in relevant projects in South Africa. It could be said that these discussions had the form of short unstructured interviews, with different focal point each time, aiming at gathering up to date and realistic data and at acquiring a better understanding of the South African context. These short "interviews" were unstructured as the experience and knowledge of the interviewers was known beforehand. (Research Methodology Lectures 2009)

4. Feed In Tariff Level

In this chapter data concerning generation costs of different RES technologies (PV, Wind, CSP trough with six hours of storage) as well as technical and financial data, are employed in order to define the suitable FIT Levels for accelerating RES deployment in South Africa under current conditions. The challenge addressed in this chapter is the identification of level of compensation for the potential RES investors that would provide sufficient incentive, without over-rewarding them at the expense of the electricity consumers, tax-payers or the governmental budget (Klein, et al. 2008), (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007).

The FIT Level required is dependent on several factors, such as the production capability of the different technologies in South Africa, the return requirement for the potential investors, the generation costs, as well as the exchange rate applicable. For this reason it is of great interest to carry out a sensitivity analysis of the required FIT Level to these main factors mentioned. Within this context, a number of different scenarios are considered and the emerging FIT Level is compared to a Base Case. (IEA,NEA,OECD 2010), (Mott MacDonald 2010), (Karlynn and Schwabe 2009)

Through this process the cost-efficiency of the established by NERSA "Financial Incentive Structure" under REFIT with focus on the Support Level is investigated so that any related problems can be identified and if any changes are needed to address them, they will be included in chapter 7.

This chapter emphasizes on the results of the relevant calculations and analysis of these results. As such, conditions, reasoning for assumptions choice, calculations etc are analytically presented in Appendix A.

4.1 Feed In Tariff Calculation Methodology

The approach utilized in the current study in order to define the appropriate Feed in Tariff Level is a Discounted Cash Flow approach based on the Levelized Cost of Electricity methodology (LCOE). The relevant model takes into consideration the project developer perspective, meaning that aim of the model is the definition of a FIT level that also provides a certain level of return to the potential investors. This point of view envisages the perception that in South Africa, it is the private sector through the Independent Power Producers, that will primarily launch RES deployment (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010).

The LCOE methodology is in general terms expressed by equation 1 and according to it, the Levelized Cost of Electricity is equal to the present value of the sum of discounted costs divided by total production adjusted for its economic time value (IEA,NEA,OECD 2010).

$$LCOE = \frac{Total\ Life\ Cycle\ Cost * (1+Discount\ Rate)^{-t}}{Total\ Lifetime\ Energy\ Production * (1+Discount\ Rate)^{-t}} \quad \textbf{(1)}$$

Within this framework, the DCF model designed in the current study, gives as an output the required FIT Level, by calculating the Net Present Value of the sum of annual cash flows for each one of the RES under consideration. The cash flows consist of total investment costs, O&M costs, energy production revenues and taxes (the equations structuring the model are analytically presented in Appendix A). More specifically the DCF model gives as an output the electricity price (FIT) for which the different RES projects (PV, Wind, CSP 6h storage) begin to deliver a positive return for an investor, or in other words the electricity price for which the Net Present Value of the Discounted Cash Flow gets equal to zero. The differentiation between the basic LCOE methodology and the proposed model is that the DCF model, through the NPV calculation, accounts also for the reasonable profitability of the RES projects instead of only their cost. The investors' expected returns as well as other financial risks and uncertainties in relation to the investment are captured in the choice of the Discount Rate utilized to calculate the NPV (IEA,NEA,OECD 2010).

As far as the taxes are concerned, the country's corporate tax structure does not affect the state's welfare on a macroeconomic level but of course influences the total financial costs for a potential RES investor, as the corporate tax introduces an extra cost that has to be paid by developers (IEA,NEA,OECD 2010). According to unofficial data from NERSA, the potential RES investors under the REFIT program should establish companies and get a registration number from CIPRO in order to be eligible for the Tariffs, meaning that they will be obliged to pay corporate taxes. For this reason the impacts of taxes are included in the present approach, stressing the even indirect private investor point of view adopted in the FIT level calculation.

The Excel spreadsheet model designed within the context of the DCF approach is a rather simplified model that allows the calculation and comparison of the FIT Level for the technology options considered. The Model is sufficiently flexible to allow the introduction of a number of sensitivity scenarios, in which the impact of variation in key assumptions can be examined. In this way the FIT Level, which is expressed in ZAR/kWh, is set according to a clear and transparent calculation methodology.

Nevertheless one should keep in mind that when establishing FITs, such models are only as good as the data inputs they use, thus even with reliable input data, it should be understood that a high degree of uncertainty is involved in relation to the final response of investors to the proposed FITs.

4.2 Assumptions

As it has already been mentioned, the appropriate FIT Level depends on several parameters (generation costs, plants' electricity production capability, Discount Rate) and under the absence of specific case studies on RES projects in South Africa, certain assumptions had to be taken into account to carry out the analysis. The main assumptions behind the Base Case considered, are presented here.

Starting with the financial assumptions utilized, they are presented in Table 4.1. These assumptions apply across all the technology options investigated.

Table 4.1: Main Financial Assumptions for the analysis (see Appendix A).

Base Case Financial Parameters	Value
Discount Rate	8,2%
Debt share	70%
Equity share	30%
Real Cost of Debt Before Tax	6,2%
Real Cost of Equity After Tax	17%
National Tax rate	28%
Inflation Rate	6%
Exchange Rate	9,51 ZAR/EUR
Project Lifetime	20 years
Depreciation Period	20 years

The Real Discount Rate of 8,2% utilized in all Base Case calculations, has been defined as the Real Weighted Average Cost of Capital After Tax and its calculation is based on the proportion of Debt to Equity financing, the Real Cost of Debt and Real Cost of Equity presented above, as well as the Corporate Tax Rate applicable in South Africa (WACC calculation analytically presented in Appendix A). The Inflation Rate of 6% taken into account is the maximum target Inflation Rate in South Africa (NERSA 2011)

In a country like South Africa with large range of variations on the Exchange Rate, the ZAR to Euro Exchange Rate (ZAR/EUR) could be a key parameter when calculating the FIT level, assuming that most of the investments' components are priced in Euros. Thus the selection of 9,51 ZAR/EUR for the Base Case is based on the average Exchange Rates from the European Central Bank. (European Central Bank 2011)

When it comes to the technical assumptions of our Base Case for each one of the three technologies under investigation, these are summarized in the following table.

Table 4.2: Main Technical Assumptions for the analysis (see Appendix A)**.**

Base Case Technical Parameters	PV	Wind	CSP 6h Storage
Reference Capacity (MW)	1	50	50
Typical Capacity Factor (%)	19%	26,9%	36,2%
Efficiency Annual Decrease (%)	1%	0%	0%

The REFIT program refers to electricity generation from large-scale (capacity equal or higher to 1MW) grid-connected RES plants (NERSA 2011), (NERSAc 2009). In order to carry out the FIT Level calculation, some reference, and indicative capacities had to be selected as the ones representative of the medium sized (large-scale) projects that will probably be considered by investors in the first place.

Considering the effectiveness of the RES plants, in terms of their annual electricity production, it all comes up to the capacity factor, as it expresses the amount of energy delivered during a year divided by the amount of energy that would have been generated if the plant was running at maximum power output throughout all the 8760 hours of a year (EWEA 2009). Since the capacity factor is dependent on the performance of a specific plant as well as the local resources, it is rather important that country specific data are utilized.

When it comes to the costs of the RES plants, limited information are available on a national level under the absence of recent RES projects in South Africa and further effort would be required to gather such data. For this reason, Capital Costs as well as Operation and Maintenance Costs estimates were utilized, after comparison of data from different sources available, resulting in the cost assumptions presented below.

Table 4.3: Main Cost Assumptions for the analysis (see Appendix A)**.**

Base Case Costs	**PV**	**Wind**	**CSP 6h Storage**
Capital Costs (m€/MW)	2,8	1,4	6
O&M Costs (€/MWh)	30	13	30,7
Total Investment Costs (mZAR/MW)	29,2	14,8	62,1
O&M Costs (ZAR/MWh)	285,3	123,6	292,3

The Capital Costs presented in million Euros per MW are "overnight costs", which means that they do not include Interest During Construction (IDC) and other financing costs (EPRI 2010). Under the assumption that most of the cost components are originated from Europe, the Capital Costs were benchmarked against the average Euro Exchange Rate defined in Table 4.1. In order to get the Total Investment Costs in million ZAR per MW, further assumptions were required with regard to Land Costs, Connection Costs and IDC (these assumptions together with the cost references are included in Appendix A). All the costs in the model are considered to be in fixed 2011 – prices.

The absence of data from specific local projects implies that the cost and performance data assumptions presented are characterized by a degree of uncertainty. Nevertheless they are deemed to be adequate for the purpose of this study.

At this point the most crucial Base Case Assumptions for the three investigated technologies are summarized in Table 4.4 (see also Appendix A for justification on all assumptions).

Table 4.4: Summary of Base Case Assumptions for the analysis.

Base Case Parameters	PV	Wind	CSP 6h Storage
Reference Capacity (MW)	1	50	50
Capacity Factor (%)	19%	26,9%	36,2%
Real Discount Rate After Tax (%)	8,2%	8,2%	8,2%
Exchange Rate (ZAR/EUR)	9,51	9,51	9,51
Total Investment Cost (mZAR/MW)	29,2	14,8	62,1
O&M Costs (ZAR/MWh/year)	285,3	123,6	292,3

4.3 Feed In Tariff Level Assessment

Taking into account the methodology and assumptions presented in the previous sections, the calculation of the minimum Feed In Tariff Level capable of attracting investors' interest and accelerating the deployment of the considered RES under the REFIT program, is carried out. The results of this calculation with respect to the technologies under investigation are presented in the following figures and discussed*. At the same time the estimated Proposed FIT Level for each technology is compared with the FIT established in 2009 by NERSA (REFIT 2009) and with the potential new FIT which is currently under consultation process (REFIT 2011). Once approved, the REFIT 2011 Tariff will replace the REFIT 2009 Tariff. It is worth reminding that up to now, none of these Tariffs has in practice be provided to investors as the application procedure has not been launched.*

The calculations have been conducted in (fixed) 2011 prices, which a normal procedure in this type of analyses. Nevertheless due to the calculation methodology employed, it should be kept in mind that *the proposed FIT is suggested to be 100% adjusted with inflation for every year after 2011* (both for newcomers and old investors) in order to account for inflation while offering investors a high degree of security by tracking changes in the broader economy (Couture and Yves 2009).

When comparing the Proposed FIT Level with NERSA's Tariffs through the graphs below, one should keep in mind that we cannot be sure that these values are directly comparable since there are details concerning NERSA's calculation methodology (e.g. pre -accounting for inflation or not) that are not precisely defined in their official documents and also their results are based upon different assumptions. In order to have the clearest possible point of view when looking in the graphs presented and trying to make comparisons, it is of great importance to identify some of the main assumptions that lie behind NERSA's calculations (see Table 4.5). Furthermore some general comments together with a brief discussion on NERSA's assumptions and methodology are included in Appendix A.

Table 4.5: Main REFIT Assumptions by NERSA.

Parameters	REFIT 2009[3]			REFIT 2011[4]		
	PV	Wind	CSP 6h	PV	Wind	CSP 6h
Capacity Factor (%)	16%	27%	40%	18%	27%	40%
Discount Rate (Real WACC After Tax) (%)	12%			9,8%		
Exchange Rate (ZAR/$)	10			7,4		
Total Investment Costs (m$/MW)	4,2	2,26	5,55	EPRI 2010		
O&M Costs (2009$/kW/year)	40	24	66	EPRI 2010		
Adjustment with inflation	100%			Only O&M adjusted		

As far as PV installations are concerned, incorporating our corresponding Base Case assumptions (summarized in Table 4.4) into the DCF excel model, results into a FIT of *2,63 ZAR/kWh* which is deemed to be the minimum Tariff adequate to boost IPP's interest towards PV investments under the current conditions. This value presented in the middle column of the graph just below is the price for which the NPV of the DCF gets equal to zero and it will be *100% annually adjusted with inflation*. (for detailed information on the calculation see Appendix A).

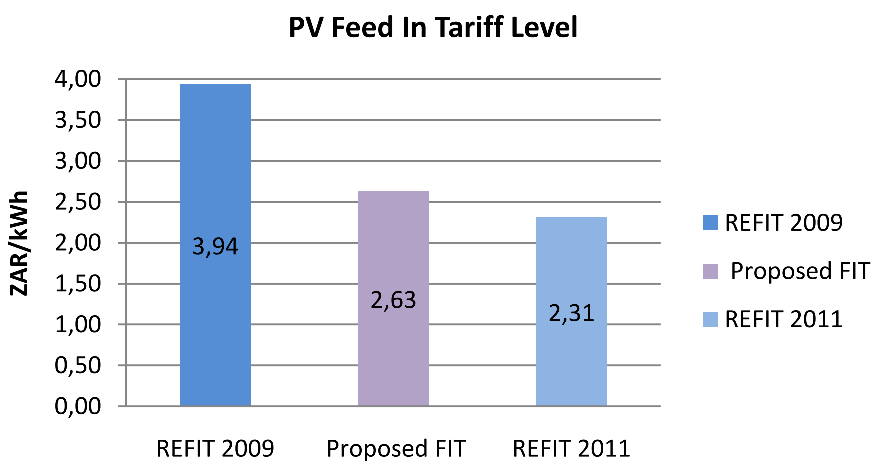

Figure 4.1: Proposed PV FIT Level in comparison with established REFIT 2009 Level and potential REFIT 2011 Level under consultation process. Once approved, REFIT 2011 will replace REFIT 2009 Tariff (NERSAc 2009), (NERSA 2011).

The Tariff of 3,94 ZAR/kWh established by NERSA under REFIT 2009, appears to be significantly high in current conditions, thus there is no doubt that it should be reconsidered and revised.

[3] Data from (NERSAc 2009) except from the FIT adjustment information coming from different NERSA documents (NERSAa 2009), (NERSAb 2009)

[4] Data from (NERSA 2011) except from the Capacity Factors coming from internal NERSA communication that cannot be published (For Adjustment with inflation formula see Appendix A)

Furthermore it can clearly be observed from Figure 4.1 that the *proposed FIT Level of 2,63 ZAR/kWh* emerging from our calculations, is higher than the currently discussed NERSA's Tariff of 2,31 ZAR/kWh . NERSA's way of FIT adjustment with inflation under REFIT 2011 creates some uncertainty on how their calculation has been conducted and in case they have someway pre included inflation in their model (see Table 4.5) then their 2011 Tariff of 2,31 ZAR/kWh, is in practice much lower than it seems to be when compared to the FIT resulting from the present DCF model. One or the other way the Tariff of 2,31 ZAR/kWh is not considered enough to secure IPP's interest towards investing in PV's taking into account, the considered as representative, Base Case assumptions.

When it comes to the FIT Level appropriate for attracting IPPs' interest to invest on Wind, the relevant conclusions can be drawn from Figure 4.2.

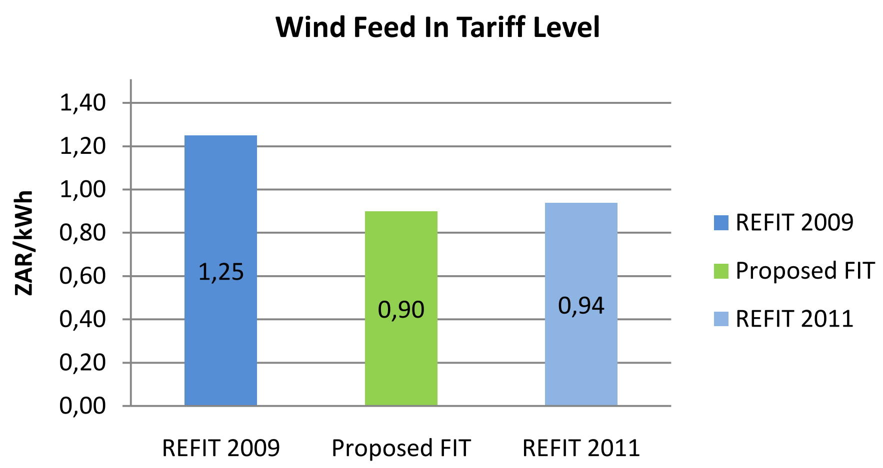

Figure 4.2: Proposed Wind FIT Level in comparison with established REFIT 2009 Level and potential REFIT 2011 Level under consultation process. Once approved, REFIT 2011 will replace REFIT 2009 Tariff (NERSAc 2009), (NERSA 2011).

As it can be seen from this Figure, it also applies for Wind that the REFIT 2009 Tariff is high under the current conditions on basic parameters such as the Total Investment Costs, O&M Costs, estimated suitable Discount Rate, etc. Thus keeping an incentive of this magnitude could lead to overcompensating IPPs at the expense of electricity consumers. The *Proposed FIT level* that comes up by applying the Base Case assumptions for Wind projects (see Table 4.4) in the DCF model designed, is equal to *0,90 ZAR/kWh* and is depicted in the middle column of the above graph. *This FIT level being adjusted with inflation* would offer sufficient capital payment to invest on, without putting unreasonable additional costs on the actors paying for the FITs.

The calculated FIT appears to be almost in the same Level with the one introduced by NERSA in their Consultation paper of March 2011 (0,94 ZAR/kWh). But since it is not clear whether NERSA's methodology leading to the REFIT 2011 Tariff of 0,94 ZAR/kWh pre includes inflation or not, in practice the incentive of 0,94 ZAR/kWh could be much lower than it seems to be. So it has to be stressed that it is not only the Tariff as a number that is judged and subjected to comparison but it is also the assumptions and methodology that lie behind the result that give a different meaning on the value Proposed as a FIT.

Concerning Concentrated Solar Power Trough with 6 hours of storage which is the third RES technology under examination, Figure 4.3 enables us to draw some conclusions on the economic efficiency of REFIT. The term efficiency here refers to a FIT Level capable of achieving the stimulation of the potential investors Willingness To Pay (WTP) under current conditions (Papadopoulos and Karteris 2009) without over rewarding them.

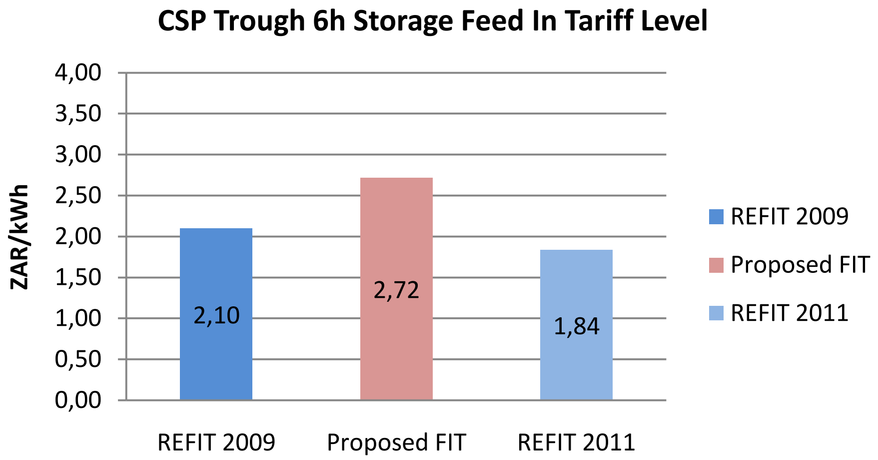

Figure 4.3: Proposed FIT Level for CSP Trough with 6 hours of Storage in comparison with established REFIT 2009 Level and potential REFIT 2011 Level under consultation process. Once approved, REFIT 2011 will replace REFIT 2009 Tariff (NERSAc 2009), (NERSA 2011).

The Tariff for CSP Trough with 6 hours of storage established under REFIT 2009 and represented by the first column in Figure 4.3 is equal to 2,10 ZAR/kWh, while the REFIT 2011 Tariff currently under consultation is equal to 1,84 ZAR/kWh. Offering the potential investors an incentive of either 2,10 ZAR/kWh or 1,84 ZAR/kWh would under compensate them, since with regard to our calculations, *a FIT of 2,72 ZAR/kWh (annually adjusted with inflation)* is the minimum value that would be able to motivate potential power producers towards investing in CSP Trough plants with 6 hours of storage. At the same time it is worth mentioning that NERSA's Tariffs for CSP Trough plants without storage are higher than the ones for CSP Trough plants with storage (both in REFIT 2009 and REFIT 2011), despite the generally lower costs involved for CSP systems without storage.

At this point, the estimated through the DCF model, Proposed Tariff Levels for the considered technologies of PV, Wind and CSP Trough with 6 hours of storage are summarized in Figure 4.4.

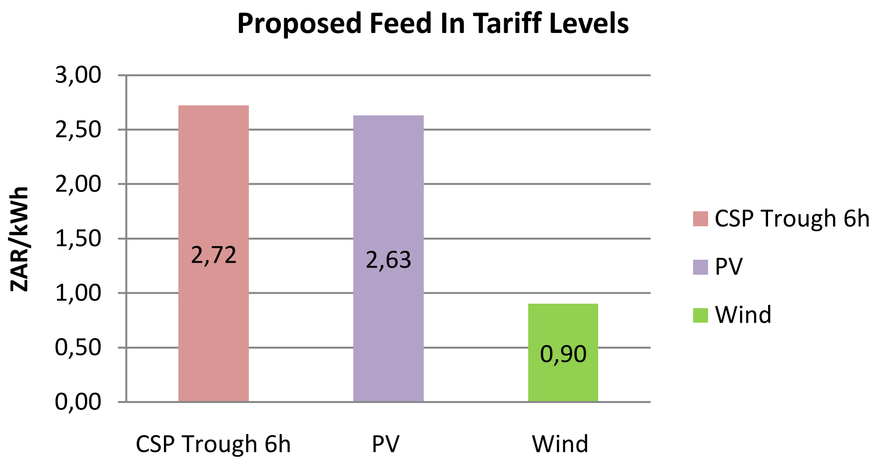

Figure 4.4: Proposed sufficient FIT Level for the considered RES Technologies; annually adjusted with inflation.

When looking in Figure 4.4 a comparison between the Support Level required for the different technologies can easily be carried out. CSP Trough plants with storage demand the highest FIT Level among the considered technologies while Wind installations demand the lowest. Large-scale PV systems require a FIT which is significantly higher than the one for Wind but quite close to the CSP FIT Level. Looking into the REFIT 2009 and REFIT 2011 Tariffs by NERSA presented in the graphs of this section, it can be observed that they follow different ranking, offering the highest Tariff to PVs, lower Tariff to CSP Trough with storage plants and the lowest Tariff to Wind plants (both REFIT 2009 and REFIT 2011).

It is obvious through this analysis that the designed DCF model for the calculation of the sufficient FIT Level allows the comparison of the required Support Level for various technologies of unequal capacities, capital costs, and efficiencies without resorting to a substantial project finance model. This simplified approach is particularly appropriate when seeking to estimate the FIT Level for the various technologies in a country to be used by policy makers and investors.

4.4 Scenario Analysis on Key Assumptions

As it has already been mentioned, the FIT Level required for a specific technology can be differentiated with regard to some basic parameters (IEA,NEA,OECD 2010), (Mott MacDonald 2010), (Karlynn and Schwabe 2009). For this reason the DCF Model designed under this study is sufficiently flexible to allow the introduction of a number of sensitivity scenarios, in which the impact of variation in key assumptions on the required FIT Level is examined. In this way the Proposed FIT Levels are supported and the consequences of choosing different assumptions are investigated.

The scenarios include variations in the following parameters, always with respect to the three technologies under investigation:

- Capacity Factor
- Discount Rate (WACC)
- Exchange Rate
- Capital Costs

Each of these variables is modified individually to test its sensitivity on the FIT Level, meaning that every time only one variable is modified and all the others are held fixed to the Base Case assumption.

4.4.1 Effect of the Capacity Factor on the required FIT Level

The Capacity Factor, as it has already been said, is the ratio of the actual output of a power plant over a period of time and its output if it had operated at full nameplate capacity the entire time. It is dependent on both the local resource and the corresponding installation's performance. The effect of the Capacity Factor on the support Level required for PV, Wind and CSP trough with 6 hours storage installations is examined through the designed DCF model and the results are presented in this section.

As far as PV ground mounted installations are concerned, the impact of different Capacity Factors on the required FIT Level is depicted in Figure 4.5. In the Base Case a Capacity Factor of 19% has been utilized as presented in Table 4.2. Since a power producer may have a different expectation than the Base Case, two additional scenarios have been constructed, where the Capacity Factor is decreased and increased by 10% respectively. The variation percentage selected is mainly based on the attempt to capture the range of variation of PV capacity factors as these have been presented in a study conducted in 2010 especially to provide data for the Integrated Resource Plan of South Africa (EPRI 2010).

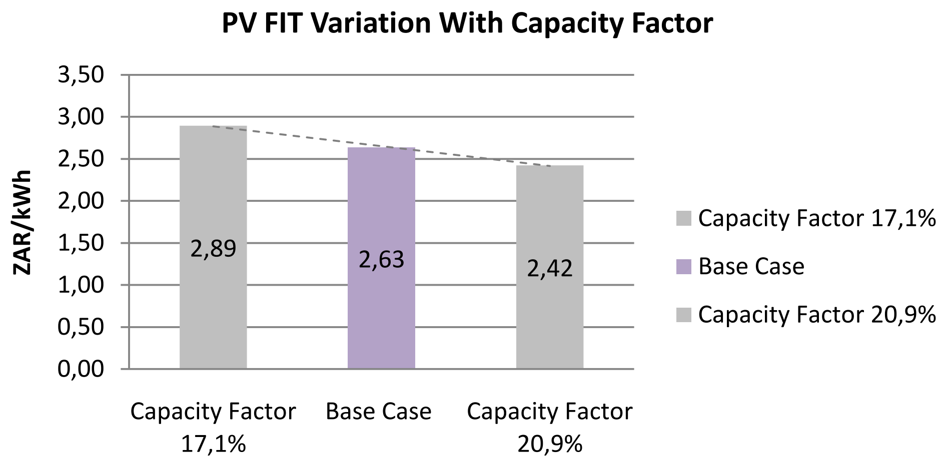

Figure 4.5: Effect of the Capacity Factor on the required FIT Level for large-scale PV ground based installations.

As it can been seen in Figure 4.5, a Capacity Factor of 17,1% would require a support level around 10% higher (required increase of 26 ZAR c/kWh) while a Capacity Factor of 20,9% would imply an around 8% lower FIT (decrease of 21 ZAR c/kWh). Also looking in the trend line makes it obvious that the Capacity Factor is inversely proportional to the required FIT Level. Nevertheless one could say that since the range of variation of the Capacity Factor is relatively low its impact on the required FIT Level is not significant.

In a similar way two scenarios have been formulated to examine the impact of possible variations in the Capacity Factors of different Wind installations. These scenarios with the resulting Tariffs are depicted in Figure 4.6.

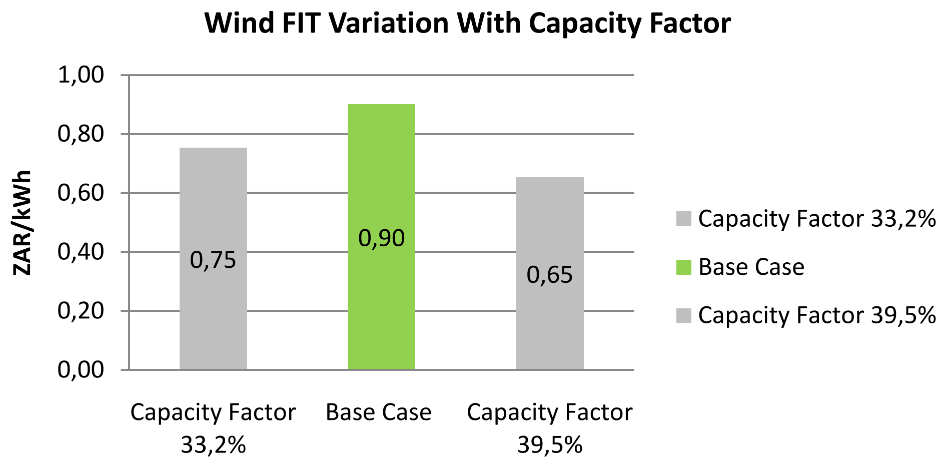

Figure 4.6: Effect of the Capacity Factor on the required FIT Level for Wind installations.

The Base Case Capacity Factor has been selected equal to 26,9%, resulting in a FIT of 0,90 ZAR/kWh. The reason behind selecting this Capacity Factor for the Base Case, despite the fact that it is relatively low compared to the ones included in (EPRI 2010) is the fact that it is closer to the Capacity Factors declared and estimated for most of the real sites under the RFI mapping conducted for the Department of Energy and the National Treasury (Ea Energianalyse 2010). Based on this fact, the two scenarios investigated both refer to Capacity Factors increased by around 23% and 47% in order to cover all the possible ranges. The result is 16% (0,75 ZAR/kWh) and 27% (0,65 ZAR/kWh) lower levels of support accordingly, compared to the Base Case. Despite the fact that it is not easily observed from the graph, the rule that the FIT Level required is inversely proportional to the Capacity Factor is once again validated.

Finally the corresponding scenarios have been devised for CSP Trough Plants with 6 hours of storage and are presented in Figure 4.7. In the case of CSP plants, a 20% Capacity Factor variation from the Base Case has been employed. The Capacity Factor in the Base Case is equal to 36,2%.

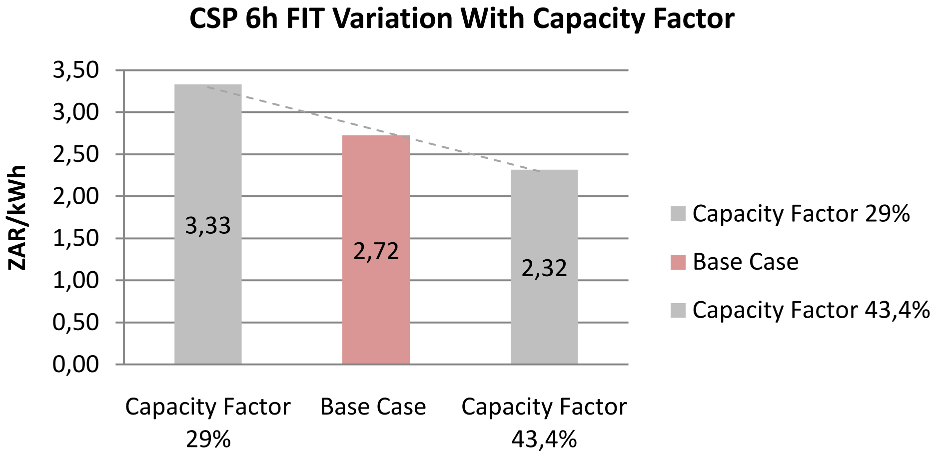

Figure 4.7: Effect of the Capacity Factor on the required FIT Level for CSP Troughs with 6 hours of Storage.

Once again with respect to the rule of inversely proportional sizes, a 20% reduction on the Capacity Factor leads to a required FIT around 18% higher (3,33 ZAR/kWh), while the respective 20% capacity factor increase leads to 17% lower required FIT Level (2,32 ZAR/kWh).

In general it can be noticed that Capacity Factor variations have a strong impact on the required FIT Level for all the different technologies and actually the FIT Level is slightly more sensitive to decreases in the Capacity Factor.

4.4.2 Effect of the Discount Rate on the required FIT Level

At this point the effect of the selected Discount Rate on the determination of the suitable FIT Level is examined. Keeping in mind the fact that the FIT Level calculated should ensure the attractiveness of RES investments to potential producers it is important that the Discount Rate is representative of the risks and uncertainties that investors will face.

The risk level affects the ratio of debt to equity financing as well as the required rate of return on both debt and equity. Since the WACC calculation includes all these parameters, it pretty much captivates the different risks in relation to the RES investments as well as the return requirement for the potential investors (IEA,NEA,OECD 2010). Thus it has been employed as the Discount Rate in the DCF model designed.

Figure 4.8 presents the sensitivity of the FIT Level required for the deployment of the different RES to the Discount Rate-WACC. All the other parameters remain fixed to the values they have in the Base Case.

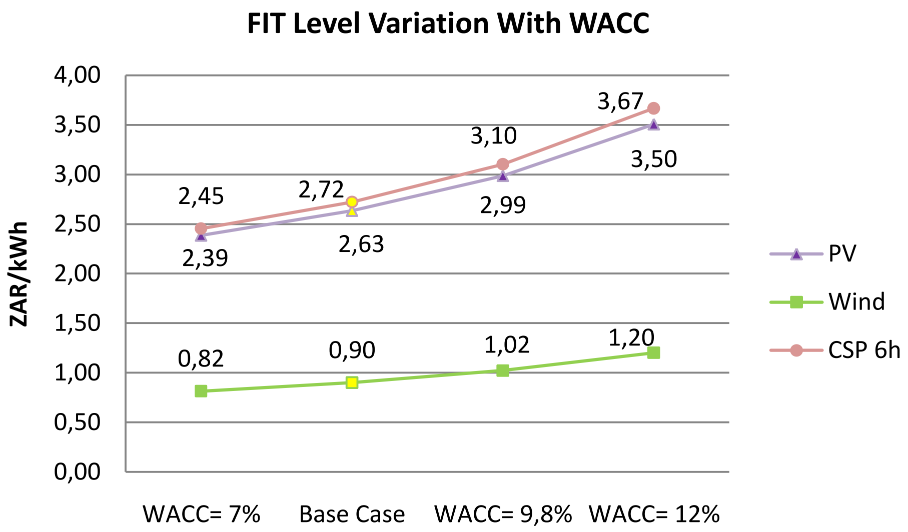

Figure 4.8: Effect of the WACC- Discount Rate on the required FIT Level for ground mounted PV, Wind and CSP Trough with 6h Storage installations.

The Discount Rate selected for the Base Case is equal to a Real WACC After Tax of 8,2% as this has been calculated with regard to the financial assumptions presented in Table 4.1. Accordingly the WACC of 7% has been calculated based on NERSA's presented official data for REFIT 2011 (see Appendix A). Furthermore the WACC of 9,8% has been chosen due to the fact that it is the Discount Rate that NERSA finally utilizes in its calculations for the FITs under REFIT 2011, despite the mismatch of this number with the data behind it. Finally the Real WACC of 12% is included in our scenarios as it is the one that NERSA had used as Discount Rate under REFIT 2009.

The idea behind the selection of these Discount Rates for the scenarios investigated is to get an understanding of the impact that a wrong selection of Discount Rate (or wrong estimation of acceptable WACC) may have on the resulted required support level. At the same time through these scenarios the required FIT Level for different levels of return requirement and risk is obtained.

As it can be observed in Figure 4.8, the Discount Rate-WACC is directly proportional to the required FIT Level, meaning that the higher the WACC, the higher the required Support Level is and the opposite way round. This is rational since in general the riskier a project is the more profitable the investors expect it to be. More analytically, a Discount Rate of 7% leads to a decrease of around 9% in the required FIT Level for all the sources examined. Respectively a Discount Rate of 9,8% leads to around 14% higher Tariffs and a Discount Rate of 12% to around 34% higher tariffs always compared with the Base Case.

It is obvious from the above graph the WACC considered reasonable for the relevant RES investments has a quite strong effect on the required Support Level.

4.4.3 Effect of the Exchange Rate on the required FIT Level

Another financial parameter that could be considered as a risk factor for potential RES investors is the Exchange Rate. This is reasonable since nowadays it is possible for the investors to contract loans in any major currency. Nevertheless the Exchange Rate risk related to the projects' financing can be constrained by financing instruments such as hedging facilities etc and going in depth with this is out of the scope of this report. On the contrary one cannot disregard the fact that under the current absence of a local RES market in South Africa, the majority of components related to the investment such as equipment, contractor costs, project preparation costs, consumables etc. have to be imported. So the impact of Exchange Rate still remains. (IEA,NEA,OECD 2010). For this reason it is of great importance to examine the influence that changes in the Exchange Rate may have on the Support Level required, especially in a country like South Africa with large Exchange Rate fluctuations (European Central Bank 2011).

Given the assumption that most of the imported components have European origin or are originated from countries with currencies tied to Euro, the Exchange Rate impact on the required FIT revel is investigated only with respect to the ZAR/EUR Exchange Rate and the respective results are presented in the Figure below.

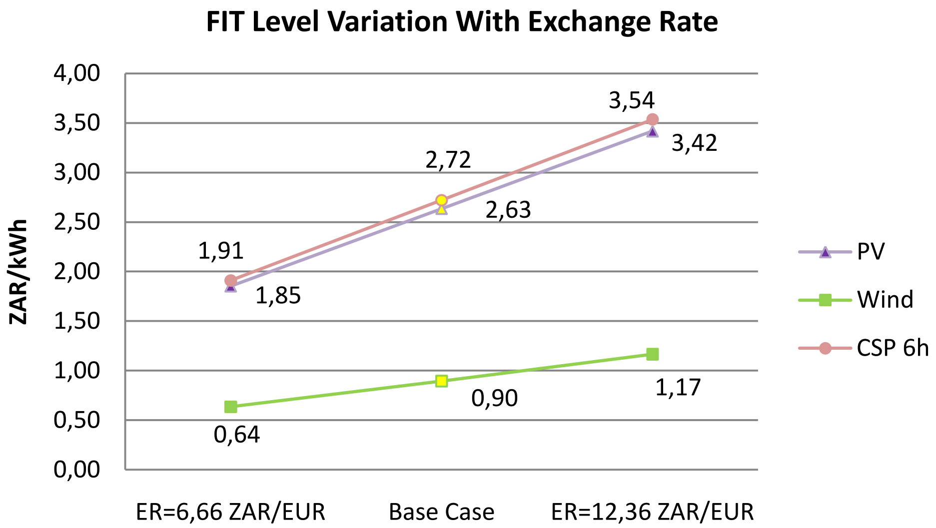

Figure 4.9: Effect of the Exchange Rate on the required FIT Level for ground mounted PV, Wind and CSP Trough with 6h Storage installations.

The Exchange Rate chosen for the Base Case is equal to 9,51 ZAR/EUR, resulting in a FIT of *2,63 ZAR/kWh* for PV, *0,90 ZAR/kWh* for Wind and *2,72 ZAR/kWh* for CSP Trough with 6h storage installations. In order to cover all the possible fluctuation range of the Exchange Rate, a 30% variation from Base Case has been employed, resulting in a low and high ZAR/EUR Exchange Rate of 6,66 ZAR/EUR and 12,36 ZAR/EUR.

Observing Figure 4.9 makes it obvious that there is a linear relationship between the ZAR/EUR Exchange rate and the required Support Level for all the three technologies. When the Exchange Rate is 6,66 ZAR/EUR, the Tariffs required are 30% lower from the Base Case and respectively when the Exchange Rate is 12,36 ZAR/EUR the Tariffs need to be 30% higher from the Base Case, confirming the great impact of the Exchange Rate on the required Support Level.

As a further step another model version was designed where the foreign ZAR/EUR Exchange Rate assumption used in the calculation of Total Initial Investment Costs of PV, Wind and CSP installations was differentiated from the one used in the operational phase of the projects, in order to test the impact that a later change in the Exchange Rate could have in the required FIT Level for a project. The results indicated that the impact of such a scenario on the required FIT was minor. Thus they are not included with a graph in the present analysis.

4.4.4 Effect of the Capital Costs on the required FIT Level

Finally a sensitivity analysis is carried out to examine the impact that an increase or decrease on the Capital Costs of the corresponding RES projects might have on the demanded Support Level. For this reason a low-cost and a high cost scenario have been formulated for each one of the technologies considered.

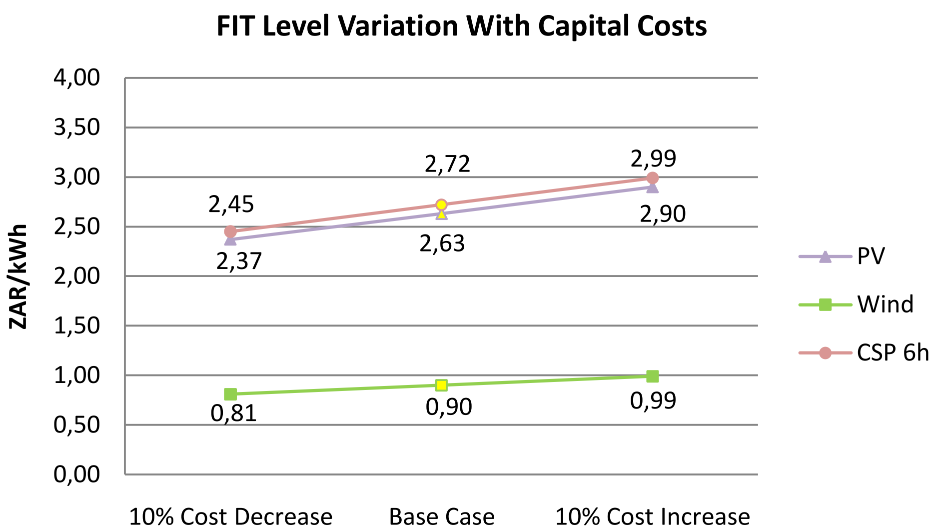

Figure 4.10: Effect of the Capital Costs on the required FIT Level for ground mounted PV, Wind and CSP Trough with 6h Storage installations.

In the low cost scenario a 10% decrease in the Capital Costs is assumed, while the corresponding 10% increase is assumed for the high cost scenario. The Capital Costs considered in the Base Case for each technology are presented in Tables 10, 11 and 12 of Appendix A.

Again as it can be concluded from graph 4.10, there is a direct proportionality between the Capital Costs and the FIT capable of attracting investors, meaning that if the Costs decrease then the required FIT Level decreases as well, reaching 2,45 ZAR/kWh for CSP plants with storage, 2,37 ZAR/kWh for PV plants and 0,81 ZAR/kWh for Wind installations. On the contrary a 10% Cost increase leads in a Tariff of 2,99 ZAR/kWh for CSP plants, 2,90 ZAR/kWh for PV plants and 0,99 ZAR/kWh for Wind installations. This proportionality is reasonable since RES investments are capital intensive (EWEA 2009).

The cost increase scenario seems much less probable to happen due to the fact that it is expected that technological learning curves will lead to cost reductions (de Jager and Rathmann 2008), (European Comission, Joint Research Center 2004). Nevertheless it is examined because there are past examples of unexpected rises in capital costs such as the great increase in Wind turbines prices due to serious bottlenecks in the supply of wind turbine generators and in some of the construction support services as well as the 2006 PV modules price increase due to a silicon shortage (de Jager and Rathmann 2008), (Klein, et al. 2008).

4.5 FIT Level under Best and Worst Case Scenarios

The results from the individual variable sensitivity analyses showed that the parameters tested had significant effect on the FIT Level, with Capacity Factor and Capital Costs probably having some of the strongest impacts even though the ranges tested were relatively small (in percentage terms from the Base Case input value). (Karlynn and Schwabe 2009), (IEA,NEA,OECD 2010)

As a next step a multivariable scenario analysis is considered that estimates the combined impact of varying an entire set of inputs simultaneously. The results of this analysis are presented in Figure 4.11.

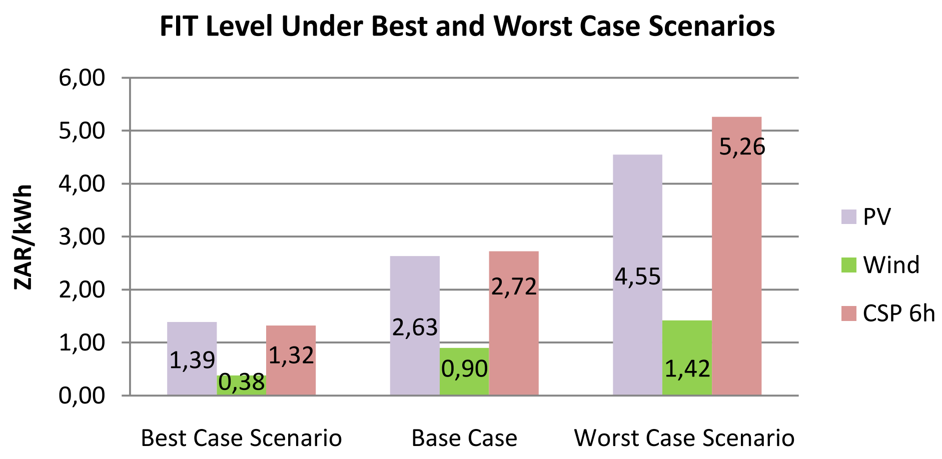

Figure 4.11: Best and Worst Case Scenarios' Effect on the FIT Level required for the considered technologies.

As it can be observed from Figure 4.11, a Best Case Scenario is considered, under which all the input parameters take at the same time values that contribute towards a decrease in the FIT Level required (according to conclusions from the individual variable sensitivity analyses). Within this concept the Capacity Factor takes its highest value for all the three technologies, the ZAR/EUR Exchange Rate takes its lowest value (6,66 ZAR/kWh), Capital Costs take their respective lowest values and the Real WACC After Tax utilized as a Discount Rate is set equal to 7%, i.e. 15% lower than the Base Case Discount Rate, to express a low risk for the investors.(see Appendix A, Tables 16,17,18).

On contrast in the Worst Case Scenario all the input parameters are set to values that have proved to cause increase in the demanded FIT Level, therefore Capacity Factors are in their lowest values, the ZAR/EUR Exchange Rate is in its highest value of 12,36 ZAR/EUR, Capital Costs are in their highest values and finally the Discount Rate selected is 15% higher from the Base Case i.e. is equal to 9,4%, indicating an increased investors' risk. The Base Case parameters are the ones summarized in Table 4.4. It should be noticed that for the case of Wind the Capacity Factor under the Worst Case Scenario is the same as in the Base Case Scenario due to the RFI mapping reasoning that has already been mentioned in section 4.4.1. (see Appendix A, Tables 16,17,18).

The resulting Tariffs for the three technologies under the different scenarios are the ones presented in the respective columns. Under the Best Case Scenario the incentives needed to attract investors in PV, Wind and CSP with Storage investments, are considerably lower compared to the Base Case. More specifically, PV plants require an incentive of 1,39 ZAR/kWh, Wind plants 0,38 ZAR/kWh and CSP plants 1,32 ZAR/kWh. On the other hand the Worst Case Scenario leads to the need of significantly higher incentives, with 4,55 ZAR/kWh for PV, 1,42 ZAR/kWh for Wind and 5,26 ZAR/kWh for CSP installations.

Of course it should be noticed that the perception of ''Best'' and ''Worst'' can have double interpretation depending on the point of view selected. From the government's side, the lower the incentives required the better but from the investors point of view it can be the opposite way round.

In any way this multivariable scenario analysis together with the individual variable sensitivity scenario analyses can become a useful tool for the policy decision making process.

5. Feed In Tariff Scheme Considerations

This chapter provides a short overview on a number of design and implementation options for REFIT scheme, since each of these options can have some impact on the efficiency of the "Financial Incentive Structure" (Couture, et al. 2010), (Klein, et al. 2008). In this way this chapter, as supplementary to Chapter 4, assists in the evaluation of the "Financial Incentive Structure" established through REFIT. At the same time it offers the ignition to think of aspects that policy makers in South Africa could take into account when further developing the REFIT scheme in case inefficiencies or need for changes are recognized.

It should always be kept in mind that the final decisions on the Financial Incentives Structure options are related to the goals that the policy under consideration, in this case REFIT, is indented to achieve (Couture, et al. 2010). Therefore the purpose here is to identify the possible options rather than give concrete answers on the individual design and implementation elements. Within this framework the "Financial Incentive Structure" considerations investigated are (Klein, et al. 2008), (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007), (Couture, et al. 2010), (Langniss, Diekmann and Lehr 2009):

- Support Level (FIT Level)
- FITs Differentiation with Technology Type
- FITs Differentiation with Resource Quality
- Inflation Adjustment
- Degression
- Revision
- Power Purchase Obligation
- Power Purchase Agreement Duration
- Actors paying for the FIT

Of course there are more design and implementation options that could be examined from policy makers when evaluating a FIT scheme but the focus of this report is in the ones outlined above as these are deemed to be the most relevant with relation to implementation of REFIT under the current South African Context. (Couture, et al. 2010), (Klein, et al. 2008), (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007)

5.1 Support Level

In principal, the Tariff Level is one of the key parameters for the FIT scheme's efficiency since it directly affects the stimulation and motivation of the investor's Willingness To Pay (WTP) (Haas 2004). If the FIT payment Level under the REFIT is not able to ensure a certain return on investment for the potential investors it is not likely that the desired RES deployment will be achieved. At the same time if the FIT Level is too high, the corresponding costs for the electricity rate payers or the tax payers (depending on who will have to pay for the extra cost) will be unreasonably increased. (Couture, et al. 2010), (Papadopoulos and Karteris 2009)

Since there must be a balance between the extra costs for the electricity consumers or tax payers and the Tariff Level in order to achieve fair for everybody and widely accepted tariffs, it is pretty important that the methodology for the Tariff Level Calculation is clear and transparent (Klein, et al. 2008), while taking into account the local South African conditions to the degree that this is possible (it also comes down to data availability).

The appropriate Support Level challenge has already been addressed in Chapter 4 through the design of a simple but at the same time transparent DCF model based on the LCOE methodology. All the differences in results, assumptions and calculation details between the suggested DCF model and the corresponding data from NERSA have been highlighted to the degree that the available information allowed this and have been included either in the analysis or in Appendix A. Nevertheless it should be stressed that only experience can show if the estimated in this report FITs are effective.

5.2 Feed In Tariffs Differentiation with Technology Type

The qualifying technologies under the REFIT program and more specifically the ones investigated in this report have proved to have different “generation costs” according to the DCF model results. A single Tariff for all of them could encourage the deployment of the lowest cost technologies (e.g. Wind) at the expense of the more costly ones (e.g. CSP with 6 hours of Storage). While this implies some economic benefit for the investors, it would support neither a diversified electricity mix nor the development of a broad ranged RES industry in South Africa. (Klein, et al. 2008) Diversification of renewable technologies is important since it can help in improving security of supply. At the same time the development of the individual RES industries can contribute towards the decrease of the total costs required for RES deployment over time (through cost reductions due to market growth (European Comission, Joint Research Center 2004)).

Within this framework and in order to reflect the varying electricity generation cost of the different technologies (e.g. PV, Wind, CSP with 6 hours Storage), technology specific FITs are recommended for South Africa. With respect to this specific FIT design option, REFIT program is successful as technology specific Tariffs have been established since REFIT 2009 (phases I & II) was launched.

5.3 Feed In Tariffs Differentiation with Resource Quality

At this point the possibility to take into account variations in resource (e.g. wind or solar resource) in different sites is discussed. Resource variations can be translated into variations in the Capacity Factors of the corresponding installations within each technology or in other words variations in annual electricity production (Klein, et al. 2008), (Couture, et al. 2010), (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007). With respect to the sensitivity analysis performed in Chapter 4 in order to examine the effect of different Capacity Factors in the required FIT Levels for ground mounted PV, Wind and CSP plants in South Africa, the results proved that for Wind and CSP Trough with Storage installations, there is a significant effect of the Capacity Factor on the FIT Level required. On the contrary FIT Level required for PV installations is not so much affected by Capacity Factor differentiations (see section 4.4.1).

Within this context there could be a possibility that a resource stepped[5] Tariff design is proposed under REFIT for Wind and CSP with Storage Installations. According to the available information from NERSA such an option has not been considered but a flat Tariff design has been established under REFIT (both REFIT 2009 and REFIT 2011) for the technologies mentioned (NERSA 2011), (NERSAc 2009), (Klein, et al. 2008).

The main idea of a proposal like this would be to avoid overcompensation of projects in sites with better resource, since plants with higher Capacity Factors have proved to require lower Support Level. In this way the extra costs for the payers and the overall costs of the FIT scheme over time would decrease, while a prospect for participation of sites with less favorable resource conditions in the RES deployment would be created, (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007), (BMU 2007) , (Couture and Yves 2009). Moreover the chance given to a variety of regions with different resource potentials to contribute in RES deployment may have positive impacts with respect to local acceptance and learning through local communities participation, jobs creation as well as benefits for grid operation, (Hvelplund, Renewable energy:political prices or political quantities 2005), (Larsen, et al. 2010), (Couture and Yves 2009).

Nevertheless it should not be overruled that there are certain risks related to FITs adjustment for resource quality. One of these risks is that the scheme may end up providing higher average payments to projects situated in locations where the resource is not so good. This could act against the principle according to which it is the most productive sites that should be first exploited. (Couture and Yves 2009), (Couture, et al. 2010)

Within this framework it is obvious that ideally the FIT payment structure should be balanced, meaning that the FITs should award the most efficient in terms of production installations, while at the same time allowing the development of a number of projects that can be profitable despite the lower production potential. (Hvelplund, Renewable energy:political prices or political quantities 2005) (Larsen, et al. 2010) The exact point of balance between these two options depends on the REFIT policy goals within the South African context. Thus it would be of great importance that these goals are carefully considered from policy makers in South Africa, so that the concept of site specific Tariffs is

[5] The definition refers to policies that differentiate the FIT prices paid to electricity generated by the same Renewable Source (Klein, et al. 2008), (IEA/OECD 2008).

incorporated into REFIT in a way that it can increase the cost-efficiency of the policy while helping RES deployment. (Couture, et al. 2010)

5.4 Inflation Adjustment

As it has already been mentioned the focus of this report is on the market independent fixed price FIT model. Employing this model provides two options; either leaving the Tariff unchanged for the duration of the contract (PPA) but also for newcomers or providing a fixed price with full or partial inflation adjustment. (Couture and Yves 2009)

Since the DCF model designed in this study does not include inflation adjustment in the Tariff Level calculation (analysis carried out in Real terms, using a Real Discount Rate), a fixed price model with full inflation adjustment is proposed (the reference year will be 2011, as it is the year that FITs have been calculated) (BMU 2007), (Fell 2009). In other words it is proposed that the entire Tariff price (100%) is adjusted with inflation on an annual basis for newcomers but also for existing project developers. In this way RES developers can be protected against declines in the real value of their income tracking changes in the broader by inflation adjustment (Couture and Yves 2009). The main idea of the proposed model is graphically presented in Figure 5.1 below.

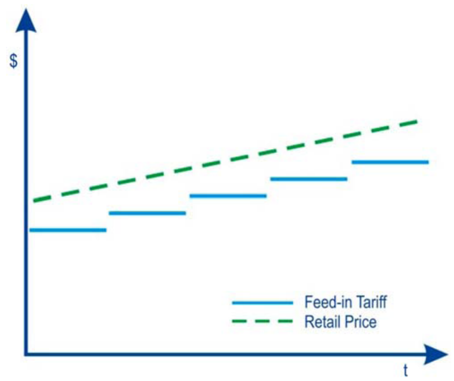

Figure 5.1: Fixed price model with inflation adjustment (Couture and Yves 2009).

An argument against the proposed structure of full inflation adjustment is that it can lead to overcompensation of the investors during the last years of the project's lifetime when most of the Initial Investment Costs have been paid off and this would be done at the expense of the payers (electricity rate payers or tax payers) over time.

Nevertheless the increased security provided to the RES investors through the FIT indexation with inflation is considered particularly important within the South African context, taking into account the high inflation rates (maximum target inflation rate 6%) together with the significant role of IPPs' participation in accelerating large-scale RES deployment (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010). At the same time despite the fact that there is a case that the FIT Level rises in the long term, there could be a possibility that proposed scheme with inflation adjustment would be politically easier to be implemented since the initial Tariffs are set in a rather low Level (compared to the FIT Level that would result from a calculation methodology where inflation was taken into account beforehand). (Couture and Yves 2009)

Under REFIT 2009 it was stated that project developers awarded the Tariffs defined by NERSA will have them adjusted for inflation using the CPI or another suitable inflation index once per annum (NERSAa 2009). Nevertheless in the third phase of REFIT, which is under consultation process (REFIT 2011), it has been anticipated that the FITs are adjusted annually to the CPI but the adjustment will be applied only to the Operation and Maintenance portion of the previous calendar year FITs (see Formula 10 in Appendix A). This does not seem to be consistent with the calculation methodology as this has been described in NERSA's documents, thus it should be re considered.

5.5 Revision

The term revision refers to an assessment in order to investigate if the Tariffs are still on an appropriate level to attract investors and reach the specific policy goals (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007). The regular revision of the scheme allows the assessment of any market developments affecting the Tariffs Level. For instance, RES plant costs may rise due to increases in the input prices (e.g. steel or silicon) or a technology breakthrough may improve conversion efficiencies leading in cost reductions for a given technology. This kind of changes is important to be marked on time, in order to ensure the schemes' cost-efficiency in the long term. Furthermore any decisions on changes should be announced the earliest possible and be implemented within an adequate notice period, to ensure stability and reliability of the scheme (Klein, et al. 2008), (Larsen, et al. 2010).

The FITs should in general be re-adjusted in the following cases:

- When there are significant changes to the costs or when more accurate cost data become available;
- When the envisaged capacity per technology is achieved;
- When the envisaged capacity per technology is not achieved within the period targeted.

The new FITs approved after such revisions should only apply to new RE projects, while RES producers of existing projects shall be entitled to old FITs. The challenge of having a FIT scheme that is flexible without reducing investors' security and certainty is one of the most crucial ones (Klein, et al. 2008).

NERSA has declared under REFIT that the Tariffs are reviewed every year for the first five year period of implementation and every three years thereafter; and the resulting Tariffs will apply only to new facilities (NERSA 2011), (NERSAa 2009), (NERSAc 2009). Within this context REFIT 2011 Tariffs are discussed as a revision of the REFIT 2009 Tariffs, despite the absence of practical REFIT implementation (no investors had been awarded with the REFIT

2009 Tariffs). This has lead to confusion and uncertainty of the potential IPPs that had already planned investments according to the REFIT 2009 Tariffs.

Another idea in order to decrease the risk for investors and increase their certainty could be to review the Tariffs applied to new plants, initially after one year, and then on a 2-3 year basis. (Couture, et al. 2010)

5.6 Degression

Tariff degression refers to the gradual reduction of the FIT Levels due to incorporation of the technological learning in the payment structure. Ideally such a reduction should reflect the potential technological learning curve for each technology, leading accordingly to further cost reductions and technology improvements (European Comission, Joint Research Center 2004), (Larsen, et al. 2010). Such a predetermined degression results in higher levels of transparency and investors' security compared to the periodical revision described in the above section (Klein, et al. 2008).

However, there is always the case that the prices of some important cost factors (e.g. steel for wind turbines or silicon for PV modules) rise unexpectedly, leading to an increase in the Capital Costs for the corresponding plants. Such an evolution is sometimes difficult to predict, leading to reduced flexibility of the FIT scheme, which should be avoided especially in a new market such as South Africa (Larsen, et al. 2010).

Within this context, NERSA's decision to exclude degression option from REFIT scheme is rational. Such an option should be reconsidered after establishment and development of an RES market in South Africa when there will be a better understanding of the local market and technologies cost development.

5.7 Power Purchase Obligation

Market independent fixed-price FIT schemes are generally accompanied by a purchase guarantee.The purchase guarantee is an essential element in designing a FIT scheme as combined with long term payments for electricity produced from RES it ensures the necessary security for both investors and financing institutions. The concept of a purchase obligation implies that electricity grid operators, energy supply companies or electricity consumers are obliged to buy the power generated from RES. (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007), (Fouquet and Johansson 2008) (IEA/OECD 2008) So NERSA's decision under REFIT on establishing a PPA to retain the purchase obligation is wise (NERSA 2011), (NERSAc 2009).

5.8 Power Purchase Agreement Duration

While there is no optimal length for the PPA, in practice the length of the guaranteed FIT payment results from a trade-off between the state who seeks to provide incentive for the efficient use and output of a technology over its expected lifetime and project developers who seek to recover their investment as quickly as possible to offset potential political and market risks.

Shorter-length FITs incorporate the danger that RES producers will stop providing sufficient attention to maximising their electricity output once the guaranteed FIT period ends. Furthermore a PPA of short duration may be perceived as risky and insufficient to ensure investors' profitability (Chadbourne and Parke 2009). At the same time a longer length PPA ensures cost recovery, can lower the cost of financing and in general leads to increased investors' confidence and security (de Jager and Rathmann 2008).

Taking these into account it is optimal that the FITs are guaranteed for a relatively long period varying between 10 and 25 years (Klein, et al. 2008), (Lipp 2007). Since 20 years is the average lifetime for many RES technologies, it is proposed, that this is the duration that the PPA should have. So NERSA's decision on this option is rational (NERSA 2011), (NERSAc 2009).

5.9 Actors paying for the FIT

The distribution of the additional costs emerging from the support of RES through REFIT is a crucial aspect of the FIT scheme structure. The possibilities for covering the extra costs are either the public budget or/and the electricity bill. In most European countries these costs are paid over the electricity bill and are sometimes differentiated for the different consumer groups (e.g. electricity-intensive industries or low income residential customers). Alternatively the costs are paid from the tax-payers or they can split between electricity ratepayers and the public budget. (Fell 2009), (Klein, et al. 2008), (Larsen, et al. 2010), (Couture, et al. 2010)

In most cases, the increase in the electricity tariff due to the additional costs of the FIT policy is relatively small. Furthermore looking at this issue in the long term, traditional electricity can become much more expensive taking into account the environmental, health and other consequences from the increased use of coal, provided that avoided costs calculations are carried out and reflected in the traditional electricity tariff. At the same time technological learning and market development (once a market has been established) can lead to overall cost reductions for the FIT policy. (Larsen, et al. 2010)

Moreover FIT funding through the tax payers is considered riskier from the investors' point of view for a number of reasons (e.g. state budget can be exhausted or not renewed by the time a project starts). Another danger when covering the extra costs of REFIT through the public budget is that successful implementation of the policy may lead to increased future budget needs that the state may not have the capability to offer. (Fell 2009), (Couture and Yves 2009)

Despite the fact that without a thorough analysis of the overall cost of financing RES through REFIT it is impossible to give a clear suggestion on which is the right way of covering the additional costs, it is proposed, through the international best practice and our understanding of local conditions in South Africa, that the costs are paid from electricity consumers over their electricity bill. Some differentiations over different consumer groups such as low income residential consumers could assist in the implementation of the scheme and ensure cost-effectiveness meaning that there is a balance between investors' profits and consumers' burden. Another option for this first phase of REFIT implementation, that costs are higher than normally, could be the partial support from the public budget up to the point that some RES development is launched (Hvelplund, Renewable energy:political prices or political quantities 2005)

NERSA's decision on the issue of funding the REFIT program is also that the additional costs of purchasing power from IPPs under the REFIT should be passed on to all Eskom consumers. The whole procedure will be supervised from NERSA, while citizens of municipalities which produce and distribute their own power, will be excluded from the commitment to pay. The reason for this according to NERSA is that the creation of a system that would directly pass the costs on every consumer would add complexity and management costs when municipal generation constitutes only 0.5% of the total national generation capacity. (NERSAa 2009), (NERSAb 2009)

The identified possible options are summarized in Appendix B.

6. Institutional Analysis in a Macro-context

The cost-efficiency of the REFIT scheme does not guarantee its implementation and is not considered enough to evaluate its effectiveness, since REFIT introduces a radical technological change and as such it involves economic redistribution and win-lose situations. Within this context even if a suitable FIT Level is in place under REFIT, an insight in "the world in which the change is taking place" is required, in order to identify potential hindering factors within the existing institutional framework. (Hvelplund and Lund, Feasibility studies and public regulation in a market economy 1998)

So this chapter aims to present analytically "the world in which the change is taking place" and is a follow up of the theoretical context defined in chapter 2, with focus on the relation of the "Financial Incentive Structure" with "Administrative and Planning procedures" and "RES Market", within the "Energy and Public Planning Policy" sphere. The legislation and actors which are part of the analytical macro structure presented in Figure 2.2, their competence in the field and their interaction are described. In other words, an overall view of the current institutional framework in which REFIT is embedded is provided, aiming in identifying the factors that hinder REFIT implementation, if any. In this way third sub question of the project is answered.

6.1 Renewable Energy Sources Legislation in National Level

The REFIT scheme introduced by NERSA in 2009 is considered as the most crucial policy as it represents the first attempt to initiate RES deployment in South Africa through the establishment of a concrete "Financial Incentive Structure". Nevertheless it is interesting to get an overview of the general South African RES regulatory framework so that we have an understanding of how does REFIT link to previous and supporting policies ("Transition" criterion). Another reason why "Transition" from one policy to another is investigated is because it is related with market stability, meaning that absence of supportive regulations or instability in the regulatory framework increases the risk for potential IPPs and at the same time creates doubts in the mind of consumers in relation to RES deployment, hindering the Market's development. (Mendonca, Lacey and Hvelplund, Stability, participation and transparency in renewable energy policy: Lessons from Denmark and the United States 2009), (S.Lüthi 2010), (Papadopoulos and Karteris 2009)

The technologies (PV, Wind, and CSP with 6 hours of storage) which constitute the focus of this report do not differ from the rest of the technologies in terms of the legislative and administrative framework they are embedded in.

The first drivers for RES deployment in South Africa can be observed in 1998 when the *White Paper on the Energy Policy of South Africa* was published by the Department of Minerals and

Energy[6]. This document established the official governmental policy for the country's supply and consumption over the decade up to 2010. Furthermore it was acknowledged in this law that Independent Power Producers (IPPs) should enter the market while the government would work towards creating a generally investor friendly environment in the energy sector. In the long term energy market should be restructured including Eskom's generation and transmission groups unbundling. Within this framework the role of the National Electricity Regulator would also be strengthened (always under the government's guidelines). (Department of Minerals and Energy 1998)

More specifically in the White Paper of 1998, five main objectives were defined with respect to the national energy policy: increasing access to affordable energy services, improving energy governance, stimulating economic development, securing supply through diversity and managing energy related environmental and health impacts. Increase of the access to affordable energy services referred mainly to households, small businesses and community services. Stimulation of economic development should be achieved through enhancing competition in the energy market. At the same time energy governance should be improved by securing better co-ordination between governmental departments and policies, while environmental and health impacts from fossil-fuel usage should be eliminated by setting targets for the reduction of emissions. Finally security of supply should be realized by encouraging RES deployment, among others, as RES (particularly solar and wind) were recognized as unlimited sources that could increasingly contribute towards long-term sustainability of the South African energy system (Department of Minerals and Energy 1998)

Within this framework it was announced by (Department of Minerals and Energy 1998) that RES demonstration, implementation and development would be supported by the government both for small and large-scale applications by creating the suitable favorable environment for RES technologies through financial and legal instruments, technology development and awareness raising, capacity building and education.

As a follow up on the White Paper on Energy Policy, the *White Paper on Renewable Energy Policy* was published in 2003, defining a medium-term governmental target of contributing 10000GWh to the country's final energy consumption from RES up to 2013. This would mainly come from biomass, wind, solar and small-scale hydro and would cover around 4% of the projected electricity demand for 2013. This according to the law would be equivalent to replacing two (2x 660 MW) units of Eskom's combined coal fired power stations. At the same time the long-term governmental target would be to create an RES industry securing in this way a sustainable, non subsidized alternative to fossil fuels. (Department of Minerals and Energy 2003)

These medium and long-term overall aims were expressed through the definition of a number of individual objectives towards introducing RES. These objectives included the

[6] Department of Minerals and Energy does not exist anymore but two new Ministries have been established in its place; the Department of Energy and the Department of Minerals and Recourses. (Department of Energy, Republic of South Africa 2009)

establishment of the appropriate Financial Instruments and incentives to promote RES implementation, the development of appropriate legal instruments that would create a stable and adjusted to support RES regulatory framework, the growth of the technologies needed to implement RES (e.g. through promoting local manufacturing, development of relevant codes and standards) and finally the developing of mechanisms raising public awareness of the RES benefits, promoting RES research and knowledge. (Department of Minerals and Energy 2003)

Furthermore it was stated (once again) that the Department of Minerals and Energy would ensure that actions taken by different stakeholders within the Energy Policy sphere would be coordinated and effective, while the National Electricity Regulator[7] (or future energy regulator) would be responsible for regulating the access of the different producers, transmitters, distributors and sellers of energy in the market. The National Electricity Regulator would also regulate the prices at which power is purchased from all generators, including Eskom and the Independent Power Producers, and approve electricity tariffs. (Department of Minerals and Energy 2003)

Finally, according to the (Department of Minerals and Energy 2003), a revised White Paper on Renewable Energy Policy would be published in 2008 to monitor the progress on the objectives defined while setting new objectives, but this review has not been published and is expected within 2011.

The *Electricity Regulation Act 4* enacted in 2006, amending *Electricity Act 41 of 1987*, had the purpose to introduce a national regulatory framework for the electricity supply industry sector. Accordingly *Electricity Regulation Act 4 of 2006* was amended by *Electricity Regulation Act 28 of 2007* in the sense that certain corrections were made, new definitions and chapters were inserted and the Minister's of Minerals and Energy power to make regulations was strengthened. (Department of Minerals and Energy 2006), (Department of Minerals and Energy 2007)

Within this framework the National Energy Regulator of South Africa (NERSA) was established as the custodian and enforcer of the national electricity regulatory framework, to be responsible for licenses and registration in relation to generation, transmission, distribution, reticulation, trading and the import and export of electricity. Regulations for the duties of the Municipalities with regard to reticulation were also formulated. (Department of Minerals and Energy 2006), (Department of Minerals and Energy 2007)

The reason why *Electricity Regulation Act 4 of 2006* together with *Electricity Regulation Act 28 of 2007* are important is because they defined the main features of the "Administrative and Planning Procedures" that are valid up to now for all electricity producers. According to these, no person without a license from NERSA can operate a generation, transmission or distribution facility, import or export electricity and in general be involved in energy trading. (Department of Minerals and Energy 2006), (Department of Minerals and Energy 2007)

[7] Established through the *Electricity Act 41 of 1987*

Furthermore the specific documents that should accompany any application for such a license were defined through these Acts. Some of these documents are: description of the applicant, including vertical and horizontal relationships with other persons engaged in the operation of the energy facility, evidence of the administrative, financial and technical abilities of the applicant, description of the proposed facility including maps and diagrams, description of the customer type to be served and the tariff and price policies to be applied, plans and ability of the applicant to comply with applicable labor, health, safety and environmental legislation, detailed specification of the services that will be provided and finally evidence of compliance with any integrated resource plan applicable at that point in time or reasons for any deviation for the approval of the Minister of Minerals and Energy. (Department of Minerals and Energy 2006), (Department of Minerals and Energy 2007)

Another important legislation was the *National Energy Act of 2008* that focused amongst others, on ensuring that diverse energy resources are available, in sustainable quantities and at affordable prices in support of economic growth and poverty alleviation. The Act further provided for energy planning, increased generation and consumption of renewable energies, contingency energy supply, promotion of energy research etc. (Department of Minerals and Energy 2008)

It is worth mentioning that in July 2009 the South African government through the Minister of Environment imposed a 0,02 ZAR/kWh environmental levy on non-renewable generation. This levy was included in a 31.3% electricity price increase permitted by NERSA, leaving Eskom with an average price increase of 24.08%. The total revenue derived from this levy was expected to be able to finance the IPPs' and cogeneration projects (around 1595 MW) planned under the first Integrated Resource Plan (IRP1) (NERSA 2010). (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010), (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010)

In order to comply with the target of 10000 GWh participation of RES in final energy consumption in 2013 as this was set by (Department of Minerals and Energy 2003), while contributing towards sustainable growth and supporting the creation of an RES industry in South Africa, NERSA introduced in March 2009 the policy called Renewable Energy Feed-In Tariff (REFIT) (NERSAa 2009). One could also say that REFIT was launched as a part of a number of actions initiated due to the electricity shortages experienced in the country in 2008 (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010).

The individual objectives and key principles of REFIT as these were defined by (NERSAa 2009) were: the creation of a stimulating environment for RES power generation, establishment of a guaranteed price for RES electricity for a fixed period of time that would provide a stable income stream and adequate return on investment for IPPs, creation of a mechanism reflecting market, economic and political developments, establishment of an equal playing field with conventional electricity and finally creation of a self sustained *RES Market*.

The initial phase of REFIT established in March 2009 included as eligible technologies Wind, CSP trough with 6 hours of storage, Small hydro and Landfill gas. Around six months later, in October 2009, REFIT phase II was launched from NERSA, adding the RES technologies of solar PV and biomass, CSP Trough without storage and CSP Tower with 6hours of storage. The main features of the FIT scheme introduced by NERSA under REFIT I & II (referred in the report as REFIT 2009) have already been indirectly described in Chapter 5, while the established REFIT 2009 Tariff levels for all the technologies are summarized in Table 20 of Appendix A. (NERSAa 2009), (NERSAc 2009)

Furthermore it was stated under REFIT 2009 that in order to get a Generation License, IPPs have to apply to NERSA in order to be judged for meeting the requirements that apply to any standard Generation License as these had been defined by *Electricity Regulation Act 2006* and its amendments. A simple graph of the REFIT structure and application process was also provided (see Appendix C); while development of a standardized generic PPA was also considered. (NERSAa 2009), (NERSAc 2009)

According to REFIT 2009 the Tariffs would be reviewed every year for the first five-year period of implementation and every three years thereafter, so that the approved 2009 Tariffs are adjusted to the respective up to date market terms. Within this framework new Tariffs were published in March 2011 and are currently under a consultation process from all the relevant stakeholders, formulating REFIT 2011 (see Table 21, Appendix A). These Tariffs represent the third phase of the REFIT program.

In order to enable and encourage the entrance of IPPs in the electricity market, ensuring this way fair treatment and non-discrimination between IPPs and the single buyer (Eskom) the *Electricity Regulations on New Generation Capacity* were published by the Ministry of Energy[8] in August 2009, as an extension of section 35 of the *Electricity Regulation Act 2006,* applying to all generation technologies including RES. Within the main objectives of the *Electricity Regulations on New Generation Capacity* was also the regulation of matters in relation to the PPA to secure transparency between the IPPs, the buyer (Eskom) and the Regulator. (Department of Energy 2009)

To act in accordance with the *Electricity Regulations on New Generation Capacity*, NERSA developed and published *Rules on selection criteria for renewable energy projects under the REFIT Program* in order to define the criteria according to which IPPs' qualification for a generation license should be judged. These criteria are the following:

- compliance with the integrated resource plan and the preferred technologies;
- acceptance by the IPP of a standardized power purchase agreement;
- preference for a plant location that contributes to grid stabilization and mitigates against transmission losses;

[8] Former Ministry of Minerals and Energy

- preference for a plant technology and location that contributes to local economic development;
- compliance with legislation in respect of the advancement of historically disadvantaged individuals;
- preference for projects with viable network integration requirements;
- preference for projects with advanced environmental approvals;
- preference for projects demonstrating the ability to raise finance;
- preference for small distributed generators over centralized generators; and
- Preference for generators that can be commissioned in the shortest time. (NERSA 2010)

Finally since compliance of the potential RES projects with IRP is required and also the amount of capacity deployed is determined by the IRP and capped once the targets have been reached, it would be of interest to refer to it. The *Integrated Resource Plan (IRP)* is a 20 year capacity plan for the electricity sector prepared from the Ministry of Energy in cooperation with Eskom and NERSA. It includes a number of scenarios with various technology mixes, both conventional and RES. It does not address the greater infrastructure issues of the country and its main aim is to provide an indication of how of the country's projected future electricity demand could be met and what would be the necessary costs to meet it. (Department of Energy 2011)

The second revision of IRP (2010-2030) is currently under promulgation and it is stated that ensures security of supply. It is also declared that it is considered as a major step towards building local industry clusters and assists in fulfilling South Africa's commitments to mitigating climate change as expressed at the Copenhagen climate change summit. IRP2 includes, in addition to all existing and committed power plants, 9,6 GW of nuclear; 6,3 GW of coal; 17,8 GW of renewables; and 8,9 GW of other generation sources up to 2030. From the 17,8 GW of RES, projected contribution from Wind will be 8,4 MW, from Solar PV 8,4 MW and from CSP 1 MW. Solar PV has an assumed roll-out of 300 MW per year from 2012 while Wind's committed capacity has a roll out of 300 MW in 2010 and 400 MW in 2013. (Department of Energy 2011)

6.2 Actor Analysis

In this section the main actors that are part of the proposed macro structure and their role within the component of Figure 2.1 they are related with (Financial Incentive Structure, Administrative and Planning Procedures, RES Market) are presented in detail. All of the components are of course part of the Energy and Public Policy Sphere.

On May 2009 the *Ministry of Energy (Department of Energy)* was established with the aim to put focus on wider energy issues and planning, including the preparation of the IRP, as it was decided by the *National Energy Act of 2008*. The new Ministry was created through the division of the Department of Energy and Mineral Resources into two different National Departments (Department:Energy - Republic of South Africa n.d.) The *Department of Energy* is considered (together with the *Ministry of Finance*) representative of the governmental policy within the *Energy and Public Planning Policy Sphere*.

One of the main concerns of the *Ministry of Energy* is the commitment to provide cheap electricity access to everybody, especially the poor. (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010) Having as a main objective the meeting of energy requirements for the poor, in a country like South Africa where a majority of the population are low-income earners is directly translated into a tendency to keep supply as cheap as possible (Tsikata and Sebitosi 2010). The Ministry's goal to provide universal access by 2014 is dependent on the funding availability via an Integrated National Electrification Program initiated in 1994 (Pegels and Stamm, Decarbonizing South Africa?Prospects and barriers to the energy transition 2009).

Since the power shortages of 2008, it seems that renewable energy started receiving attention from the *Ministry of Energy* (and the Government in general). No significant legislative action has taken place after the *White Paper on Renewable Energy of 2003*, apart from the publication of *Electricity Regulations on New Generation Capacity* in 2009 (Clean Energy Information Portal-reegle 2011). An announcement was however made in early 2010 by the South African president Jacob Zuma concerning the establishment of an Independent System Operator (separate from Eskom) that will act as the contractor of IPPs (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010).

Moreover a Request for Information (RFI) to potential IPPs was issued by the *Department of Energy* in cooperation with the *Ministry of Finance* in October 2010 in order to ascertain the depth of the market for investments in renewable energy projects under the REFIT programme as well as the readiness of the market to enter into accelerated procurement and negotiation processes. Since the RFI results indicated that the target of generating 10,000 GWh by 2013 is achievable if the regulatory framework is in place and the PPAs can be signed, a decision was taken to move ahead as quickly as possible with the procurement of the first phase of REFIT. Within this context since mid January 2011 the *Ministry of Energy* and *Ministry of Finance* are in discussions with NERSA, Eskom and other stakeholders in order to finally develop the necessary documents defining the rights and responsibilities of Government, the Buyer of renewable electricity and the Sellers of renewable electricity. (Ea Energianalyse 2010)

Accordingly the *Ministry of Finance* is responsible for the efficient and sustainable public financial management in order to secure economic development, good governance and a rising standard of living for all South Africans and is considered also part of the *Energy and Public Planning Policy* Sphere. The *National Treasury* as an internal Department of the Ministry of Finance is responsible of ensuring transparency, accountability and sound financial controls in the management of public finances. Furthermore the *National Treasury* is involved in the administering of the REFIT program in collaboration with NERSA and Eskom as it is entitled to perform functions assigned to it in relation to different legislative issues. (National Treasury n.d.), (Ea Energianalyse 2010)

Through the monitoring of the involvement of the *National Treasury* into the *Administrative and Planning Procedure* for REFIT it has been observed that the *Ministry of Finance* has been a bit reluctant towards the "Financial Incentive Structure" implementation in terms that it has expressed unrest with regard to the level of profitability of the IPPs under the Tariffs introduced by NERSA. The idea behind this opposition seems to be that according to the existing national legislation private investors (and consequently RES investors) should only have reasonable profits, so that the national budget is not used in favour of only some people. During recent informal discussions on REFIT, there has also been a proposal mainly from the *National Treasury* for adoption of a bidding process having as caps the REFIT 2009 Tariffs. This fact indicates the existence of conflicting approaches in relation to RES deployment as far as the governmental policy is concerned. (Ea Energianalyse 2010)

In an energy system so coal based such the South African, it is of great importance to investigate if there are any independent lobbyists such as *NGOs or International Partnerships* that participate in the policy creation process (*Energy and Public Planning Policy Sphere*), supporting RES deployment (and consequently REFIT), so that the policies are not are designed only according to the needs of the strong interest groups. (Hvelplund, Innovative Democracy and Renewable Energy Strategies: A full-scale experiment in Denmark 1976 - 2009 2009)

Within this framework it is worth mentioning that there is the *NGO Sustainable Energy Africa (SEA)* that has as an aim the promotion of sustainable energy approaches and practices for the development of South Africa as well as the transition to more sustainable forms of energy such as solar and wind. Main focus of the organization is sustainable development through integrated energy planning, while most of their work is dedicated to supporting local and provincial government towards developing strategies, policies and planning which facilitate a move towards sustainable development. (Sustainable Energy Africa n.d.)

A non profit organization focused on renewable energy and energy efficiency is the *Sustainable Energy Society of Southern Africa (SESSA)*. Target of this organization is the creation and development of an independent renewable energy and energy efficiency forum in Southern Africa. Among its objectives is to contribute in increasing the use of RES through informal education, demonstration and information to end-users and decision makers of all levels as well as the creation of opportunities for persons and institutions interested in RES, to meet on common ground. (SESSA n.d.) It is however worth mentioning that up to now, none of these two NGOs presented seem to actively participate towards encouraging and facilitating REFIT implementation.

Another actor within *the Energy and Public Planning Policy* sphere is *Research Institutes*. Examples of such Institutes are the *South African National Energy Research Institute (SANERI),* the *Energy Research Center (ERC)* of the University of Capetown as well as the *Centre for Renewable and Sustainable Energy Studies* in Stellenbosch University. (Clean Energy Information Portal-reegle 2011) All these institutes contribute in different ways towards the IRP formation and can have an effect on the political decision processes through their research. Nonetheless it should be stressed that since the innovation system in South Africa is characterized by high path dependency (with Eskom as main investor on research), the energy research of the above mentioned institutes has for many years concentrated on coal technologies. Furthermore RES technologies lack the capacity basis at all levels of education, making it even more difficult for the Research Institutes to work towards RES deployment and help REFIT implementation. (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010) , (Tsikata and Sebitosi 2010)

The main actor that is currently clearly related to the *Administrative and Planning Procedures* of the REFIT program is the *National Energy Regulator of South Africa (NERSA)*. *NERSA* that has been established in 2004 (as National Electricity Regulator back then), regulates the electricity, natural gas and petroleum markets in South Africa and has as a mission the regulation of the relevant markets with regard to with government laws, policies, standards and international best practices in support of sustainable development. At the same time *NERSA* acts as an advisor to the *Ministry of Energy* on matters related to the electricity supply industry. It is funded by the parliament, levies and funds collected under different legislative actions, charges for dispute resolution etc. (NERSA n.d.) Among its responsibilities are several functions related to RES implementation, such as the issuing of generation licenses for the IPPs, securing non-discriminatory access to electricity networks, general regulation of electricity market access, define prices at which power is purchased from generators, approve and review Tariffs etc. (Department of Minerals and Energy 2003) Within this context *NERSA* has published REFIT scheme and is in charge for its administration.

Eskom is an actor with multidisciplinary tasks as it has a crucial role both in the electricity and consequently *RES Market* and in the *Administrative and Planning Procedures*. It is the state-owned electricity supplier that dominates generation capacity, producing around 90% of the country's electricity from coal. With coal being extracted locally, Eskom is in the favorable position to secure fixed priced long term contracts with the mining houses, providing an average electricity price of 0,25 ZAR/kWh prior to the 2008 supply shortages. These shortages were caused from a rise in the demand in combination with inadequate investment in additional supply. For this reason *Eskom* decided to proceed with a capacity expansion program, including 10 GW of capacity from coal, 1.2 GW from a pumped storage scheme, and about 150 MW of renewable energy. In order to finance its expansion program *Eskom* applied for a 60 per cent electricity tariff increase and was allowed by *NERSA* a 31.3% rise in 2009, followed by and 24.8% for 2010/2011, while another two 25% increases are expected for the following two years as it has already been said in the introduction. (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010), (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010)

The 150MW of *Eskom's* investment in RES is mainly related to the commitment of the company to the World Bank as it has been granted a loan. Other than that it seems that *Eskom* does not have any real economic interest in investing in RES plants but rather focuses on the construction of its new coal based production units. In this way *Eskom* is a competitor of IPPs but at the same time is entitled as the single buyer of their electricity, fact that highlights the conflicting roles that *Eskom* plays within the *RES Market* and *Administrative and Planning Procedures* (Tsikata and Sebitosi 2010), (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010), (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010). Another important point is that *Eskom* is responsible for the electricity IRP formulation in consultation with the *Ministry of Energy* and *NERSA*, fact that stresses *Eskom's* influence on the potential RES deployment and REFIT implementation (Department of Energy 2011).

When it comes to the *RES Market*, *Independent Power Producers (IPPs)* are considered key actors for REFIT implementation. Their attitude towards the RES investments under REFIT is vital for the creation and growth of the *RES Market* in South Africa (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010). With the publish of REFIT in 2009 investors' interest for RES was initiated and despite the strong competition against the low unit costs of electricity provided by *Eskom* a positive attitude was marked from the *IPPs*, as this was reflected under the RFI. The RFI results on *IPPs'* interest are presented on the Figure below.

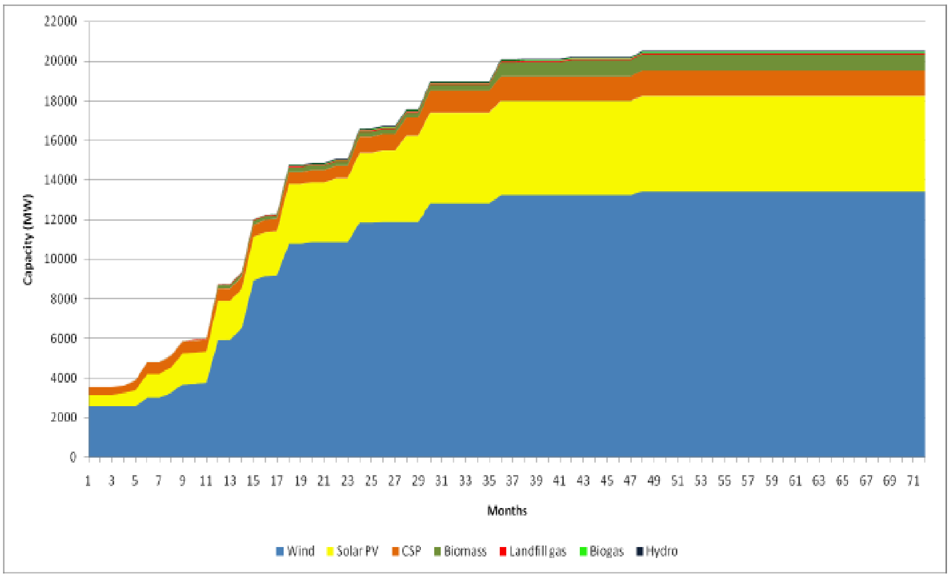

Figure 6.1: Cumulative Capacity of REFIT technologies according to RFI answers to the question: Expected months, after license issued and PPA approval, until connection to the grid (Ea Energianalyse 2010).

The 365 responses indicated that approximately 20 GW of REFIT projects can potentially be developed within 4 years after signing the PPA under REFIT, with the majority coming from wind and solar plants. Wind energy projects accounted for 70% of the entire capacity, solar PV projects accounted for 15% of the entire capacity (one third of the responses) while CSP accounted for 8% of the capacity (around 5% of the responses). The remainder was made up of mostly biomass projects with some hydro, landfill gas and biogas. This proved the increased interest of *IPPs* towards REFIT implementation. (Ea Energianalyse 2010)

Nevertheless the fact that not a single PPA has been signed between 2009 and 2011 in combination with the new decreased Tariffs announced by NERSA under REFIT phase III in March 2011, has disappointed *IPPs* that had already spent money to prepare their projects and it is expected to further hinder *IPPs* interest towards REFIT projects due to the increased uncertainty and risk for the Tariffs that the PPA will be finally based on. (Engineering News, Real-Economy News, Industry News 2011)

Allowing to different types of investors (beyond corporations) to own RES plants can contribute in achieving higher and quicker RES deployment, while securing wider public support for the policy. At the same time the participation of smaller and more risk-averse investors such as *community groups*, citizens, non-profit organizations, local communities etc can enhance the regional welfare benefits from RES (Hvelplund, Renewable energy:political prices or political quantities 2005), (Hvelplund, Renewable energy and the need for local energy markets 2006), (Fell 2009), (Klein, et al. 2008). Currently according to unofficial information from NERSA (official document is soon to be published) eligible of the FITs under the REFIT are only corporations that have a registration number from CIPRO. Within this context, the South African policy designers must carefully reconsider who can benefit from the FIT payments and ensure the consistency of the REFIT scheme on the ownership issue with the overall policy objectives. For this reason *community groups* are considered an important actor within the *RES Market*.

Finally another important actor within the *RES Market* that indirectly affects REFIT implementation is *electricity consumers* in South Africa, including industrial and domestic consumers. On the one hand load shedding affects Eskom's consumers as they have to decrease their consumption, so implementation of the REFIT program could offer increased electricity supply in areas which are currently off-grid or where supplies are limited (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010). On the other hand the effects of REFIT Tariffs on the electricity rates paid by consumers are indirect and difficult to estimate and since the additional costs are passed to consumers, high rises in the electricity prices may cause opposition towards REFIT implementation.

6.3 Barriers to REFIT Implementation

The REFIT scheme established by NERSA could form a solid base for the deployment of renewable energy in South Africa. Nevertheless it is of great importance to record the potential hindering factors for REFIT implementation in relation to the existing institutional framework, as these have been identified through the analysis performed in the above sections as well as through the findings from a number of workshops held by NERSA, Ea Energianalyse and Energinet.dk on the implementation of REFIT.

One main barrier in relation to REFIT implementation is the existence of conflicting approaches in relation to the final decision for REFIT implementation, recently reflected by an alternative proposal from some governmental arms for adoption of a bidding process having as caps the REFIT 2009 Tariffs[9]. Within this context there is absence of clarity in relation to the roles of the different actors involved. More specifically there is not a clear division of the roles between *NERSA*, *Ministry of Energy* and the *Ministry of Finance*. This also results in an uncertainty on which of the authorities has the final responsibility in the decision making process as far as the REFIT implementation is concerned. This uncertainty accordingly creates a tendency to over regulate by all parties as there is also doubt for whom bears final responsibility for ensuring compliance with the conditions of approval for REFIT projects. The result is complicated design of administration process and reduced investors' confidence. (Ea Energianalyse 2010)

The absence of a standardized and specialized for RES projects PPA under the REFIT, constitutes a major administrative barrier. The current PPA has been designed for conventional power plants with a capacity of up to 1.000 MW and is signed for 15 years, so it does not reflect the needs and requirements of RES plants. Under the REFIT 2011 consultation paper, NERSA has announced the intention to facilitate the conclusion on the REFIT PPA and the associated commercial agreements necessary for buying and selling power between a REFIT IPP and the Buyer-Eskom (NERSA 2011).

Despite IPPs' interest towards REFIT scheme and *RES Market* creation as this was declared through the RFI process, the fact that not a single PPA has been signed between 2009 and 2011 in combination with the new decreased Tariffs announced by NERSA under REFIT 2011 and the lack of transparency in the Tariffs calculation methodology has disappointed *IPPs* and is expected to further hinder their interest towards REFIT projects due to the increased uncertainty and risk for the Tariffs that the PPA will be finally based on (Engineering News, Real-Economy News, Industry News 2011). In other words the potential of initiating the creation of an *RES Market* through REFIT is obvious but cannot be realized under the existing conditions of risk and uncertainty for the IPPs.

Another problem towards REFIT implementation is the fact that currently there is no first point of contact and no clear guidelines on the REFIT application process. As a result it is very difficult to obtain the increased amount of information required especially in the initial phases of developing a project. The lack of guidelines and a first point of contact can become a major barrier especially when project developers require permits, approval and licensing as it can result in IPPs being shunted from one authority to the next without getting reliable information. At the same time it seems that there also a lack of internal guidelines on the handling of applications by NERSA in terms that no special REFIT license has been developed, the chronological order between the different requirements has not been strictly defined and there is not a strict timeframe within which projects should be commissioned.

[9] Unofficial Discussion Information in Ea Energianalyse

Moreover the lack of clarity on how deep[10] connection costs are divided between the Transmission System Operator (Eskom) and the IPP with respect to the *Rules on selection criteria for renewable energy projects* published by NERSA, can also pose an uncertainty on potential investors.

In a further step these *Rules* published as guidelines for selecting eligible IPPs under REFIT seem to contain a number of administrative barriers themselves with main concern that the interested *IPPs* have to also face the uncertainty of whether they will be chosen as participants in REFIT. The preference for generators able to be commissioned in the shortest time could hinder the implementation of larger projects such as CSP plants that require time consuming planning. At the same time, exclusion of small REFIT projects (≤1 MW) favors strong investors and existing market players, while local investors such as *community groups* are prevented from the potential REFIT benefits. The preference for investors able to demonstrate ability to raise finance could also be negative, since there is no financial risk for the state in relation to this and an unnecessary step is added in the administrative procedure. Finally the idea of evaluating the projects according to positioning, connection costs and effects on the grid does not have any meaning under the absence of grid map indicating the suitable connection and coupling points for REFIT projects (Ea Energianalyse 2010).

As far as eligibility to REFIT Tariffs is concerned, allowing ownership of RES plants only to corporations with a CIPRO number can further hinder REFIT implementation as securing wider public support for the policy is lost by not allowing participation of risk-averse investors such as *community groups*, citizens, non-profit organizations, local communities. (Hvelplund, Renewable energy:political prices or political quantities 2005), (Hvelplund, Renewable energy and the need for local energy markets 2006), (Fell 2009), (Klein, et al. 2008)

In the broader Energy and Public Planning Policy level *another factor* that could hamper REFIT program is the absence of long-term planning by *NERSA*, as no further incentives for RES deployment are defined beyond 2013, fact that also creates insecurity on the timeframe for which IPPs will be financed under REFIT. The absence of recent RES policy (last one was the *White Paper of 2003*) setting updated national long term goals for RES deployment is also a negative factor as it may be perceived as a policy risk by investors.

The fact that Eskom is the sole buyer of electricity from IPPs and the System Operator puts doubt that the company's monopoly could be seriously challenged taking into account that *Eskom* is also a competitor to *IPPs*, despite the *Regulations on New Generation Capacity* published in 2009. This can create distrust of *Eskom* by private developers as far as the connection costs and the connection timeframe are concerned. *At the same time* participation of *Eskom* in the *IRP* formulation *in combination with* concerns on the fact that

[10] Deep connection costs are defined as the additional infrastructure costs for upstream and downstream strengthening of the network, necessary for connection operation of the facility (NERSA 2010).

REFIT implementation is capped by the *IRP* targets on RES deployment (solar PV has an assumed roll-out of 300 MW per year from 2012 while Wind's committed capacity has a roll out of 300 MW in 2010 and 400 MW in 2013) puts further uncertainty and risk on investors (Edkins, Marquard and Winkler, Assessing the effectiveness of national solar and wind energy policies in South Africa 2010).

Furthermore the lack of skills in relation to RES projects such as skills in the areas of project design, financing, installation; operation maintenance etc. in combination with the absence of innovative domestic technological capacity in all educational levels could be a serious bottleneck for REFIT implementation, especially when also taking into account the lack of a framework enabling the delivery of reliable and accurate energy data (e.g. National Energy Agency), since Eskom holds all the country's energy data that are of vital importance for large-scale RES penetration. (Tsikata and Sebitosi 2010), (Pegels, Renewable energy in South Africa:Potentials, barriers and options for support 2010)

Taking into account the need to shift from a centralized energy system to a decentralized one, the relevant energy infrastructure needs to be established so that there is the ability to cope with the fluctuating RES technologies in a cost efficient way. Such an infrastructure together with required the grid code facilitating RES technologies does not exist in the South African electricity system, highlighting another important barrier towards REFIT practical implementation.

Finally major obstacles towards RES deployment under REFIT is the current absence of local manufacturers and the small number of RES related companies (e.g. consultancies) combined with the strong political links to coal industry and the weak independent RES lobby. The absence of concrete steps towards creation of a local *RES Market* is a factor that also influences IPPs Willingness To Pay for RES investments as there is absence of potential for the creation of a favorable and stable economic environment.

7. Conclusions and Recommendation

This report has attempted to define whether *the REFIT scheme introduced by the National Energy Regulator of South Africa is effective especially with respect to PV, Wind, and CSP Trough with 6 hours storage technologies.* In order to answer the overall research question, four sub research questions have been formulated. These sub questions tackle a smaller aspect of the overall research question and each answer gives a partial understanding of the problem. By tackling each aspect outlined, important conclusions can be drawn and relevant recommendation can be provided in case it is needed. These conclusions and recommendation are presented in this chapter, together with a brief discussion and some ideas for further research on the problem field.

Of critical importance for the structure and flow of the report has been the definition of a theoretical context- macro perspective that offered the concrete methodology to approach the problem and inspired the analysis (Hvelplund, Electricity Reforms, Democracy and Technological Change 2001). According to this context, the effectiveness of REFIT scheme with respect to PV, Wind, and CSP Trough with 6h storage technologies is investigated with regard to the “Financial Incentive Structure”, “Administrative and Planning Procedures” and “RES Market” aspects, taking into account their interrelation with “Energy and Public Planning Policy Sphere” (Figure 2.1) (Sperling, Hvelplund and Mathiesen 2010). Choosing another macro perspective that would had taken into account less or more parameters (e.g. only the Financial Incentive Structure), could have lead to different conclusions concerning the effectiveness of the REFIT scheme.

Within this framework, the cost-efficiency of the “Financial Incentive Structure” and some important for its general efficiency, design and implementation considerations are investigated in chapters 4 and 5 accordingly, the “Administrative and Planning Procedures” as part of the broader institutional framework with focus on the actors and challenges in relation to them are analyzed in chapter 6, while the “RES Market” , approached through the actors that are for and against its creation is presented in chapter 6 as well. Finally the possible required policy recommendation emerging from the analysis is presented in the current chapter. Each chapter answers one of the sub research questions formulated.

In order to provide an answer to the question *of what should the Feed In Tariff Level be for the technologies under consideration in South Africa*, quantitative analyses have been carried out so that the relevant FIT Levels are estimated, enabling at the same time the evaluation of, the established through REFIT, “Financial Incentive Structure” with focus on the Support Level for the respective technologies. Through this procedure certain conclusions are drawn and the most important are presented at this point.

First of all the REFIT 2009 Tariff for PV installations is significantly high under current conditions, thus if not revised it would lead to overcompensation of the potential IPPs. On the other hand the REFIT 2011 PV Tariff currently under consultation is not considered enough to secure IPP’s interest towards investing in PV installations. As far as Wind plants are concerned, once again the established REFIT 2009 Tariff is far above the Level sufficient to attract investors and would lead to unreasonably extra costs for the payers. The Wind Tariff currently discussed under REFIT 2011 could be more than enough to secure investments, depending on the exact calculation methodology that NERSA has utilized and of which we cannot be absolutely sure. When it comes to CSP Trough with 6 hours of storage installations, both REFIT 2009 and the under consultation REFIT 2011 Tariffs are not enough to boost the relevant investments. To sum up it could be said that Feed In Tariff Level for the considered technologies under REFIT scheme is not efficient, in terms of either being too high or not sufficient (see from Figure 4.1 to Figure 4.3)

Within this context the Proposed Feed In Tariff Level, as it has been estimated through the DCF model designed in excel, is 2,63 ZAR/kWh for ground mounted PV installations, 0,90 ZAR/kWh for Wind plants and 2,72 ZAR/kWh for CSP Troughs with 6 hours of storage (see Figure 4.4). The Proposed FIT for each technology will be 100% adjusted with inflation for every year after 2011, since the calculation has been conducted in fixed 2011 prices. These FITs are the breakeven points for which the corresponding investments become profitable (prices for which the NPV of corresponding DCF gets equal to zero). In this way sufficient incentive is provided, without over-rewarding potential RES investors at the expense of the electricity consumers, tax-payers or the governmental budget (Klein, et al. 2008), (Mendonca, Feed-in Tariffs: Accelerating the Deployment of Renewable Energy 2007).

As part of the investigation for the appropriate FIT Levels of the respective technologies in South Africa, a number of sensitivity scenarios are formulated, through which the impact of variation in key assumptions on the required FIT Level is observed; The FIT required to attract RES investors is directly proportional to the WACC-Discount Rate deemed as sufficient and utilized in the calculations, the ZAR/EUR Exchange Rate against which the costs (both Capital Costs and O&M Costs) are benchmarked and the Capital Costs of the relevant investments. On the other hand the required FIT Level is inversely proportional to the Capacity Factor of the corresponding installations i.e. the higher the Capacity Factor, the lower the required FIT Level. These apply for all the technologies under investigation. For analytical results see Section 4.4 from Figure 4.5 to Figure 4.10.

A concrete conclusion on which of the key factors tested has the strongest impact on the required FIT Level is not possible through the present analysis, as the range of variation assumed is different for each sensitivity scenario. Nevertheless it could be argued that the Capacity Factor and the Capital Costs parameters seem to have a slightly stronger effect. Finally estimating the sufficient FIT under a Best and Worst Case scenario highlights the significant impact of the simultaneous variation of more than one of the above mentioned parameters on the Support Level deemed as sufficient (see Figure 4.11 for analytical results).

Looking into *which Feed In Tariff scheme design and implementation options should be considered* in order to *further* evaluate the efficiency of REFIT scheme*,* an overview on the design options of; Support Level, FITs Differentiation with Technology Type, FITs Differentiation with Resource Quality, Inflation Adjustment, Degression, Revision and implementation options; of Power Purchase Obligation, Power Purchase Agreement

Duration, Actors paying for the FIT is carried out, as these are deemed to be the most relevant with relation to implementation of REFIT under the current South African Context (Couture, et al. 2010), (Klein, et al. 2008).

As far as the *Support Level* is concerned, it has been validated that there is absence of transparency in NERSA's calculation methodology for the REFIT Tariffs, as well as calculation mismatches (see Appendix A) together with selection of some non reflective of the conditions assumptions (e.g. Nominal Cost of Debt based on the JIBAR rate). Thus this option has been the first to be allocated through Chapter 4. In relation to *Differentiation of the FITs with Technology Type*, REFIT has been successful in terms of establishing technology specific Tariffs since it was first launched in 2009 (see section 5.2). When it comes to the option of *FITs' Differentiation with Resource Quality*, such a possibility has not been considered under REFIT despite the fact that it could contribute in the overall cost efficiency of the scheme by preventing from overcompensation of IPPs in sites with better resource (especially relevant for Wind and CSP installations-see Figure 4.6 and 4.7), leading in decrease of the extra costs while also creating the potential for exploitation of less favourable sites (see section 5.3).

Looking into the *inflation adjustment* option, while taking into account the REFIT calculation methodology by NERSA to the point this is clarified, the establishment of full annual inflation adjustment of the Tariffs under REFIT 2009 is considered reasonable and necessary. Nevertheless the partial adjustment of the Tariffs with inflation under REFIT 2011 as it is discussed in the consultation paper, is not consistent with NERSA's methodology and should be reconsidered as it could lead to insufficient incentive (see Appendix A).

Revision of REFIT for every year within the first five year period of the scheme's implementation, despite to the relevant rationality it may have (due to the lack of experience and local conditions understanding), could be perceived as a risk from the potential investors, since it creates uncertainty on which FITs will apply. On the contrary NERSA's choice to exclude the *degression* option from REFIT scheme is rational under the current absence of a local RES market in South Africa that could provide a better understanding of the technologies cost development.

Both the decision for establishing a PPA to retain the *power purchase obligation* and the decision of 20 years for the *PPA duration* under REFIT, undoubtedly contribute to the scheme's efficiency. Finally definition of the electricity consumers as the payers of the additional costs that REFIT implies is in line with the international best practices, though absence of group differentiations (e.g. low income residential consumers) might have a negative impact on REFIT scheme's efficiency.

When it comes to *the potential hindering factors for the REFIT implementation within the existing institutional framework,* mainly in relation to the "Administrative and Planning Procedures", "RES Market" and "Energy and Public Planning Policy", as these have been identified through an insight of "the world in which the change is taking place" in Chapter 6, the most important ones are summarized as follows (see section 6.3 and Appendix E):

1. Conflicting approaches in relation to the final decision for REFIT implementation and lack of clarity in relation to the roles of the different actors involved.

2. Not appropriate development of Administrative Procedures for REFIT by NERSA (e.g. absence of a standardized and specialized for RES projects PPA)

3. The Selection Criteria for REFIT projects complicate rather than ease the Administrative Procedures (e.g. preference for generators able to be commissioned in the shortest time hinders implementation of larger projects).

4. Lack of long-term planning by NERSA in combination with lack of recent governmental RES policy.

5. Absence of concrete steps towards creation of a local *RES Market.*

6. Non existence of energy infrastructure for decentralized system and of grid code facilitating renewable energy.

Finally the answer to the last sub question: "*What changes should be implemented in order to make the REFIT program effective, in case it is not?"* is provided through the following recommendation that aims to suggest ways of eliminating all the factors which hinder REFIT implementation and RES deployment under REFIT.

As far as the *Feed In Tariff Level* of the technologies under consideration is concerned, NERSA's calculation methodology should be further clarified and some of their assumptions should be revised so that more cost-reflective and representative Tariff Levels are established under REFIT, in order to provide sufficient incentive to potential RES investors without over rewarding them at the expense of the electricity rate payers. The designed under the current study DCF model could be useful for the South African policy makers, as it constitutes a simple and transparent way of determining suitable Tariff Levels. Within this context the indicative Feed In Tariff Levels of 2,63 ZAR/kWh for ground mounted PV installations, 0,90 ZAR/kWh for Wind plants and 2,72 ZAR/kWh for CSP Troughs with 6 hours of storage , with full annual inflation adjustment for every year after 2011 could be taken into account for establishing the final Tariffs under REFIT 2011 phase (currently in consultation process).

Concerning the *inefficiencies* of the Financial Incentive Structure *with respect to the design and implementation options* evaluated apart from the Support Level, focus should be put on the option of differentiating the FITs for Wind and CSP technologies with Recourse Quality as it could contribute to the scheme's overall cost efficiency. Moreover the inflation adjustment option as this has been presented through the REFIT 2011 consultation paper should be reconsidered as it poses an extra concern on whether the REFIT Tariffs will be sufficient. With respect to Revision option, the concept of revising the REFIT Tariffs in a 2 to 3 year period basis (instead of annual revision) already after establishment of the REFIT 2011 Tariffs could decrease the feeling of risk and uncertainty for the potential REFIT investors.

Finally the option of establishing group differentiations (e.g. low income residential rate payers) within the electricity consumers responsible for paying the extra costs emerging from REFIT implementation could assist the implementation and decrease any opposition towards REFIT.

With regard to addressing the institutional hindrances to REFIT implementation, a set of possible recommendation is identified and shortly presented as follows (for analytical presentation, see Appendix F):

1. Clear definition of the division of roles and responsibilities of the different stakeholders under the REFIT program, so that conflicting approaches of the stakeholders are eliminated and their actions are coordinated.

2. Establishment of simple, transparent, predictable and timely Administrative Procedures on REFIT.

3. Reconsider the Selection Criteria so that they don't impose extra barriers. The reasoning behind each selection criteria and the effect it has must be carefully thought.

4. Long term planning required from NERSA in combination with update on the RES governmental policy.

5. Encourage manufacturers to create units in South Africa and take steps towards facilitating the creation of local RES Market.

6. Establish suitable infrastructure that supports RES integration to the grid while also updating the grid code to incorporate renewable energy technologies efficiently.

To sum up, the REFIT scheme introduced by the National Energy Regulator of South Africa could constitute an important step towards RES deployment in South Africa. Nevertheless the lack of suitable Administrative and Planning Procedures and the absence of coordination between the different stakeholders within the Energy and Public Planning Policy Sphere in combination with the non successful definition of a stable and cost-efficient Financial Incentive Structure especially with respect to the technologies of PV, Wind and CSP Trough with 6 hours of storage imply that currently the REFIT scheme is not effective. Specific recommendation towards the overall scheme's effectiveness has been provided through this report.

At this point it should be noted that the transitional phase of REFIT scheme (procedure of revision for the REFIT 2011 Tariffs) hindered our analysis in terms of having to assess two different Tariff Levels (also some different design options and assumptions) for each one of the considered technologies. This fact also implied some difficulties in relation to up to date data acquisition. Furthermore the absence of specific case studies on RES projects in South Africa forced that a large number of cost, financial and performance assumptions had to be taken into account to carry out the analysis, introducing a degree of uncertainty in the conducted calculations. Nevertheless such assumptions are deemed to be adequate for the purpose of this study.

As it has already been said, the limited timeframe imposed certain delimitations. The focus is on specific technologies (mainly in terms of the FIT Level definition). Moreover the same WACC-Discount Rate has been assumed for all the examined technologies, despite the different technology specific risks applying in some cases. Further to these, not all the possible scheme design and implementation options have been considered and calculations on the socioeconomic costs/benefits in relation to REFIT scheme have been excluded from the analysis. Also technical and infrastructural barriers have not been identified in depth. Last but not least all the calculations were conducted in fixed terms so no sensitivity analysis on inflation has been carried out.

It should also not be forgotten that some actors and laws (such as banks, Energy Security Master Plan 2007 etc) have not been included in the analytical macro structure presented, despite the fact that they could also affect the result (e.g. refusal of banks to provide financing for RES projects would put an extra barrier on REFIT implementation), as the main focus has been the assessment of the scheme effectiveness with respect to attracting investors while not burdening electricity rate payers.

Within this context a study of how could inflation affect the required FIT Level would be especially appropriate given the generally high inflation rates applicable in South Africa. Another possibility of further research could be to make the model more detailed through the different technologies (e.g. calculate and incorporate different WACC- Discount Rates) while also further expanding the model in terms of estimating Capital and O&M costs, as well as Capacity Factors on the basis of local conditions.

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Appendix A

In this Appendix all the calculations that lie behind the results presented in Chapter 4 as well as the assumptions that the results are based on are presented.

Model

As it has already been mentioned, the Discounted Cash Flow model approach adopted in the current study, is based on the Levelized Cost of Electricity (LCOE) methodology, as this is defined by the simplified formula below:

$$\boldsymbol{LCOE} = \frac{\sum_{t=1}^{T}((Total\ Investment_t + O\&M_t + Fuel_t + Carbon_t + Decommissioning_t) * (1 + Discount\ Rate)^{-t})}{\sum_{t=1}^{T}(Electricity_t * (1 + Discount\ Rate)^{-t}))} \qquad \textbf{(1)}$$

$Electricity_t$ is the amount of electricity produced in year t, $Total\ Investment_t$ is the Total Investment Cost in year t, $O\&M_t$ is the Operation and Maintenance costs in year t, $Fuel_t$ is the Fuel Costs in year t, $Carbon_t$ is the Carbon Costs in year t, $Decommissioning_t$ is the Decommissioning costs in year t and $(1 + Discount\ Rate)^{-t}$ is the discounting factor for year t (IEA,NEA,OECD 2010). In our approach and with respect to our delimitations, the parameters $Fuel_t$, $Carbon_t$ and $Decommissioning_t$ are considered equal to zero.

Looking into equation (1), the key parameters that one should take into account when designing a model of LCOE calculation can be identified:

- Total Investment Cost
- Operation and Maintenance Costs
- Technical inputs (Capacity Factors, Typical Capacities under examination etc.)
- Financial inputs (Discount Rate)

Within such an approach, the value chosen for the Discount Rate, which remains fixed for the lifetime of the project, represents all of the characteristics of the finance instrument as it reflects an expected return on capital for a project developer (i.e. the minimum rate of return that might be required). (IEA,NEA,OECD 2010)

In combination with the parameters above mentioned, the Discounted Cash Flow (DCF) model designed, takes into account taxation and gives as an output the electricity price (FIT) for which the different RES projects (PV, Wind, CSP 6h storage) begin to deliver a positive return for an investor, or in other words the electricity price for which the Net Present Value of the Discounted Cash Flow gets equal to zero. The annual cash flow is expressed (in a simplified way) by formula (2) and the calculation is conducted in fixed 2011 prices, meaning that the O&M Costs as well as the electricity price (FIT) calculated are assumed to remain at the same level through the lifetime of the project (all output, once produced, is immediately sold at this price). This is a normal procedure in such type of analyses.

$$Cash\ Flow_t = -Total\ Investment_t + Energy\ Income_t - O\&M_t - Corporation\ Tax_t \quad \textbf{(2)}$$

Where

$$Energy\ Income_t = Energy\ Yield_t * Degradation\ Index_t * FIT \quad \textbf{(3)}$$

$$Corporation\ Tax_t = (Energy\ Income_t - O\&M_t - Depreciation_t) * National\ Tax\ Rate \quad \textbf{(4)}$$

$$Depreciation_t = \frac{Total\ Investment\ Cost_t}{Depreciation\ Time} \quad \textbf{(5)}$$

$$Degradation\ Index_t = Degradation\ Index_{t-1} * (1 - Efficiency\ Annual\ Decrease) \quad \textbf{(6)}$$

And

$$Degradation\ Index_1 = 1 \quad \textbf{(7)}$$

As it has already been mentioned, the Discount Rate utilized in the NPV Calculation reflects an expected reasonable return on capital for a project developer, thus it is determined by a market-based Weighted Average Cost of Capital (WACC). The WACC represents the weighted mix of debt and equity costs for the investor and is calculated according to the following equation:

$$WACC = \left(\frac{D}{V}\right) * r_d * (1 - T) + \left(\frac{E}{V}\right) * r_e \quad \textbf{(8)}$$

r_d is the Cost of Debt Before Tax, r_e is the Cost of Equity After Tax, T is the Tax Rate on corporate profit, D/V is the Debt share of the total capital base and E/V is the Equity share of the total capital base.

To be more accurate, the Discount Rate employed in this particular model is equal to the Real Weighted Average Cost of Capital After Tax, which means that the Cost of Debt and Cost of Equity in formula (8) are expressed in real terms (Real Cost of Debt and Real Cost of Equity). For this reason, inflation is not taken into account into the cash flows (e.g. O&M are not inflated).

Furthermore, the Cost of Debt is reduced by the Tax Rate, because interest on Debt is included in allowable costs against tax, and therefore acts as a tax shield. The Cost of Debt should reflect the Cost of Debt according to the mix of currencies in which project developers are borrowing, as for example Debt costs in ZAR may be higher than those in other countries where funding is raised.

Assumptions

At this point it is worth referring to the main assumptions presented in chapter 4 which are taken into account in order to calculate the required FIT for the different technologies. The sources and reasoning behind these assumptions are presented.

Financial assumptions

In the Base Case, a Real Discount Rate of 8,2% is utilized, estimated as the Real WACC After Tax with regard to formula (8). The Real Cost of Debt of 6,2% is calculated through equation (9) employing the data presented in Table 1 below and an inflation rate of 6%, which is based on the maximum target inflation rate in South Africa.

Table 1: Nominal Cost of Debt Calculation[11].

Interest Rate on a 15 year interest rate swap (as of 1st of April 2011)	8.58%
+	+
Bank Liquidity Costs + Bank Costs+ Risk Premium + Interest Rate Hedging Costs	4%
Nominal Cost of Debt	12.68%

$$Real\ Cost\ of\ Debt = \left[\frac{(1+NCD)}{(1+I)} - 1\right] * 100\% = 6{,}2\% \qquad \textbf{(9)}$$

Where NCD is the Nominal Cost of Debt and I inflation.

The assumptions on Debt Share (70%), Equity share (30%), Real Cost of Equity After Tax (17%) and the National Tax Rate (28%) are based on official data from NERSA (NERSA 2011), (NERSAc 2009). It should be stressed that 17% is considered as a rather high Cost of Equity especially when compared to the ones utilized in Europe (IEA Wind 2011) but since there were not any more specific official data to calculate it, this value was accepted as it was officially provided by NERSA.

Accordingly, the Exchange Rate is considered equal to 9,51 ZAR/EUR because this is approximately the average ZAR to EUR rate for the last 10 years but also the average rate during the last year. (European Central Bank 2011)

The project lifetime of 20 years has been selected for simplicity reasons for all three technologies (PV, Wind CSP) as the Power Purchase Agreement (PPA) will be signed for 20 years according to (NERSA 2011), (NERSAc 2009) and also because it can be considered as the Lifetime of PV and Wind plants.

[11] Data provided by South African Bank: Nedbank

Finally the Depreciation Period is assumed equal to the Project Lifetime of 20 years for simplicity reasons as well.

Assumptions on Technical Parameters

The term Technical Parameters refers to the characteristics of the respective RES plants that are related to their size and performance. These parameters are presented in Table 4.2.

According to (EPRI 2010), a study specially conducted to provide data for the South African IRP of 2010 together with rough calculations based on data gathered from the Request for Information (RFI) responses issued to potential developers under the REFIT program by the Department of Energy and the National Treasury (Ea Energianalyse 2010) , the average capacity factors presented in Table 4.2 were selected for the Base Case, yielding in the corresponding amounts of annual production for the RES under consideration presented in Table 2 below. Furthermore a decrease of 1% in performance efficiency is considered for PV plants, while for Wind and CSP such a decrease is neglected.

Table 2: Annual Production of considered RES.

Base Case Technical Parameters	**PV**	**Wind**	**CSP 6h Storage**
Reference Capacity (MW)	1	50	50
Typical Capacity Factor (%)[12]	19%	26,9%	36,2%
Annual Production (MWh)	1664	145.416	158.556
Annual Production/MW installed (MWh)	1664	2908	3171

[12] (EPRI 2010), (Danish Energy Agency, Energinet.dk 2010)

Cost Assumptions

After comparison of data on costs from different reports such as “Technology Data for Energy Plants” (Danish Energy Agency, Energinet.dk 2010), “Projected Costs of Generating Electricity” (IEA,NEA,OECD 2010), “Power Generation Technology Data for Integrated Resource Plan of South Africa” (EPRI 2010), “The Economics of Wind Energy” (EWEA 2009) , UK Electricity Generation Costs Update (Mott MacDonald 2010) etc as well as from online sources together with some market research, the assumed Capital and O&M Costs derived are the ones presented in Table 4.3 in m€/MW and €/MWh accordingly.

Given the absence of real cost data from projects in South Africa, the presented Capital and O&M Costs have not been separately analyzed to their components in the designed model. Nevertheless a careful selection of the costs data has been made so that they include as many as possible from the components presented in Tables 3&4. In a next step the DCF model can be further expanded particularly in terms of estimating Capital and O&M costs on the basis of local conditions including analytically all the parameters in these tables.

It should be noted that Wind Capital Costs, as it is mentioned in their source report, do not include the transaction costs of administration, insurance, consultancy, project management and approvals by authorities (Danish Energy Agency, Energinet.dk 2010). But since according to recent data, the Capital Costs for Wind have decreased in around 1,25 m€/MW (IEA Wind 2011) , it is considered that the value of 1,4 m€/MW, is high enough to include the transaction costs mentioned above.

Table 3: Capital Costs Parameters Description.

Parameter	**Key Features**
Project Preparation Costs	Include design, feasibility
Equipment Costs	Include shipping, delivery and import duties
Licensing Costs	Include initial permits, licenses, power purchase agreements, tariff application
Contractor costs	For construction or project management
Contingency	Additional costs based on historical operating experience
Land purchase costs	Costs for purchasing the land for the plant
Grid Connection Costs	Costs to connect to grid
Interest During Construction Costs	Financial costs during construction phase

Table 4: Operation and Maintenance Costs Parameters Description.

Description	**Key Features**
On site staffing	Base Full time-equivalent person count for onsite staff. Costs for base salaries
Pensions and Benefits	Personnel costs in addition to the base salaries
Consumables	O&M materials and commodities required to operate the plant, ie chemicals off-site power etc.
Repair costs	Cost for special equipment items needed for repairs, levelised over lifetime on an annual basis (not including salaries)
Purchased services and contracts	All subcontractors and consultancy costs for special maintenance or repair tasks
Regulatory fees	Cost of inspections and maintenance of permits
Material Disposal Costs	Costs of disposal of any spent fuel or other materials
Administrative costs	Apportioning of general company overhead costs for site management
Capital Replacement	Any large item equipment that is expected to be replaced during plant operation. Should be levelized on an annual basis
Contingency	Any contingency to deal with uncertainty based on historical operating experience

Since important cost components such as Land Purchase Costs, Grid Connection Costs and IDC Costs are not included in the Capital Costs values obtained from the respective sources (footnoted in Table 4.3), cost adjustments are required, so that the Total Investment Costs presented in Table 4.3 in mZAR/MW are obtained. These adjustments are presented in following Table.

Table 5: Cost Adjustments Description.

Costs & Adjustments	**PV**	**Wind**	**CSP**
Capital Costs (€/MW)	2800000[13]	1400000[14]	6000000[15]
Capital Costs (ZAR /MW)	26628000	13314000	57060000
Land Purchase Costs (ZAR /MW)	133140	133140	133140
Grid Connection Costs (ZAR /MW)	213024	213024	213024
IDC Costs (ZAR /MW)	2183496	1091748	4678920
Total Investment Costs (ZAR /MW)	29157660	14751912	62085084

The Land Purchase Costs are estimated as the 1% of the Wind Capital Costs (133140 ZAR/MW), since the only data from South Africa on Land Costs (internal confidential communication) is related to a Wind plant. The same Land Costs are of course applied in all the technologies. In the same way in order to define the potential Grid Connection Costs an assumption that the Connection Costs are equal to 0,8% of the PV Capital Overnight Costs has been made (Petsa 2011), yielding in 213024 ZAR/MW for all the technologies, as there should not be any variation in the Grid Connection Costs with respect to the different technologies. Finally the IDC is considered equal to the Discount Rate utilized, which is 8,2% for the Base Case and the yielding IDC Costs for each technology are equal to the IDC multiplied by the respective Capital Costs (the leading time is assumed equal to one year for all the different technologies). The Total Investment Costs are obtained by adding the Land Purchase Costs, Grid Connection Costs and IDC Costs to the Capital Costs for each technology.

REFIT Assumptions by NERSA

At this point a more careful insight in some of NERSA's assumptions, as these are presented in Table 4.5, is provided. The Real WACC After Tax of 12% that has been utilized as a Discount Rate by NERSA under REFIT 2009 as well as the Real WACC After Tax of 9,8% utilized in REFIT 2011 calculations don't seem to match with the data behind them. This can be realized if the data from Table 6 are replaced into formula (8).

[13] (SolarServer Online Portal To Solar Energy 2011), (Petsa 2011)
[14] (Danish Energy Agency, Energinet.dk 2010)
[15] (Mott Mc Donald confidential document u.d.)

Table 6: NERSA's Financial Assumptions and WACC Calculation (NERSA 2011).

Financial Assumptions	**REFIT (2009) phase I&II**	**Calculated[16] (2009)**	**REFIT (2011) phase III**	**Calculated (2011)**
Debt share(%)	70.00%		70.00%	
Equity share(%)	30.00%		30.00%	
Nominal Cost of Debt (%)[17]	14.90%		9.93%	
Real Cost of Debt (%)	6.39%	6.39%	3.71%	3.71%
Real Cost of Equity	17.00%		17.00%	
Nominal Cost of Equity (%)		26.36%		24.02%
Inflation (%)	8.00%		6.00%	
Tax Rate (%)	28.00%		28.00%	
Real WACC after Tax (%)	12.00%	8.32%	9.80%	6.97%
Nominal WACC after tax (%)		15.42%		12.21%

As it can be observed from the above Table there is a clear difference of 3,68% in the calculated WACC for REFIT 2009 and of 2,83% in the WACC calculated for REFIT 2011 against the corresponding WACCs calculated by NERSA and published in their Consultation Paper (NERSA 2011) . So this calculation should be verified by NERSA.

Concerning adjustment of the FITs with inflation over time under REFIT III, the following formula is defined by NERSA:

$$REFIT_{j+1} = Capex_{2011} + OM_j * (1 + RSA\_CPI_j/100) \qquad \textbf{(10)}$$

Where j is any calendar year ≥ 2011, $REFIT_{j+1}$ is the PPA tariff in year j,$Capex_{2011}$, is the Capital Expenditures (ZAR/kWh) in 2011, OM_j the Operation and Maintenance Costs in year j (ZAR/kWh) and RSA_CPI_j the Actual South African CPI for year j (NERSA 2011)

This formula fixes the capital return portion of the total REFIT tariff in nominal terms, based on a real return to capital providers. This has the effect of delivering a reducing real return on capital expenditure for debt and equity capital providers as the project matures.

The LOC_{capex} typically consists of 2 components being the EPC costs levelized over the project lifetime and the return to capital providers (debt and equity). While it is recognised that the EPC of a renewable project is incurred upfront and as such are fixed in real terms, debt and equity providers, however, realise their return over the life of the project in nominal terms.

[16] This column as well as the one for 2011 indicate the result of our own calculation

[17] This Nominal Cost of Debt is based on the JIBAR rate as at the end of 2010 plus a risk premium for power generation projects (NERSA 2011)

Given that more than 80% of the LOC_{capex} generally consist of the return to capital providers, it would be more rational that the LOC_{capex} of the FIT is also indexed to South African CPI in a similar manner to the OM (O&M) in the Tariff indexation formula.

If there is no indexation of the LOC_{capex} tariff element then a nominal rate of return to capital providers should be utilised in the calculation of the LOC_{capex} tariff element instead of the real return to capital as currently proposed from NERSA.

As far as NERSA's cost assumptions are concerned, their tariffs appear to be based on least cost scenarios for large plants in the EPRI report. This is not representative as the cost assumptions should reflect a broader range of REFIT projects within each technology and the fact that these are first-of-a-kind power plants in South Africa.

Feed In Tariff Level

The Tariffs calculated with the DCF model and presented in Figures 4.1, 4.2 and 4.3 are summarized in the Table below for all the three technologies under consideration.

Table 7: Estimated proposed FITs for the different RES technologies in comparison with FITs introduced by NERSA (NERSA 2011)**,** (NERSAc 2009).

FIT Level	**REFIT 2009 (phase I & II)**	**Proposed FIT**	**REFIT 2011 (phase III)**
PV (ZAR/KWh)	3,94	2,63	2,31
Wind (ZAR/KWh)	1,25	0,90	0,94
CSP trough 6h storage (ZAR/KWh)	2,10	2,72	1,84

Scenario Analysis on Key Assumptions

Some of the sensitivity scenarios analyzed in section 4.4 are at this point separately presented and at the end all the scenarios are summarized, together with their assumptions and their corresponding results on the required FIT Level, in three Tables one for each of the investigated RES plants.

Effect of the Discount Rate on the required FIT Level

Different scenarios representing different Discount Rates or in other words different WACC (Real, After Tax) assumptions have been formulated and are presented together with their results in the Table below. These values are behind Figure 4.8.

Table 8 and all the separately presented Tables of individual sensitivities indicate the changes in the corresponding input parameter considered as variable while the rest of the assumptions are considered the same as in the Base Case.

Table 8: Effect of WACC- Discount Rate on required FIT Level for ground mounted PV, Wind and CSP Trough with 6h Storage installations.

Scenarios:	**Scenario 1**	**Base Case**	**Scenario 2**	**Scenario 3**
WACC (%)	**7%**	**8,2%**	**9,8%**	**12%**
PV (ZAR/kWh)	2,39	2,63	2,99	3,50
Wind (ZAR/kWh)	0,82	0,90	1,02	1,20
CSP 6h (ZAR/kWh)	2,45	2,72	3,10	3,67

Effect of the Exchange Rate on the required FIT Level

In the same way, as it has been mentioned in chapter 4, two scenarios representing different Exchange Rate assumptions have been formulated and are compared to the Base Case in Figure 4.9. The numbers represented in Figure 4.9 are from Table 9 below.

Table 9: Effect of Exchange Rate on required FIT Level for ground mounted PV, Wind and CSP Trough with 6h Storage installations.

Scenarios:	**Scenario 1 -30%**	**Base Case**	**Scenario 2 +30%**
Exchange Rate	**6,66 ZAR/EUR**	**9,51 ZAR/EUR**	**12,36 ZAR/EUR**
PV (ZAR/kWh)	1,85	2,63	3,42
Wind (ZAR/kWh)	0,64	0,90	1,17
CSP 6h (ZAR/kWh)	1,91	2,72	3,54

Effect of the Capital Costs on the required FIT Level

The sensitivity of the demanded support Level to the Capital Costs of the RES plants considered is examined through the design of an increased and decreased cost scenario for each technology. The results of these scenarios are presented in Tabes 10, 11 & 12 and are graphically depicted in Figure 4.10. Since the Capital Costs are converted in ZAR/MW through the exchange rate of 9,51, they are presented in the Tables below in both currencies.

Table 10: Effect of Capital Costs on required FIT Level for ground mounted PV installations.

Scenarios	**Scenario 1 -10%**	**Base Case**	**Scenario 2 +10%**
Capital Costs (€/MW)	2520000	2800000	3080000
Capital Costs (ZAR/MW)	23965200	26628000	29290800
PV FIT (ZAR/kWh)	2,37	2,63	2,9

Table 11: Effect of Capital Costs on required FIT Level for Wind installations.

Scenarios:	**Scenario 1 -10%**	**Base Case**	**Scenario 2 +10%**
Capital Costs (€/MW)	1260000	1400000	1540000
Capital Costs (ZAR/MW)	11982600	13314000	14645400
Wind FIT (ZAR/kWh)	0,81	0,90	0,99

Table 12: Effect of Capital Costs on required FIT Level for CSP Troughs with 6h Storage.

Scenarios:	**Scenario 1 -10%**	**Base Case**	**Scenario 2 +10%**
Capital Costs (€/MW)	5400000	6000000	6600000
Capital Costs (ZAR/MW)	51354000	570600000	62766000
CSP 6h FIT (ZAR/kWh)	2,45	2,72	2,99

Summarized Results from Scenario Analysis

At this point an overview of the different individual variable scenarios with the analytical assumptions behind them and their results is presented in the format of Tables, one for each of the technologies considered.

In the Tables below CF stands for Capacity Factor, DR for Discount Rate, ER for Exchange Rate, CC for Capital Costs, while BASE indicates the Base Case.

Table 13: Effects of Key Assumptions on required FIT Level for ground mounted PV installations.

PV Scenarios		**CF**		**DR**			**ER**		**CC**	
	BASE	**-10%**	**+10%**	**7%**	**9,8%**	**12%**	**6,66**	**12,36**	**-10%**	**+10%**
CF (%)	19	17,1	20,9	19	19	19	19	19	19	19
DR (%)	8,2	8,2	8,2	7	9,8	12	8,2	8,2	8,2	8,2
ER (ZAR/EUR)	9,51	9,51	9,51	9,51	9,51	9,51	6,66	12,36	9,51	9,51
CC (mZAR /MW)	26,63	26,63	26,63	26,63	26,63	26,63	26,63	26,63	26,26	32,06
O&M C (ZAR/MWh)	285,3	285,3	285,3	285,3	285,3	285,3	285,3	285,3	256,8	313,8
FIT (ZAR/kWh)	**2,63**	**2,89**	**2,42**	**2,39**	**2,99**	**3,50**	**1,85**	**3,42**	**2,37**	**2,9**

Table 14: Effects of Key Assumptions on required FIT Level for Wind installations.

Wind Scenarios		**CF**		**DR**			**ER**		**CC**	
	BASE	**+23%**	**+47%**	**7%**	**9,8%**	**12%**	**6,66**	**12,36**	**-10%**	**+10%**
CF (%)	26,9	33,2	39,5	19	19	26,9	26,9	26,9	26,9	26,9
DR (%)	8,2	8,2	8,2	8,2	8,2	12,0	8,2	8,	8,2	8,2
ER (ZAR/EUR)	9,51	9,51	9,51	9,51	9,51	9,51	6,66	12,36	9,51	9,51
CC (mZAR /MW)	13,3	13,3	13,3	13,3	13,3	13,3	13,3	13,3	11,9	14,7
O&M C (ZAR/MWh)	123,6	123,6	123,6	123,6	123,6	123,6	123,6	123,6	111,2	136
FIT (ZAR/kWh)	**0,90**	**0,75**	**0,65**	**0,82**	**1,02**	**1,20**	**0,64**	**1,17**	**0,81**	**0,99**

Table 15: Effects of Key Assumptions on required FIT Level for CSP Trough with 6h Storage installations.

Scenarios		**CF**		**DR**			**ER**		**CC**	
	BASE	**-20%**	**+20%**	**7%**	**9,8%**	**12%**	**6,66**	**12,36**	**-10%**	**+10%**
CF (%)	36,2	29,0	43,4	19	19	36,2	36,2	36,2	36,2	36,2
DR (%)	8,2	8,2	8,2	8,2	8,2	12,0	8,2	8,2	8,2	8,2
ER (ZAR/EUR)	9,51	9,51	9,51	9,51	9,51	9,51	6,66	12,36	9,51	9,51
CC (mZAR /MW)	57,1	57,1	57,1	57,1	57,1	57,1	57,1	57,1	51,4	62,8
O&M C (ZAR/MWh)	292,3	292,3	292,3	292,3	292,3	292,3	292,3	292,3	263,1	321,6
FIT (ZAR/kWh)	**2,72**	**3,33**	**2,32**	**2,45**	**3,10**	**3,67**	**1,91**	**3,54**	**2,45**	**2,99**

Best and Worst Case Scenarios

Two multivariable scenarios have been formulated for each technology investigated and have been analyzed through the DCF model to evaluate the impact on the FIT Level of varying more than one of the Key assumptions simultaneously. The assumptions behind these scenarios together with their results are presented in Tables 16, 17 &18.

Table 16: Best and Worst Case Scenarios' Effect on the FIT Level required for ground mounted PV installations.

PV Scenarios	**Best Case**	**Base Case**	**Worst Case**
Discount rate-WACC (%)	7%	8,2%	9,4%
Capacity Factor(%)	20,9%	19%	17,1%
Exchange Rate (ZAR/EUR)	6,66	9,51	12,36
Capital Cost (€/MW)	2520000	2800000	3080000
FIT (ZAR/kWh)	1,39	2,63	4,55

The values of the above Table represent the purple columns in Figure 4.11

Table 17: Best and Worst Case Scenarios' Effect on the FIT Level required for Wind installations.

Wind Scenarios	**Best Case**	**Base Case**	**Worst Case**
Discount Rate-WACC (%)	7%	8,2%	9,4%
Capacity Factor(%)	39,5%	26,9%	26,9%
Exchange Rate (ZAR/EUR)	6,66	9,51	12,36
Capital Cost (€/MW)	1260000	1400000	1540000
FIT (ZAR/kWh)	0,38	0,90	1,42

The values of Table 17 represent the green columns in Figure 4.11 and finally the values of Table 18 represent the pink columns in Figure 4.11.

Table 18: Best and Worst Case Scenarios' Effect on the FIT Level required for CSP Trough with 6h Storage installations.

CSP 6h Scenarios	**Best Case**	**Base Case**	**Worst Case**
Discount Rate-WACC (%)	7%	8,2%	9,4%
Capacity Factor(%)	43,4%	36,2%	29%
Exchange Rate (ZAR/EUR)	6,66	9,51	12,36
Capital Cost (€/MW)	5400000	6000000	6600000
FIT (ZAR/kWh)	1,32	2,72	5,26

Appendix B

At this point possible suggestions identified in relation to the different FIT scheme's Design and Implementation Options that are deemed to be relevant and interesting are summarized with regard to the analysis conducted in Chapter 5.

Table 19: Overview of Recommendation for REFIT Design and Implementation Options.

Design& Implementation Option	Recommendation
Support Level	LCOE Methodology: FITs calculated for priority technologies – wind, solar PV, CSP Trough 6 hours Storage.
FITs Differentiation with Technology Type	Yes. Differentiation with Technology Type.
FITs Differentiation with Resource Quality	Yes. Differentiation with Resource Quality could be positive.
Inflation Adjustment	Yes. Full annual inflation adjustment.
Degression	No. Possible introduction once there is a better understanding of market and technology cost development in the local context.
Revision	Yes. E.g. initially after one year and every 2-3 years later. Possibly less frequent as experience is gained.
Power Purchase Obligation	Yes. Eskom to purchase all power generated by approved sites.
Power Purchase Agreement Duration	20 years suggested as baseline.
Actors paying for the FITs	Electricity ratepayers (groups differentiations possible)/ partial initial public budget contribution.

Appendix C

Table 20: Tariffs published by NERSA under REFIT 2009 (NERSAa 2009), (NERSAc 2009).

REFIT 2009	Technology	ZAR/kWh
Phase I	Wind ≥ 1MW	1,25
	CSP Trough with 6h storage per day ≥ 1MW	2,10
	Small Hydro ≥ 1MW	0,94
	Landfill Gas ≥ 1MW	0,90
Phase II	Large-scale grid-connected PV Systems ≥ 1MW	3,94
	CSP Trough without storage ≥ 1MW	3,14
	CSP Tower with 6h storage per day ≥ 1MW	2,31
	Biomass solid ≥ 1MW	1,18
	Biogas ≥ 1MW	0,96

Table 21: Tariffs published by NERSA under REFIT 2011 (NERSA 2011).

REFIT 2011	Technology	ZAR/kWh
Phase III	Wind ≥ 1MW	0,94
	Large-scale grid-connected PV Systems ≥ 1MW	2,31
	CSP Trough with 6h storage per day ≥ 1MW	1,84
	CSP Trough without storage ≥ 1MW	1,94
	CSP Tower with 6h storage per day ≥ 1MW	1,40
	Small Hydro ≥ 1MW	0,67
	Landfill Gas ≥ 1MW	0,54
	Biomass solid ≥ 1MW	1,06
	Biogas ≥ 1MW	0,84

Appendix D

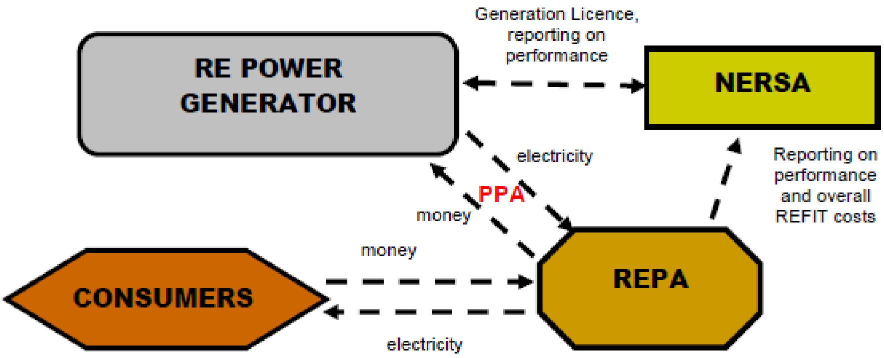

Figure 1: REFIT structure and application process outline (NERSAa 2009).

Appendix E

Analytical Presentation of institutional hindrances to REFIT implementation (see also section 6.3)

1. Conflicting approaches in relation to the final decision for REFIT implementation and lack of clarity in relation to the roles of the different actors involved.

2. Absence of a standardized and specialized for RES projects PPA under the REFIT.

3. No first point of contact for potential investors and no clear guidelines on the REFIT application process.

4. Lack of internal guidelines on the handling of applications by NERSA (no special REFIT license developed, the chronological order between different requirements not strictly defined, no strict timeframe within which projects should be commissioned).

5. Lack of clarity on how deep connection costs are divided between the Transmission System Operator (Eskom) and the IPP.

6. Preference for generators able to be commissioned in the shortest time could hinder the implementation of larger projects such as CSP plants that require time consuming planning. Furthermore preference for investors able to demonstrate ability to raise finance adds unnecessary step in the administrative procedure.

7. Exclusion of small REFIT projects (≤1 MW) and allowance of ownership of RES plants only to corporations with a CIPRO number prevents local investors such as community groups from participation and potential REFIT benefits.

8. Absence of grid map indicating the suitable connection and coupling points for REFIT projects.

9. Lack of long-term planning by NERSA (no further incentives for RES deployment defined beyond 2013).

10. Absence of recent RES policy (last one was the *White Paper of 2003*) setting updated national long term goals for RES deployment.

11. Eskom’s conflicting roles (sole buyer of electricity from IPPs, System Operator, and competitor, partially responsible for IRP formulation).

12. IRP Targets could cap RES deployment under REFIT.

13. Lack of skills in relation to RES projects (e.g. project design, operation etc) and absence of innovative domestic technological capacity in all educational levels.

14. Non existence of energy infrastructure for decentralized system and of grid code facilitating renewable energy.

15. Absence of concrete steps towards creation of a local *RES Market* (no local manufacturers and small number of RES related companies).

16. Strong political links to coal industry and weak independent RES lobby.

Appendix F

Analytical recommendation to institutional hindrances:

1. Clear definition of the division of roles and responsibilities of the different stakeholders under the REFIT program is required, so that conflicting approaches of the stakeholders are eliminated and their actions are coordinated.

2. A simplified, standardized PPA, reflecting the specific conditions and requirements of the REFIT program should be developed the soonest possible.

3. Establishment of a front office or one-stop shop could provide investors with a first point of contact offering assistance and guidance on REFIT related issues such as how and where to apply for permits etc. Development of external guidelines on a good REFIT application process could assist investors in getting approval for REFIT projects.

4. An internal handbook with a decision tree should be developed for internal administration of REFIT applications to streamline application processing. This will clarify how applications must be processed internally and ensure a consistent and predictable handling of each application, creating this way a transparent and predictable environment for applicants and ensuring that NERSA's decision making process is consistent.

5. Develop transparent and clear methodology for determining the grid connection costs and clarify their division between the TSO and the IPP.

6. Reconsider the Rules for Selection Criteria so that they don't impose extra barriers rather than assisting the administrative procedure (e.g. reconsider preference for generators able to be commissioned in the shortest time and for investors able to demonstrate ability to raise finance).

7. Capacity classifications for qualifying technologies and ownership rules should be reviewed to ensure that small investors such as community groups can also participate and benefit from REFIT.

8. Demand from the TSO (Eskom) to provide a grid map indicating the grid's capacity for integrating REFIT projects.

9. Long term planning required from NERSA to make clear the intentions for further RES incentives and reduce the perception of policy risk for potential investors.

10. Update on the governmental RES policy (e.g. revised White Paper on Renewable Energy Policy) or creation of a single law on renewable energy to evaluate targets

accomplishment and set new national long term goals for RES deployment. Development of sub legislative acts and laws to define further rules, norms and standards could also be useful.

11. Secure non-discriminatory open access to the national electricity grid and divide-clarify Eskom's roles (e.g. Establishment of Independent System Operator).

12. Remove possible cap on South Africa's REFIT through the IRP to allow REFIT practical implementation and large-scale RES deployment.

13. Design public regulation measures that remove the innovation obstacles to support research in RES technologies and development of skills related to RES projects.

14. Establish suitable infrastructure that supports RES integration to the grid while also updating the grid code to incorporate renewable energy technologies efficiently.

15. Encourage manufacturers to create units in South Africa and take steps towards facilitating the creation of local RES Market.

16. Need for increase in the number of independent RES lobbyists in South Africa and strengthened participation in the political process.