Drivers of effective renewable energy policies.

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ABSTRACT

Sustainability and ‘green’ issues are becoming an integral part of business and management. There is a conscious shift that needs to be embraced by the business and management sector. Sustainable energy generation falls into this field. Large gird connected renewable energy (RE) facilities form a subset of sustainability and the clean technology sector. Independent Power Producers (IPPs) cannot compete with traditional fossil fuel generated electricity and hence support policies are required to encourage and protect these IPPs. Different policy mechanisms have been deployed with varying degrees of success in predominately developed countries. Countries like Denmark, Spain and The UK, to mention a few, have developed RE sectors, where spill over affects have taken place. From a business perspective, it is important to understand what policies are available and what factors (drivers) play a key role. This study identifies five main RE policy mechanisms (Feed-In Tariffs (FITs); Tradable Green Certificates; Renewable Portfolio Standards; Bidding/Tendering and Fiscal) of which the FIT has experienced the most success in establishing a RE sector. In addition twenty four key drivers are extracted that feed into a policy design. Using the qualitative method of Fuzzy Cognitive Mapping, the study relates the policies to the drivers to identify which drivers are most effective within a RE sector. Finally the study reviewed the current developments of RE in South Africa and questions whether the current competitive bidding system with a tariff ceiling (‘REBID”) policy is set to create a sustainable local RE sector.

This study has been based on an extensive literature review and the findings have formed the model. Model validation has used both country specific case studies and expert input, resulting in a model that can be applied universally. Modelling concluded that FITs deployed in isolation of the twenty four drivers are no better than a no-policy stance. In addition the model has identified Big Players, The Non-RE Sector, Cost Competitiveness and Risk as the most influential drivers and when managed properly, can lead to a more successful RE sector. Finally, this study could not conclude with certainty that SA’s current policy framework is indeed sustainable, however, if Energy and Capital Costs are monitored and managed, REBID with South African Renewable Initiative (SARi) have the potential to create a solid RE sector in SA.

DECLARATION

I, Adam Treki, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

(Adam Treki)

Signed at Johannesburg, South Africa

On the 15 MAY 2012.

DEDICATION

This thesis is dedicated to my Great Great grandchildren that I will never meet. I sincerely hope that a conscience shift today towards sustained sustainability, (amongst all its definitions) will allow them to experience this planet as our generation has.

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1.1 Purpose of the study

The purpose of this research is to analyse the policy road map that South Africa (SA) needs to follow to establish a sustainable renewable energy (RE) sector. SA is currently implementing the regulatory framework for this sector, but needs to ensure the system route map is clearly defined. This is required to reduce the high level of uncertainty and risk, to attract investment, foreign and domestic, public and private. Any abrupt changes can lead to a stunting of growth in this sector.

1.2 Context of the study

Energy exists in many forms (kinetic, potential, sound, wave etc), This research report focuses on marketable energy, specifically grid-connected electricity. Electricity can be generated from many sources, such as liquids, nuclear, renewables, natural gas and coal (EIA, 2010a). The main focus is the renewable segment. The renewable segment is further divided up into various generating sources and includes hydro (including tidal and wave), solar, wind, geothermal, biomass, etc. The U.S Independent Energy Information website defines renewable energy as “Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean, thermal, wave action, and tidal action” (2010b: 1). For the purposes of this report this definition is adopted.

Energy is a topical item on the world’s agenda. With traditional sources of electricity being generated from fossil fuels (non-renewable), resource depletion and increased levels of Greenhouse Gases emissions (GHG) are major concerns. This leads to climate change issues (increasing temperature levels on the planet) and a risk to the security of future energy requirements. Various world initiatives have been established to tackle these two issues. The most popular one has been the Kyoto Protocol, which is a commitment by 141 countries to reduce GHG emissions to 5%

of the 1990 levels by 2012 (UN, 1998). SA is classified as a developing country and hence is excused from the commitments of the Kyoto Protocol. By virtue of it being a developing country, it is classified as a Non-Annex country and hence has no obligations to reduce its GHG emissions (Christie, Frittelli, Levetan and Stein, 2009). However, SA has adopted various strategies that will align to this international target, one being the establishment of a Renewable Energy Policy White Paper, in 2003 (Christie et al., 2009).

The energy sector is a crucial element for supporting economic development (Davidson, Halsnaes, Huq, Kok, Metz, Sokona et al., 2003). Davidson et al (2003:101) go on to add that energy adds to the social services in “energy accessibility, affordability, adequacy, quality, reliability, safety and environmental impacts”. In SA, only 70% of households are connected to the electricity grid, thus highlighting that SA has a high ‘energy poverty’ (Edkins, Marquard and Winkler, 2010a). The primary objectives for SA, at a high level, are poverty alleviation and development (Haw and Hughes, 2007). For this reason along with goals to reduce GHG emissions, SA has shown a keen interest in developing its RE sector.

In order to establish a RE sector, which is desirable from a societal point of view, government support is required (Finon and Perez, 2007). Compared to traditional electricity generation, the cost to establish it privately is prohibitively high and the RE electricity rates are not competitive (Finon and Perez, 2007). Various financing mechanisms exist for RE venture creation, like Carbon Credits, Government grants and incentives (tax breaks) and Climate Change funds, however, these need high level support. For this reason various government support policies and regulations need to be established to develop this sector. Traditionally there have been three high level instruments that have been used in countries that have already established a RE sector and these include Feed-In-Tariffs, bidding systems and Tradable Green Certificates. These can be broadly categorised into price driven (Feed In Tariffs (FIT) and bidding/tendering systems) and quantity driven (quotas on Tradable Green Certificates (TGCs) (Faber, Haas, Held, Ragwitz and Resch, 2007). All have varying degrees of application and in certain cases a hybrid system can be used (Kelly, 2007). Traditionally, the Renewable Energy Feed In Tariff (REFIT) has demonstrated the fastest growth rate in this sector (Faber et al., 2007). This is due to the long term stability of the agreed prices (price certainty).

This report is aimed at establishing a clear picture of the policy development that has occurred in SA with a comparison with countries with an established RE sector. The premise is to allow business to gauge the potential and the risks of the route that SA is following so that investment decisions can be made. If managed properly, the growth of this sector will see GHG emission reductions, increased employment and more security around electricity supply.

1.3 Problem statement

1.3.1 *Main problem*

The research problem is to investigate the influences of high level policies on the growth of a country's renewable energy sector; to identify the key factors (drivers) that influence growth on a renewable energy sector, and to illustrate plausible future scenarios for the South African renewable energy sector. This research is aimed at creating an understanding of how policy affects the business of renewable energy.

1.3.2 *Sub-problems*

The first sub-problem is to develop a model of the influences of high level policies on the growth of a country's renewable energy sector.

The second sub-problem is to identify the key factors that influence the growth of a country's renewable energy sector.

The third sub-problem is to illustrate plausible future scenarios for the South African renewable energy sector.

1.4 Significance of the study

The study fills a gap in that no piece of work has been carried out at WBS or SA business schools thus far that looks at how the chosen policy in SA will create an environment where investors feel the risks are low enough and the returns attractive, to invest. Pockets of work have been done in SA surrounding the following areas:

- Technological application to SA (Fluri and Von Backstrom, 2009)
- SA's RE capacities (Haw and Hughes, 2007; Fluri, 2009)
- SA Policy Road Map (Haw and Hughes, 2007; Edkins, Marquard and Winkler, 2010b; Edkins et al., 2010a)
- Green House Gas emissions (Basterfield, Gilder, Shabalala and Warburton, 2007)

However, no definitive work exists on the affect that policy could have on investment and growth in this sector. In addition no work is thus forthcoming that shows how the policy environment will evolve once the sector starts to mature. Such government support and incentives are not sustainable in the long term with technology and establishment costs declining as the sector matures. This has been seen in Denmark, where the policy regime evolved as the sector matured (Lindboe, Odgaard and Sovacool, 2008). In the USA changes in political leadership and hence renewable energy policies saw spurts of development (Grace, Rickerson and Sawin, 2007), leaving the USA with a relatively small RE Sector in relation to when development started over three decades ago (Martinot and Sawin, 2010).

The study will provide guidance to investors and policy makers about how the future landscape of the RE Sector could look if the correct high level policy and regulatory decisions are made now and supported by the government. It is aimed at providing a clear understanding of how the sector can evolve and maintain a good growth trajectory, providing the necessary confidence to investors. The long term benefactors will be the investors, society (present and future), stakeholders and indeed the people who can become part of this sector and benefit from the employment created.

1.5 Delimitations of the study

The area of RE is vast and relatively immature within the SA context. For this reason the following delimitations are made:

- The literature review has highlighted the currently available RE technologies, but is not a full technical review. This is done to provide insight for the reader of how local resource and technology maturity influence policy choice.

- This is not a review of the capacity or national targets for RE within a region. This has been covered in other studies. Reference is made, but is not the sole focus of this research.

- The policy review from countries within well established RE markets is limited to Denmark and The UK. These countries have well established policy environments (that have been deployed for over 20 years) that are used to validate the model. Where applicable, other countries are referenced to provide evidence on points discussed.

- RE can be used to produce heat, electricity and fuel for transport. This research project focuses solely on RE used to generate electricity. In addition, electricity generation from biofuels or the related policies does not form part of this research report.

- This research report will focus on grid-connected RE and exclude rural, off-grid schemes. While rural electrification is crucial, the focus of this model is to determine the major drivers for large electricity generation.

- Energy efficiency and demand side management does not form part of this research paper. It is acknowledged that such measures form part of policy and the quest to reduce energy consumption and GHG emissions, but does not form part of the scope of this report.

- International initiatives and funds designed to support RE generation are referenced for illustrative purposes and form part of the model. However, this research is focused on national policy and/or sub-constituencies in a region, and not these international agreements as a sole driver. For example, the CDM (carbon financing), under the Kyoto Protocol, is an instrument that allows greener projects, of with RE generation forms a subset, to qualify for funding. A country may ratify such international agreements, but this is not a local policy choice, hence they are delimited out.

- This research does not analyse the myriad of design options for each policy type. It is acknowledged that variations within specific policy exist; however, this report looks at the global applicability and success of the standard format of each instrument.
- As Fuzzy Cognitive Maps (FCMs) cannot cater for policy nodes accepting incoming causal links, the model does not facilitate policy evolution scenarios.
- This research project does not enter a debate on the application of regulation and legislation aspects of the policies. This paper is interested in market based principles of RE support mechanisms for mass deployment. These aspects appear in parts of the literature review, but are not factored into the model (Basterfield et al., 2007).

1.6 Definition of terms

The following list is a list of terms to help fill in the knowledge gap for readers. A full list of Abbreviations is included in Appendix A

Table 1: List of Definitions and Acronyms

No.	**Term**	**Definition**	**Reference**
1	Clean Development Mechanism (CDM)	This is the most commonly discussed method for providing a financial incentive to developing countries to reduce greenhouse gas emissions.	(Banks and Schäffler, 2006)
2	Clean Technology	Refers to any product, service or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than conventional offerings.	(Pernick and Wilder, 2008)
3	CSP	Concentrated Solar Power	-
4	DoE	Department of Energy	-
5	DTi	Department of Trade and Industry	-
6	FCM	Fuzzy Cognitive Mapping	
7	FIT	Feed In Tariff	-
8	Fossil Fuels	A natural fuel such as coal or gas, formed in the geological past from the remains of living organisms.	(Oxford, 2011)
9	Greenhouse Gas (GHG)	A gas that contributed to the greenhouse effect by absorbing infrared radiation.	(Oxford, 2011)
10	HDR	Hot Dry Rock	-
11	IPP	Independent Power Producer	-
12	IRP	Integrated Resource Plan	-
13	NERSA	National Energy Regulator of South Africa	-
14	PPA	Power Purchase Agreement	-
15	PV	Photovoltaic	-
16	REBID	Renewable Energy Bidding	
17	REFIT	Renewable Energy Feed In Tariff	-
18	REFSO	The Renewable Energy Fund and Subsidy Office	-
19	SA	South Africa	-
20	TGC	Tradable Green Certificates	-
21	WBS	Wits Business School	-

1.7 Assumptions

The following assumptions have been made:

- An initial assumption is that such a body of work for this research problem has not already been produced in SA.

- All work is conducted as a desktop study. It is assumed that sufficient written material is available that can feed into the causal links for the model.

- It is assumed that causal links between nodes that have been derived from the chosen country examples are applicable to a developing economy like SA.

- It is assumed that sufficient knowledge is available to develop this model. If the causal links that have been identified in the country examples are significantly different from SA, the FCM model may not work accordingly.

- As this research project will not be based on interviews and questionnaire formats, the risk of validation may need to be tackled through industry expert analysis. It is assumed that sufficient expertise and availability is present in SA. In addition, experts from South Africa and abroad have been earmarked to help validate this model.

- This research does not take into account the affect of new technologies that are being developed outside of the fossil fuel and renewable resource categories e.g. International Thermonuclear Experimental Reactor (ITER). The possibility that an undiscovered source of energy may exist or is being developed that could make RE generation techniques obsolete (game-changer).

2 LITERATURE REVIEW

2.1 Introduction

This section contains the literature review that is applicable to this area of concern. After a background discussion Part 1 is a review of what high level policies have been used to support the growth of the RE sector. This section references specific countries to illustrate developments. Generic advantages and disadvantages are extracted for each policy grouping. In Part 2 follows a brief overview of the available RE technologies. The choice of technology is dependent on what renewable resource is locally available for exploitation and hence has an influence on the applicable policy mechanism. Therefore a review of technology needs its own section. Part 3 is a review of the other key factors (drivers) that influence the growth of countries' RE sector. In Part 4, the current RE policy development in SA is reviewed, drawing on parallels and highlighting gaps. Finally, in Part 5, the literature review section is concluded with an overview and the key findings.

Prior to starting the literature review, a few words to discuss the concept of sustainability. Sustainability is a modern day buzz word that appears in daily language and mainstream media and is often used without much regard. Indeed in such times, sustainability is used in conjunction with development. The World Commission on Environment and Development (WCED) has defined sustainable development as "an approach to progress which meets the needs of the present without compromising the ability of future generations to meet their own needs" (1987: 8). This definition is the generally accepted version (UNEP, 2011b). More recent literature on sustainability and development involves the fields of economics, the environment and social aspects (Adams, 2006; UNEP, 2011b). Sustainability deals with the concept that within our biosphere, there are limits and it is recognised that with greater demands on limited resources, the global village needs to rethink how we live and use our resources (Adams, 2006; UNEP, 2011a) The field of renewable energy is one spoke in the solution to achieving sustainable development and offers opportunities greater than energy generation. This report shows that if a sustainable renewable energy policy is adopted, the spill over affects can add to achieving sustainability in all aspects.

2.2 Background Discussion

Renewable energy forms a subset of the clean technology sector, which is mfade up of energy, transportation, water and materials (Pernick and Wilder, 2008). RE has been defined by the U.S Independent Energy Information (IEA) website as “Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action” (2010b:). For the purposes of this research report, only renewable sources that are used to produce electricity will be considered.

Various policies to support the RE sector have been developed over the past three decades (Martinot and Sawin, 2010). In the early 80’s only a handful of countries had a policy in place and now there are over a 100 countries with some sort of policy to spur growth across all RE generation methods (heat, electricity and fuel) (Martinot and Sawin, 2010). These policies have been enacted at various levels, namely national, regional, provincial and even at city level (Martinot and Sawin, 2010). The number of such constituencies with a deployed RE policy almost doubled from 2005 to 2010 (Martinot and Sawin, 2010). The deployment of RE policy(s) has influenced investment, industry and market developments in relation to RE (Martinot and Sawin, 2010). It is important to note that prior to employing a RE policy to promote RE generation, targets need to be set. Targets are generally set at national level, and define what portion of the energy (primary or final supply) need to come from renewable sources. Targets range from 5 to 90% and are backstopped by a timeframe to achieve this in (Martinot and Sawin, 2010). Most countries have set these targets for the 2010-2012 years, however, longer time frames to 2030 have also been set (Martinot and Sawin, 2010). Once targets are set and agreed, a policy instrument or combination thereof is deployed to promote RE electricity generation (Martinot and Sawin, 2010). An analysis of successful achievement of these targets is beyond the scope of this report.

The reasons for the growth of a RE sector range from security of energy supply, with job creation, to the reduction of GHGs (Daniels, Hoffmann, Lescot, Meibom, de Noord, Skytte et al., 2003). Leading developed countries have been engaged in high level policy formulation to agree targets for reducing GHG emissions. RE is seen as a key component in achieving these targets and reducing the reliance on traditional methods of electricity generation. As with any new industry, the barriers to entry are numerous and therefore they need high level support to gain critical mass to become cost-competitive. For this reason various support mechanisms have been developed (Busch, Held, Klein, Merkel, Pfluger, Ragwitz et al., 2007).

At present, 83 countries have developed/adopted some sort of policy to spur their RE power generation (electricity) (Martinot and Sawin, 2010). Of the 83, 41 are developed countries and the balance is from the developing world (Martinot and Sawin, 2010). These countries have adopted a single or a combination of the following ten main policy instruments and these are found in table 2:

Table 2: Available policies and their categorisation

No.	Policy	Price / Quota Driven?*
1	Feed-In Tariffs (FITs)	Price
2	Renewable energy portfolio standards (RPS)	Quota
3	Capital subsidies or grants	Price (Fiscal)
4	Investment tax credits	Price (Fiscal)
5	Sales tax or VAT exemptions	Price (Fiscal)
6	Tradable Green Certificates (TGC)	Quota
7	Direct energy production payments or tax credits	Price (Fiscal)
8	Net metering	Price
9	Direct public investments or financing	Price
10	Public competitive bidding	Quota

- The categorisation did not form part of the original table and has been interrupted for the literature review.
- Source: Renewables 2010 Global Status Report. (Martinot and Sawin, 2010)

These support mechanisms have had varying degrees of success and not all are equally effective or efficient (Martinot and Sawin, 2010). It has also been found that a combination of policies has produced better results (Martinot and Sawin, 2010). Finally, a need has arisen to evolve policies as countries' RE sector matures (Martinot and Sawin, 2010).

The main support mechanisms can be broadly categorised into two main sections: price driven (supply side) and quota driven systems (demand side). This can be further dimensioned into capacity and generation categories. A perceptual map is found in Figure 1that depicts this segmentation on the 2 axes. Price driven systems include Feed-in Tariffs (FITs), while quota driven systems include Tradable Green Certificates (TGCs) and bidding/tendering systems. In addition to the above various other incentive schemes have been used, which included fiscal incentives and investment grants (Faber et al., 2007). These are discussed below.

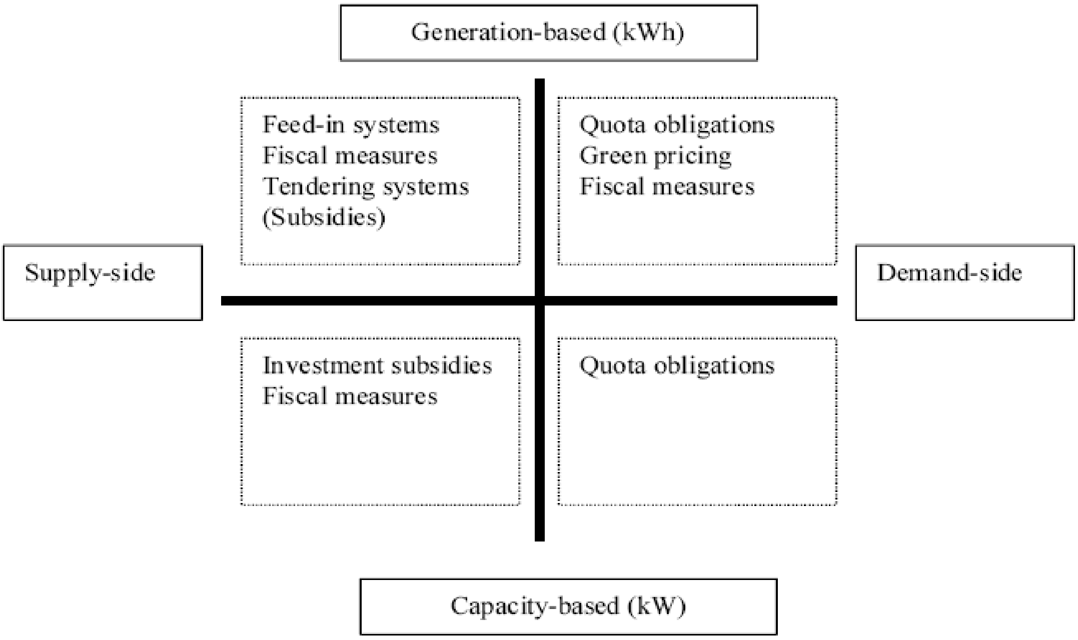

Figure 1: Types of policy instruments used for supporting renewable electricity

Source: Renewable electricity market developments in the European Union: Final report of the ADMIRE REBUS project.

2.3 Part 1: Existing RE policies

This section reviews the available policies. The above ten main policy type will be grouped and discussed, with examples of which countries use the policies. At the end of this section, the main and most effective policies are extracted for modelling purposes. The review differentiates the policy types into price and quota driven categories.

2.3.1 *Price Driven Policy*

a. *Feed in Tariffs (FITs)*

One of the most effective and prevalent policy support mechanisms for developing a RE sector are Feed-In Tariffs (Faber, Green, Gual, Haas, Huber, Resch et al., 2001; Faber et al., 2007; Grace et al., 2007; Martinot and Sawin, 2010; Pegels, 2010). FITs were first deployed successfully in Germany (Pegels, 2010). FITs are price driven incentives on the supply side (Faber et al., 2007). FITs set out a schedule of tariffs that can be earned per unit of electricity produced. This is generally measured as a rate per kilowatt hour (Pegels, 2010). The FITs guarantee the power producers a fixed rate over a set period that can range from 10 to 25 years (Pegels, 2010). The FIT tariff can either be a flat rate or a market rate with a premium paid on top (Faber et al., 2007). FITs help investors make long term decisions by providing guaranteed future revenue streams. Another design aspect of the FIT is that the rates differ for different technology types (Pegels, 2010).

This mechanism is aimed at mobilising the private sector, by guaranteeing the investor/developer a profit (price certainty). Successful developers and Independent Power Producers (IPP) enter into a Power Purchase Agreement (PPA) that sets out the terms and conditions for the purchase of electricity from the facility (Faber et al., 2001; Pegels, 2010).

The design of FITs vary from country to country and various points are debated (Martinot and Sawin, 2010). Generally, FITs are established on the following key points: tariff levels; the stepped tariff decrease over time; the length of time the tariff will be valid; the manner in which the tariff is shared among consumers; capacity levels; payment for net versus gross production; ownership type and selective treatment of the various available technologies (Martinot and Sawin, 2010). The main feature is to set rates purposefully higher than the market value for traditionally produced electricity. This is done to make the rates of return for investors and producers attractive to invest. Consumers or the public purse ultimately bare the cost of the higher tariffs. In addition, the tariffs are decreased periodically as the RE sector matures. This is done to allow technological experience learning curves to take effect and to mitigate against the consumer paying too much (Pegels, 2010). Policy needs to outline when and how these decreases will take place so that investor can factor this into the investment decisions (Pegels, 2009; Pegels, 2010).

FITs have been used successfully in 20 of the 27 EU countries (Busch et al., 2007). Globally, over 50 countries have adopted the FIT policy as their main policy mechanism (Martinot and Sawin, 2010). FITs have influenced innovation, interest and investment in these countries (Martinot and Sawin, 2010). With tariff decreases, the need to maintain margins of profit, has influenced the need to invest in innovation and has thus brought down the cost of the technology, making the technology cost-competitive with traditional generation methods. As an example wind generation methods only existed in a few countries in the 1990s, but is now present in over 82 countries. With this increase in geographical presence, the number of manufacturers has increased and newer more efficient wind turbines are available on the market (Edkins et al., 2010b). In addition, innovation has seen the development of small wind turbines, as well as larger offshore wind turbines. As a result, the FITs for wind energy is one of the lowest and is reaching cost-competitiveness with traditional generation methods (Martinot and Sawin, 2010; Pegels, 2010). Similar trends are being experienced in the solar market.

Table 1 shows FITs employed in three select EU countries. This has been included to illustrate the rates, duration and the technologies that FITs have been allocated to. It is also worth noting how different EU countries have employed different RE generation methods based on their maturity e.g. Denmark has no wind FIT rates (anymore) as wind has been utilised to generate electricity for almost three decades, while Spain and Germany still have capacity for wind generation.

Table 3: Level and duration of support for RES-E plants commissioned in 2008

		Tariff level in 2008 [€ Cents/kWh] and duration of support for different technologies							
Country	**Fixed / Premium**		**Small Hydro**	**Wind Onshore**	**Wind Offshore**	**Solid Biomass**	**Biogas**	**PV**	**Geothermal**
Denmark	Fixed	Rate	-	-	-	8	8	20-25	6.9
		Duration				10	10	20	20
Germany 1)	Fixed	Rate	7.65-12.67	9.2	13-15	7.79-22.67 2)	7.79-22.67 2)	31.94-43.01	10.5-20
		Duration	20	20	20	20	20	20	20
Spain	Fixed	Rate	7.8	7.3	-	10.8-15.9	8-10.8	23.-44	6.9
		Duration	25	20		15	15	25	20
	Premium	Rate	6.5-8.5	7.1-8.5	14.1-16.4	10.4-16.6	9.4	-	9.5
		Duration	no limit	no limit	no limit	no limit	no limit		no limit

1) For installations commissioned according to the new EEG from June 2008.

2) The max value given for Germany is only available if all premiums are accumulated. This combines the enhanced use of innovative technologies, CHP generation and sustainable biomass use in a relatively small plant. This max value is rarely achieved.

Source: Evaluation of different feed-in tariff design options: Best practice paper for the International Feed-in Cooperation

Table 4 below summarises the advantages and disadvantages of FITs:

Table 4: Advantages and Disadvantages of FITs*

No.	Advantages	Disadvantages
1	The most successful policy to ignite a RE sector in terms of deployment.	Producers’ surplus
2	Spurs innovation and learning curves experience.	High costs passed onto consumers or the public purse.
3	Reduces risk through PPAs and price certainty.	Technology with the most attractive rates deployed and hence diversity is stunted.
4	Rapidly reduces RE generation methods to cost-competitive rates.	Not compatible to the market as electricity needs to bought independently from demand.
5	Guarantees investment security.	Unexpected surges in electricity supply that can become difficult for grid managers
6	Low administration costs.	The greater the capacity built, the great the cost to the consumer.

**This table has been created to summarise the body of literature above.*

b. *Capital Subsidies*

Capital subsidies are subsidies provided to fund the establishment and installation costs of RE infrastructure. This is necessary as the capital costs of RE is so high. These are one-off payments and have been the most widely used mechanism to start a RE sector (Boots, Martens, Schaeffer and Voogt, 1999; Martinot and Sawin, 2010). This can be at the various levels of involvement and can range between 30 to 50% (Finon, Lamy and Menanteau, 2001; Busch et al., 2007; Martinot and Sawin, 2010). This amount is calculated on either RE energy output, or more commonly on the installed capacity (Boots et al., 1999; Finon et al., 2001). Such subsidies are not without their drawbacks. The approval process for the subsidy may be long and cumbersome leading to delays in deployment. In addition, the subsidy needs to be accompanied by a selling capacity agreement in order to encourage efficiency and to ensure the power producer does not stop production abruptly. Finally, such subsidies are prone to withdrawal as political will shifts (Boots et al., 1999; Martinot and Reiche, 2000; Martinot and Sawin, 2010).

This has been a popular instrument for demand side management. Eskom in SA has made capital subsidies available for the installation of solar water heaters (SWH), in order to reduce the demand on the grid at peak times (Martinot and Sawin, 2010). In addition project subsidies for RE facilities was originally offered through the

Renewable Energy Fund and Subsidy Office (REFSO) (Edkins et al., 2010b). This mechanism has also been used in various states in the US for supporting the solar PV market (Martinot and Sawin, 2010).

Table 5 below summarises the advantages and disadvantages of capital subsidies:

Table 5: Advantages and Disadvantages of Capital Subsidies*

No.	Advantages	Disadvantages
1	Direct relationship between finance and capacity requirements.	Long approval periods.
2	Access to capital.	Administratively onerous.
3	Relies on the public purse and not the private sector for financing.	Susceptible to withdrawal with political shifts (climate politics).
4		No incentive to improve efficiency.
5		A capacity buying agreement is needed to lock producers in.

**This table has been created to summarise the body of literature above.*

c. *Fiscal Incentives*

(The following mechanisms have been grouped together under the banner of 'fiscal incentives': Investment tax credits; sales tax or VAT exemptions; direct energy production payments or tax credits; direct public investments or financing).

Various fiscal measures can be used to spur a RE sector. One such measure can be applied to the taxation of the venture. Exemptions or rebates on taxes are one way of doing this. This can be done through an energy tax, the corporation tax or even on the income tax (Jansen, 2003). This can be applied through lower VAT rates, tax refunds or by allowing more attractive depreciation schemes (Jansen, 2003). This application can either be on the production side of the venture or the investment side. By way of example, France has a 50% income tax credit for RE generation and Australia has an AUD 8/watt rebate (Martinot and Sawin, 2010).

Another tax incentive scheme has been the internalisation of the external costs of GHG emissions from traditional generation methods (Jansen, 2003). A method of doing this has been by green taxes, where green energy generators have been exempt from them. This leads to a decrease in the cost gap between renewable and non-renewable sources, thus giving an incentive to develop more renewable generation capacity. This method is hindered by the non-uniform application of taxes in liberalised markets, e.g. in the EU (Jansen, 2003). The main issue is that agreement cannot be reached on the tax levels, due to conflicting industry pockets and political drivers. For example, a risk lies in the fact that this could detract from EU products to the USA or Japan, due to internalisation of these external costs (Boots et al., 1999).

Production payments, also known as premiums, are a fixed price per kilowatt hour (Martinot and Sawin, 2010). This is a payment made to the producer for energy generated through renewable resources. The additional revenue helps close the funding gap for the RE generation scheme. Countries like India and the USA employ such production payments (Martinot and Sawin, 2010).

Another form of tax that is very topical at present is the carbon tax. Carbon taxes, which are applied to the amount of carbon dioxide being produced (output), seek to reduce the investment in traditional generation methods like coal (Basterfield et al., 2007; Pegels, 2010). Carbon tax emissions are aimed more at reducing GHGs, but can be seen as another mechanism for raising funds for RE projects, directly or indirectly as producers seek greener methods for their core activities (Jansen, 2003). This is a direct tax on producers and this increases the price of electricity. This price increase is passed onto the consumer (Pegels, 2010). In a country with a monopolistic utility, like Eskom in South Africa, a carbon tax would not entice the utility to seek greener generation methods and thus the consumer would ultimately suffer. An alternative to a carbon tax on output would be a cap-and-trade system. Here licenses for emitting carbon dioxide are auctioned off with a “cap” or “ceiling” for the maximum allowable emissions and these licences can be traded between emitters (Basterfield et al., 2007; Pegels, 2010). This not only raises revenue, but also incentivises emitters to use greener methods for their processes. Such a system relies on a financial sector that can handle the technicalities of such a system and also has enough players to sustain it (Pegels, 2010). In addition, such a system is classified as a market based instrument, even though the licenses and caps are dictated by regulation and the trade element is governed by legislation (Basterfield et al., 2007).

Investment subsidies are the oldest and most widely spread mechanism for promoting RE sector growth (Daniels et al., 2003). This is one manner of introducing non-competitive technologies into a market and can be used to support the FIT and TGC mechanisms (Daniels et al., 2003). Various constituencies have established special funds geared to RE generation establishment. These include direct financing, low interest loans or facilitation of the RE sector through auxiliary services e.g. education, research or standards formulation (Martinot and Sawin, 2010).

Table 6 below summarises the advantages and disadvantages of fiscal incentives:

Table 6: Advantages and Disadvantages of Fiscal Incentives*

No.	Advantages	Disadvantages
1	Good support for other RE policies.	Success depends on how liberated the energy market is in the particular country.
2	Auxiliary industry investment potential.	Onerous on administration of monitoring procedures to ensure producers are adhering to conditions of incentives.
3	Protects non-competitive technology.	More expensive RE technology is often discarded as margins are reduced.
4	Creates markets for trading across boarders.	Due to disagreement on levels of fiscal incentives across regions, industry competitiveness may be lost to other global regions.
5	Incentives to develop greener generation methods.	No long term vision can see funds/incentives withdrawn, leading to a stunted growth in the RE sector.

**This table has been created to summarise the body of literature above.*

d. *Net metering*

Net metering involves the selling off of excess electricity back to the utility company (Faden, 2000). Net metering allows people who have installed renewable energy equipment to reduce the cost of the installation by selling any excess generated electricity (Faden, 2000). This is especially applicable to, but not limited to, roof mounted PV installations. In principle, the generated electricity is off-set against the electricity used in the installation. This is generally of a small scale, but way is being made to incorporate larger installations. Indeed, the amount of installations qualifying for net metering was previously capped in the California, USA, but is being revised as capacities are reached (Martinot and Sawin, 2010). Net metering allows consumers to be customer-generators and the benefits include reduced GHG emissions, improved health, economic stimulation and reduced dependence on energy imports (Faden, 2000). Net metering is still in its infancy, with laws being developed to deal with excess generation, energy credit ownership and communally controlled installations (Martinot and Sawin, 2010).

Globally, net metering has only been deployed in 10 countries and within 43 US states (Martinot and Sawin, 2010).

Net metering is also envisaged to gain in popularity as building codes are revised to mandate the installation of solar PV on new construction projects (Martinot and Sawin, 2010). This policy will have to be phased out as technology costs become competitive and revised building codes make such installations mandatory. However, for the time being, net metering is a good policy incentive for demand side management and for increasing energy security, by allowing consumer generation.

Table 7 below summarises the advantages and disadvantages of net metering:

Table 7: Advantages and Disadvantages of Net Metering*

No.	Advantages	Disadvantages
1	Allows consumers to off-set their energy use and reduce the installation costs by selling into the grid.	Caps on capacity reduce mass deployment.
2	An increased degree of energy security.	Excess feed into the grid, may become a financial burden on public purse or the utility.
3	Small scale, with growing economies, can help decentralise electricity production.	High initial capital investment needed which may be a large barrier for some consumers, especially in developing countries.
4	Incentive to build new structures with included RE generation capacity, as opposed to retro-fitting	Very few countries have deployed this policy.
5	Reduced demand on national grid capacity.	Administration and regulation is onerous.

**This table has been created to summarise the body of literature above.*

2.3.2 *Quota Driven Policy*

a. ***Renewable energy portfolio standards (RPS)***

RPS is a quota based policy that regulates the increased quantities of electricity generation from renewable resources or the amount of electricity to be bought from

RE generators. Generally, this obligation lies on the producer and set on energy output and not capacity (Berry and Jaccard, 2001; Faber et al., 2001). RPS is also known as Renewable Energy Standard (RES) in the USA and Renewables Obligation (RO) in the UK (Martinot and Sawin, 2010). Once again these can exist at various levels and sets targets for the amount of electricity to be generated from renewable energy sources. The targets typically range between 5 and 20% and have a deployment timeframe constraint (Martinot and Sawin, 2010). RPS targets set out the size/capacity required and this indicates the amount of investment needed (Martinot and Sawin, 2010). The design of an RPS system seeks to incentivise RE producers to drive costs down, improve efficiency, reduce the level of government involvement and also links environmental targets to the regulated market (Berry and Jaccard, 2001).

RPS policy has been popular in the USA and UK, but results in terms of effectiveness and means for reaching these quotas varies across countries (Martinot and Sawin, 2010). In The USA, RPS systems have been used in combination with Production Tax Credits (PTC), a fiscal measure, but when the tax credits were removed, the RPS was not sufficient on its own to spur the large growth in capacity. This suggests that a RPS is a policy instrument that needs to be used in combination with other incentive mechanisms.

Table 8 below summarises the advantages and disadvantages of RPS:

Table 8: Advantages and Disadvantages of RPS*

No.	Advantages	Disadvantages
1	Less onerous on authorities to provide funding.	Varied success across countries. No consistency.
2	More applicable in developed countries where energy markets have been liberalised.	Developing countries, with monopolies on electricity production may not have the finance or capacity to meet these targets.
3	Increases competition.	Expertise may be lacking and require new skills to be imported to the country
4	Increased efficiency.	Cannot be used as a standalone policy instrument.
5	Increased innovation.	

**This table has been created to summarise the body of literature above.*

b. *Tradable Green Certificates (TGCs)*

TGC’s are quantity driven incentives on the demand side (Faber et al., 2007). TGCs were started in the Netherlands (Daniels et al., 2003). Government sets the targets (usually through law) for RE generation capacity or consumption and then the generator, wholesaler, retailer or consumer is obliged to meet these production or consumption targets (Faber et al., 2001). Where FITs fix the price of the tariff, such quota systems fix the quantity of electricity to be produced or consumed using RE (Pegels, 2010). For each unit of ‘green electricity’ produced, a certificate is issued to the producer or consumer (Boots et al., 1999). These certificates serve two purposes: to audit the amount of green electricity produced and secondly to establish the independent (to the electricity) market for tradable green certificates (Boots et al., 1999). A market for TGCs is established where these issued certificates can be traded and where market forces dictate the price of the certificates. This establishes two potential revenue streams for the producers: from the ‘green’ electricity sold and from the trade of the TGCs (Boots et al., 1999; Faber et al., 2007). Technology types are not differentiated as it would not be realistic to create separate technology markets for the different certificates (Faber et al., 2007).

Each TGC represents a set amount of produced electricity, measured in kWh or MWh. The obligation to present a set amount of TGCs may be imposed on the producer or even the consumer in a certain time period (Boots et al., 1999). Generally, this period is set to a year. If at the end of the year, the obligation is not met, a penalty is imposed on the obliged party (Boots et al., 1999). This penalty incentivises consumers to buy certificates from generators and thus the certificates become valuable. As the value and demand for these certificates increases, the supply of green electricity increases and thus the long term price of RE electricity will decrease to cost-competitive levels (Boots et al., 1999). TGCs are seen as a cost-competitive mechanism for meeting high level renewable energy targets.

Issues to be considered under this mechanism include:

- How will the certificates be regulated? A system to number and monitor the issue of certificates needs to be established. In addition, institutions need to be established to provide transparency for handling the system of certificates.
- Agreement on which RE technologies will have TGCs issued. For example does large scale hydro electricity qualify for TGCs as it is a mature technology, requiring no support?
- The time validity of the certificates. When do they expire?
- The level of the penalty for missing set targets. With certificate prices dictated by market forces, the penalty price should be set above this moving target to ensure the obligated party is incentivised to meet targets.
- Who will the certificate system be applied to? Actors need to be clearly defined.
- Does the local market have sufficient generators and consumers to support such a system?

(Daniels et al., 2003)

The above suggests that using a TGC policy to spur the RE sector introduces a number of additional considerations that make the administration and success of such a system more onerous.

TGCs do not differentiate between technologies and hence the cheapest technology will be used by producers (Boots et al., 1999). This suggests a pitfall of the TGC system. Generators will deploy the cheapest technology, which is usually the most mature e.g. hydro and / or wind. This stunts the investment in innovation for the less mature technologies like PV. So from an innovation perspective, TGCs do not support cost-competitive development of newer, less mature technology.

The demand for TGCs can also be driven on a voluntary basis (see Green Pricing below) or through fiscal incentives as discussed above.

Table 9 below summarises the advantages and disadvantages of TGCs:

Table 9: Advantages and disadvantages of TGC*

No.	Advantages	Disadvantages
1	Competition between producers is encouraged, leading to efficiency.	Markets too thin to allow true market forces to shape the price of the certificates. Fewer active players lead to higher prices and hence risk. Risk is equated to higher financing costs and possible shelving of projects.
2	An additional source of revenue for producers.	Difficulties in measuring and monitoring the certificates. Administratively onerous, requiring independent organisations. May even lead to corruption.
3	Creates a secondary industry within the financial markets.	Diversification of RE technology deployment is not encouraged as producers opt for the cheapest RE generation method.
4	TGC are tradable across borders.	Not enough countries produce enough certificates to make international trade viable at this stage
5	Promotes least-cost generation methods, and thus reduces the cost on society.	Technologies in their early stages are neglected and thus their development is stunted.
6	High economic efficiency.	Volatility in revenue. Less certainty for investors on future prices, as market forces determine the price of the certificates.
7		Certificate supply issues. Certificates may be withheld until market prices increase.
8		If penalties are not high enough, obligated parties may just pay the penalty and RE deployment targets may not be met.

**This table has been created to summarise the body of literature above.*

c. *Bidding/Tendering Systems*

Another demand side quota policy is to cap the capacity for RE generation and allow investors to bid/tender publicly for that generation capacity (Martinot and Sawin, 2010). Bidding/tendering may form part of a RPS system or can be managed by the government bypassing the utility. RE generators are invited to bid/tender for a set financial budget or capacity for RE generation. This mechanism aims to allow the most cost effective bidder to be awarded the generation capacity (Boots et al., 1999). Bidders are invited in for each technology band and the lowest bid per kWh is sought. This encourages competition between RE generators. Successful awards in effect work like a FIT system, where the successful generator/investor receives a guaranteed rate (kWh) for the electricity produced (Finon et al., 2001). The terms and conditions are presented in the Power Purchase Agreement (PPA) as per the FIT system. Finally, an obligation is set on the distributors, wholesalers or retailers of the electricity to buy the generated electricity from the successful bidders (Finon et al., 2001).

While this instrument has provided economically cost efficient prices, there are other issues that are introduced (Faber et al., 2001). These include bidding success rates are low; the successful bidder has a limited timeframe to implement the project and the project can run into planning issues due to local stakeholder objections and finally successive bidding rounds do not clarify which technologies will be favoured (Boots et al., 1999). Finon et al (2001) add that due to the lower rate per kilowatt-hour, the installed capacity is limited and the profitability is uncertain on submitted bids with the bidder carrying all the development costs. The increased risks and the reduced profit margins make this instrument less successful to large RE deployment in comparison to the price certain instrument of the FIT (Finon et al., 2001). Simply put, the risks are too large to entice investors to establish RE generation projects.

Such policies have been used in the UK with its Non Fossil Fuel Obligation programme (NFFO) which was started in the early 1990s and then replaced with the Renewable Obligation (RO) in 1997 (Daniels et al., 2003; Kelly, 2007) ; China’s wind power concession and also Brazil‘s *O Programa de Incentivo às Fontes Alternativas de Energia* (PRONIFA) (Boots et al., 1999; Martinot and Sawin, 2010). Subsequently, these programmes in the UK and China have evolved into FITs and TGCs (Martinot and Sawin, 2010).

Table 10 below summarises the advantages and disadvantages of bidding/tendering:

Table 10: Advantages and disadvantages of Bidding/Tendering Systems*

No.	Advantages	Disadvantages
1	Competition among bidders drives the price of the generation method down, avoiding expensive cost to the consumer.	A long process with no surety of success. Risk increases and hence drives financing costs up.
2	PPA agreements give generators/investors comfort that projects can be progressed to implementation phase.	Opposition by local stakeholders can shelf a project, with large sunk development costs.
3	Lower burden on the consumer/public purse.	Technology evolution may see previous bids becoming unviable.
4		Limited success globally.
5		Low capacity growth.
6		Developers carry the large costs with little to no certainty that their scheme will be successful.

**This table has been created to summarise the body of literature above.*

d. *Green Pricing*

Green pricing falls under the quota driven banner. This is more of a voluntary mechanism that needs policy support, like tax exemptions (Martinot and Sawin, 2010). This is where consumers are willing to pay a surplus for their electricity in order to promote RE generation (Finon et al., 2001). The surplus paid is then channelled into RE infrastructure. Three main ways of green power purchasing exist. The first is through the green pricing by utility companies. The second is through competitive retail pricing by third-party generators, which is made possible through liberalised energy markets. Finally, through the voluntary trade of RE certificates. An important element of this mechanism is that the green electricity needs to be certified and adds an extra layer of administration. In the EU, the Guarantee of Origin (GO) certificate fulfils this requirement, yet this has not been implemented uniformly across the union (Martinot and Sawin, 2010). Green electricity is supplied by generators to meet the demand of their customers for green electricity and also to act as a point of differentiation to their competitors (Finon et al., 2001). This differentiation is only needed within a liberalised energy market, where competition for customers is a driving force (Finon et al., 2001). This is the case in the EU, The USA and Australia (Martinot and Sawin, 2010).

Green electricity purchasing has been around since the 1990s and currently worldwide there are 6 million customers (Martinot and Sawin, 2010). This was initially led by the Netherlands (2005 to 2008) and was promoted through a tax on fossil fuel and tax exemptions on green electricity (Martinot and Sawin, 2010). Subsequently, this lead has been reduced due to the withdrawal of the tax and the exemption (Martinot and Sawin, 2010). In The USA, various states require utilities to offer green electricity to their customers (Martinot and Sawin, 2010) and large American companies involved with aerospace, computer hardware and food manufacturing organisations are voluntarily purchasing green electricity. This suggests a move to market themselves as environmentally conscious and in anticipation of the introduction of carbon taxing.

While Longo, Markandya and Petrucci (2008) have presented a paper suggesting that consumers in localised areas are willing to pay higher prices for electricity to internalise the external costs of traditional electricity production, this is not a globally applicable attitude. Voluntary green electricity purchases by consumers have not always achieved the targets set by policy makers, as consumers are not prepared to pay for the polluters emissions (Boots et al., 1999). The principle of ‘free-riding’ is also prevalent here, where individuals are not prepared to pay more for green electricity for the greater good, as not all consumers are willing to pay this higher rate (Finon et al., 2001). This suggests that such policy is not the most effective in encouraging growth in the RE sector.

It can also be added that TGCs (above) and green pricing have various synergies and can be included under one banner.

Table 11 below summarises the advantages and disadvantages of green pricing:

Table 11: Advantages and Disadvantages of Green Pricing*

No.	Advantages	Disadvantages
1	Helps spur lower prices and innovation in liberalised energy markets where generators are competing for customers.	Withdrawal of exemptions can stunt the RE generation sector growth.
2	Compatible with TGC's.	Reluctance of consumers to bare the polluters cost through higher green electricity costs.
3	Lower burden on the consumer/public purse.	Certifying that consumed electricity is indeed green can be onerous. Corruption can be experienced.
4		Relies too heavily on cultural mind sets that buying green is the right thing to do. These increased costs may not be viable in developing economies.

**This table has been created to summarise the body of literature above.*

2.3.3 *Summary of Current RE Policies*

The available RE policy frameworks have been discussed above. Various countries, states and provinces have adopted one or more of these to spur their RE sector. It is also important to note that RE polices can be used in combination as has been mentioned above, e.g. in the USA the use of RPS with Production Tax Credits, a fiscal instrument. It is also worth noting that RE policies can evolve as the sector matures. This is discussed in the next section.

Table 12 summarises the policies employed in the countries that have instruments in place to help support their RE sector. The table has been included to show the reader that over 80 countries have shown interest in this field and hence adopted an RE policy. In addition, from the table it can be seen that both developed and developing economies are forging a way in this area, for example, the small African Island Mauritius has fiscal policy to stimulate investment in a RE sector. Finally, the table also highlights the fact that various policy mechanisms can be used in combination and hence they are not mutually exclusive. For example, Algeria has chosen a FIT, yet also offers various tax based fiscal incentives. Further countries current RE promotion policies are contained in Table 12 below:

Table 12: Renewable Energy Promotion Policies

Country	Feed In Tariff	RPS	Capital Subsidies, Grants, rebates	Investment or other tax credits	Sales tax, energy tax, excise tax, or VAT reduction	TGC	Energy production payments or tax credits	Net metering	Public investment, loans or financing	Bidding/ Tendering
EU – 27										
Austria	X		X	X		X			X	
Belgium		(*)	X	X	X	X		X		
Bulgaria	X		X						X	
Cyprus	X		X							
Czech Republic	X		X	X	X	X		X		
Denmark	X		X	X	X	X		X	X	X
Estonia	X		X		X		X			
Finland	X		X		X	X	X			
France	X		X	X	X	X			X	X
Germany	X		X	X	X			X	X	
Greece	X		X	X				X	X	
Hungary	X		X	X	X				X	X
Ireland	X		X	X		X				X
Italy	X	X	X	X	X	X		X	X	
Latvia	X				X				X	X
Lithuania	X		X	X	X				X	
Luxembourg	X		X	X	X					
Malta			X		X			X		
Netherlands			X	X	X	X	X			
Poland		X	X		X	X			X	X
Portugal	X		X	X	X				X	X
Romania		X			X	X			X	
Slovakia	X			X	X				X	
Slovenia	X		X	X	X	X			X	X
Spain	X		X	X	X	X			X	
Sweden		X	X	X	X	X	X		X	
UK	X	X	X		X	X			X	
Other developed countries										
Australia	(*)	X	X			X			X	
Belarus									X	
Canada	(*)	(*)	X	X	X			X	X	X
Israel	X				X					X
Japan	X	X	X	X		X		X	X	
Macedonia	X									
New Zealand			X						X	
Norway			X		X	X			X	
Russia			X			X				
Serbia	X									
South Korea	X		X	X	X				X	
Switzerland	X		X		X					
Ukraine	X									
United States	(*)	(*)	X	X	(*)	(*)	X	(*)	(*)	(*)

Developing Countries	Feed In Tariff	RPS	Capital Subsidies, Grants, rebates	Investment or other tax credits	Sales tax, energy tax, excise tax, or VAT reduction	TGC	Energy production payments or tax credits	Net metering	Public investment, loans or financing	Bidding/ Tendering
Algeria	X			X	X					
Argentina	X		X	(*)	X		X		X	X
Bolivia					X					
Brazil				X					X	X
Chile		X	X	X	X				X	X
China	X	X	X	X	X		X		X	X
Costa Rica							X			
Dominican Republic	X		X	X	X					
Ecuador	X			X						
Egypt					X					X
El Salvador				X	X				X	
Ethiopia					X					
Ghana			X		X				X	
Guatemala				X	X					
India	(*)	(*)	X	X	X	X	X		X	
Indonesia	X			X	X					
Iran				X			X			
Jordan					X			X	X	
Kenya	X			X						
Malaysia									X	
Mauritius			X							
Mexico				X				X	X	X
Mongolia	X									X
Morocco				X	X				X	
Nicaragua	X			X	X					
Pakistan	X							X		
Palestinian Territories					X					
Panama							X			
Peru				X	X		X			X
Philippines	X	X	X	X	X		X	X	X	X
Rwanda									X	
South Africa	X		X		X				X	X
Sri Lanka	X									
Tanzania	X		X		X					
Thailand	X				X				X	
Tunisia			X		X				X	
Turkey	X		X							
Uganda	X		X		X				X	
Uruguay		X								X
Zambia					X					

Notes: Entries with an asterisk (*) mean some states/provinces within these countries have state/province-level policies but there is no national-level policy. Only enacted policies are included in the table; however, for some policies shown, implementing regulations may not yet be developed or effective, leading to lack of implementation or impacts. Policies known to be discontinued have been omitted. Many feed-in polices are limited in scope or technology. Some policies shown may apply to other markets beside power generation, for example solar hot water and biofuels.

Source: Renewables 2010 Global Status Report. (Martinot and Sawin, 2010)

From the literature review above, it is clear that a number of instruments exist to help a RE sector grow. For the purposes of this research report, only the most popular and successful ones will be included in the model. Table 13 groups these various policies together and these will form the policy nodes in the FCM:

Table 13: Policy Nodes for FCM*

Policy Node no.	**Instrument**	**Reason/Notes**
1	FITs	This has been the most successful in creating growth in a RE sector.
2	TGC	Green Pricing will form part of this instrument as they follow similar principals.
3	RPS	This mechanism has been largely deployed in The USA and UK.
4	Bidding / Tender	Uses market forces to drive down the cost to society.
5	Fiscal	Fiscal and financial incentives are viewed as secondary mechanisms for supporting the RE sector (Daniels et al., 2003). For this reason all the aforementioned fiscal incentives will be grouped together. This will include: capital subsidies, Investment tax credits; sales tax or VAT exemptions; direct energy production payments or tax credits; direct public investments or financing.

**This table has been created to summarise the body of literature above.*

Note that net metering has been excluded. This research is concerned with large grid-connected schemes and net metering does not meet this delimitation.

2.3.4 *Evolution of Renewable Energy Policy*

The incentives and/or policies that are offered to ignite the RE sector of a country are not sustainable in the long run. These mechanisms place financial strain on the economy and end user, and they need to evolve as the sector matures. This maturity is coupled with technological advances, with RE generation reaching a cost-competitive plain with traditional generation methods (Finon et al., 2001; Daniels et al., 2003; Pegels, 2010). Experience from the EU shows that RE policy has evolved as the sector has matured and/or government targets have been met. For example, in the UK, up until 2002, a bidding/tender instrument was employed and due to government targets not being met, the TGC system was instated (Faber et al., 2007;

Kelly, 2007). This suggests, that once a country has chosen a RE policy, it does not mean that this will be set forever.

In addition, there are various ways of designing a chosen instrument. For example FIT designs can vary from country to country, tailored to the regional conditions. The level of support through the tariffs may differ across regions and indeed the choice of technology can differ depending on the most abundantly available RE resource. In the EU, 20 of the 27 member states have deployed a FIT policy (Busch et al., 2007). Of these, Spain, Denmark, Estonia, Czech Republic, The Netherlands and Slovenia pay a premium tariff for the electricity produced. Denmark, however, only apply the premium tariff, to onshore wind (Busch et al., 2007). This serves to illustrate how a commonly deployed high level policy may vary in its regional applicability.

Figure 2 shows how some of the EU member states have evolved their policies over period of a decade. This figure is included to show a time referenced evolution of RE promotion policy in the EU, where much of this sectoral development has occurred and this is useful to illustrate policy effectiveness. In chapter 4, it will be shown how Denmark established a mature RE sector over 40 years and how this was done by moderate changes to their FIT system. In contrast it will also be shown that The UK, promotion policy changed from a bidding/tendering system to a quota based system in the early 2000s, bringing mixed results. Again, this is illustrated in chapter 4.

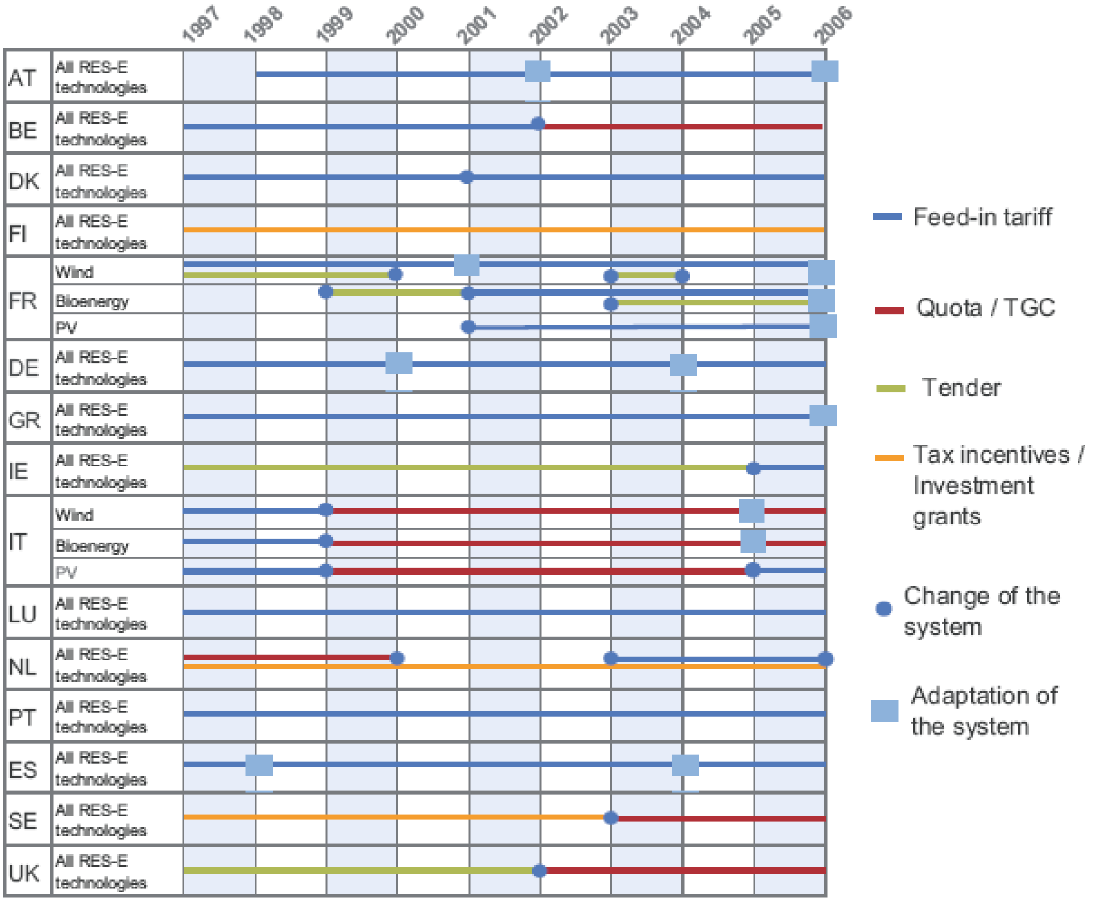

Figure 2: Evolution of the Main Policy Support Schemes in EU-15 Member States

Source: Feed-in tariffs and quotas for renewable energy in Europe (Faber et al., 2007)

2.3.5 *Conclusions*

Specific policy designs vary and evolve, from region to region. Evolution depends on the level of sector maturity, technological cost-competitiveness and the attainment of set capacities. For the purpose of this research report, one must be conscious that this is a common feature of RE policy. However, for the sake of this research report and model, the nuances of design difference of a common high level policy will not be investigated. In addition, the evolution of one policy type to another will only be modelled by switching different policy nodes on and off, by running the model separately.

2.4 Part 2: An overview of current available RE technologies

In order to provide a more holistic picture of the RE sector, this section seeks to explain what technologies exist and the constraints that drive their deployment. From the above section, it is suggested that technology plays a vital role in policy choice and its deployment. Examples are also be referenced, to show where they have been deployed globally. In addition, market figures are referenced to show how capacity has grown. The choice of renewable energy is dependent not only on policy measures, but on what type of renewable energy sources are available to that specific country and hence forms a major constraint. For example, a small island country like Mauritius may have an abundance of wind and solar energy, but the energy need may not warrant large scale solar and wind farms. Similarly, a water rich country, with low radiation levels like Norway may opt for hydro installations which are considered a mature technology with no policy mechanism to support mass deployment. So for this reason, aligning the technology choice and country specific conditions are crucial.

The following sections are subdivided into the large generic renewable resources and the types of technologies that can harvest electricity from each are briefly explained. Bio-resources are mentioned, as they are used to generate electricity, however, biofuels are excluded as they are mainly used in the transportation sector. This is not intended to be a full technological and market review, but to provide a brief background for the reader.

2.4.1 *Solar*

Solar energy uses the energy of the sun to generate electricity. Intuitively, such generation methods are only favourable in regions with good solar resources (Fluri, 2009; Edkins et al., 2010b). Dependency here is on the availability of sun and not the intensity. The choice of solar generation is dependent on this. There are two broad categories.

a. *Solar Thermal*

Solar thermal plants rely on the heat of the sun to generate electricity. The sun's radiation is used through thermal dynamic properties to convert it to electricity (Busch et al., 2007). This can be done through parabolic troughed mirrors or through a central receiver. The sun's heat is focused onto a fluid device (usually oil) that is heated and in turn used to boil water to create steam that drives a traditional turbine system (Busch et al., 2007; Fluri, 2009).

This method relies on the availability of water to create the steam and hence a water supply is essential for this method (Fluri, 2009). In addition, thermal energy is not constant throughout the year/day and hence a storage component of the system is necessary that keeps the system primed for when the radiation levels return. Typically storage facilities range between 6 and 8 hours (Fluri, 2009).

Concentrated Solar Power (CSP) was first deployed in The USA in the 1980s on an experimental basis (Edkins et al., 2010b). Until 2004, less then 300MW of global capacity existed (Edkins et al., 2010b). Favourable policy has seen planned investment increase to 8000MW in Spain and The USA (Edkins et al., 2010b). Technology developments are seeing dish shaped systems that rely on greatly reduced water requirements that make this technology more of an option for very arid areas (Martinot and Sawin, 2010).

b. *Photovoltaic (PV)*

Photovoltaic technology is made up of cells that convert solar radiation into direct current (Busch et al., 2007). The use of semiconductors and the principle of the photoelectric effect are used to generate a current (Busch et al., 2007). PV technology relies on ultraviolet levels and not the heat of the sun.

Both large and small scale PV installations exist around the world. Small scale (<1MW) include household and rural installations needed to meet localised energy demand, while large scale (>1MW) installations are grid connected where electricity is fed into the national system. Policy differentiates between large and small scale installation in order to show where financial support/incentive is applicable. For example, in SA, PV installations greater then 1MW qualify for the FIT (NERSA, 2009).

In 2008, over 10GW of PV capacity was added globally (Edkins et al., 2010b). Germany was the leader with an installed capacity of 5.3GW (Edkins et al., 2010b).

2.4.2 *Wind*

Wind technology converts the kinetic energy of the wind into rotational energy (mechanical energy and then electrical energy) that is used to drive a generator (alternator), through the rotation of the turbine blades (Busch et al., 2007). Wind generation methods are location specific and where the deployment of the technology relies more on the low variance of wind, rather than the intensity of wind. For example, wind resources are higher in coastal regions then inland, leading to lower production costs (Finon et al., 2001).

Wind electricity generation is one of the most mature technologies in the RE sector and has a relatively quick deployment time (on average of two years) (Edkins et al., 2010b). This technology is widely deployed globally and gaining in popularity in developing economies like China and India. The wind energy sector has grown in both the manufacture of wind turbines as well as the installation and operation of large wind farms (Edkins et al., 2010b). Globally, utility companies and well backed IPPs have dominated this market. Prior to 2008, the EU had the largest installed wind capacity in relation to other technologies. Subsequently, China and The USA have surpassed this in terms of growth rates (Edkins et al., 2010b). The successful deployment of wind generation capacity in the EU and USA have been through clear government policy support (Edkins et al., 2010b).

Two types of large scale wind generation methods exist.

a. ***Onshore***

Onshore wind has seen the most significant deployment. These are installations installed on land.

b. *Offshore*

Offshore installations are set in water, and mostly in coastal regions where wind levels are higher (Busch et al., 2007). Due to difficulties in connecting offshore wind locations to electricity grids and the perceived unsightly nature of the turbines, the cost to deploy them offshore has been limiting in comparison to onshore. The additional costs have made onshore more favourable. However, offshore wind farm installations are gaining momentum as onshore sites with good wind resource are diminishing (Martinot and Sawin, 2010).

2.4.3 *Water*

For the purposes of this report, all water based renewable energy generation methods will be grouped together. Water, both onshore and offshore can be used to generate electricity. The following categories exist:

a. *Hydro*

Hydro electric can be classified as one of the most mature renewable energy sources (Faber et al., 2001) Hydro plants exist on river courses or regions that have abundant supplies of water. Such schemes have been in existence for many centuries and have become cost competitive in modern times with traditional methods of electricity generation and hence rarely qualify for policy support (Faber et al., 2001; Busch et al., 2007). Hydro can also be divided into large scale and small scale installations. In the EU large scale hydro has a threshold of >10MW installed capacity (Busch et al., 2007). Hydro power uses potential or kinetic energy of water to generate electricity (Busch et al., 2007). Hydro power can be further divided into two types of systems: storage and run-of-the-river systems (Busch et al., 2007). Storage systems use reservoirs that dam up water that is released when needed. The kinetic energy released during the flow is used to turn hydro turbines and generate electricity (Busch et al., 2007). It is the difference in altitudes that allows this generation to take place. There is another type of storage system, called a pump storage scheme. Here water is pumped back (recycled) to an upper reservoir using off-peak electricity and released when on-peak demand for electricity is needed (Busch et al., 2007). The pumping stage of this system uses electricity from the grid and is not considered renewable globally (Busch et al., 2007). On the other hand run-of-the-river systems do not store water and use the continuous flow of water to turn turbines to generate electricity. This method relies on the continuous flow of the river and its capacity to generate electricity is directly related to water levels in the system (Busch et al., 2007).

The differentiation between large and small scale hydro schemes is an important one. Hydro power has been in existence for many centuries, being used for example to grid wheat in pre-industrial revolution times. This technology has been adapted to generate electricity in large dam projects and is considered a mature technology as it is cost-competitive with fossil fuel electricity generation. In addition the investment and implementation timeline, notwithstanding the environmental impacts, are large and for this reason, such schemes do not receive policy support under the RE sector (Faber et al., 2001). The EU large hydro power schemes have been mostly depreciated and hence do not need support (Busch et al., 2007). On the other hand, small hydro plants (EU <10 MW) receive policy support, as few exist and are encouraged for localised generation capacity (Busch et al., 2007).

b. *Tidal*

Offshore water resources are also used to generate electricity. Two methods can be used to harness this resource: tidal barriers and tidal currents (Faber et al., 2001; Busch et al., 2007). Under tidal barriers, the property of tides (rise and fall of sea level) is used to store up sea water in a reservoir barriered by a barge. When tides fall, this water is released and used to drive a turbine as in hydro schemes (Busch et al., 2007). The second method, tidal current, uses underwater currents to drive turbines, similar to wind generation schemes (Faber et al., 2001; Busch et al., 2007). Marine energy is 25 years old, yet tidal current technology is still in the development phase and has not been deployed as widely as other RE technologies like wind and solar (Lynch, 2010). A demonstration facility exists near Orkney, Scotland, where underwater twin bladed turbines have been deployed into the sea (Lynch, 2010).

c. *Wave*

Wave energy can use either the energy of surface wave action or the changes in wave pressure to generate electricity (Busch et al., 2007). There are a number of devices that can capture this energy, but the two most popular are oscillating water columns and tapered channel systems (Busch et al., 2007). Oscillating water utilises a tube that is partially submerged. As water rises, the remaining air in the tube is pushed through a turbine (Busch et al., 2007). This is turn generates electricity. Such generation methods have been deployed in Scotland (Busch et al., 2007). On the other hand, tapered channels, use sea water that is forced into a channel to fill a reservoir that is located above sea level (Busch et al., 2007). As the water flows back down due to gravity, it is directed through a turbine that generates electricity (Busch et al., 2007).

2.4.4 *Bio – Resource*

Bio-resources can be classified into biomass and biogas. These are explained separately below:

a. *Biomass*

Biomass uses organic material that is living or recently harvested (Busch et al., 2007). This includes material for agriculture or forestry crops; dregs, from both vegetal or animals and biogenic portion of waste (Faber et al., 2001; Busch et al., 2007). It needs to be noted, that natural process also produce biomass, like geological pressures that transform organic material to coal, oil and natural gas (Busch et al., 2007). Such resources are classified as fossil fuels and do not form part of the biomass category (Busch et al., 2007).

Solid biomass is used to fuel steam production through the combustion process. This steam is used to produce electricity through traditional methods. In addition, biomass can be converted into biogas and used in a similar manner (see next section).

Biomass is considered carbon neutral (Busch et al., 2007). The process of producing the biomass extracts carbon dioxide from the atmosphere while it is growing. When the biomass is burnt, it produces carbon dioxide, thereby off-setting the carbon dioxide absorbed (Faber et al., 2001; Busch et al., 2007).

b. *Biogas*

Biogas is the gas produced through anaerobic digestion of organic material (Busch et al., 2007). This organic material comes from agricultural waste, sewage and also organic wastes from animals (Busch et al., 2007). Various types of gases are produced through this anaerobic digestion, that include methane (45-70%), carbon dioxide (25-55%) and others like nitrogen, oxygen and hydrogen sulphide (Busch et al., 2007). These gases are collected and burnt to generate steam and in turn electricity.

It is worth noting that biogas is more efficient then biomass in energy production (Faber et al., 2001; Busch et al., 2007).

2.4.5 *Geothermal Power*

Geothermal power uses the heat trapped in the ground to generate energy (Faber et al., 2001; Busch et al., 2007). As above, different technologies/processes can be used to harness this resource depending on the form of geothermal resource in an area. The first uses hydrothermal resources, which include hot water or steam. These are piped to the surface and used to drive a turbine to generate electricity or supply heat. In the second resource category, only heat trapped in rock formations exist. (i.e. no water or steam). Here Hot-Dry-Rock (HDR) technology is needed. This involves drilling two holes to depths of 4000m plus (Busch et al., 2007). Then water from the surface is pumped down through one hole, where it is heated and then through the second hole, the water is lifted back to the surface and used to generate electricity through a turbine. Hydrothermal technologies are already widely deployed, while HDR is only existent in a demonstration capacity, highly constrained by the depths needed to exploit the trapped heat (Busch et al., 2007).

Location and hence availability are key drivers for this type of generation. Thermal belts only exist is certain regions of the world and is currently deployed in countries like The USA, Italy, Mexico and Indonesia (Martinot and Sawin, 2010) . In addition, it is worth noting that such resources will deplete over time and debate exists to the classification of it being renewable. This falls more under the clean technology banner as it does not produce GHG. It has been included for illustrative purposes to show the range of technologies available.

2.4.6 *Other*

The above technology categories are the most popular. It does however, need to be noted that other developments and sectors that also form part of the RE technology sector. They have been excluded as they are either still in the development stage; used for off-grid functions or form part of efficiency management. Some of these are listed below:

- *Solar Water Heaters (SWH)* – this uses solar based technology to heat water and is mainly applicable at a domestic level. SWH installation has been encouraged by Eskom through their Demand Side Management Programme aimed at increasing energy efficiency (Edkins et al., 2010b). This technology is also encouraged in rural areas that are not grid connected and hence have support policies to realise this goal (Edkins et al., 2010b).

- *Cogeneration (or Combined Heat and Power CHP)* – traditional electricity generation produces heat as a by-product (Dincer, Le and Rosen, 2005). This is not just confined to electricity generation, and can include big industry like pulp and metal processing plants. It can also be extended to mechanical processes (Biezma and Cristóbal, 2006). Various technologies have been developed to capture this heat and use it for heating purposes or recycling the energy back into the process. Cogeneration is aimed at increasing efficiencies and utilising the heat by-product (Dincer et al., 2005). Cogeneration has formed part of policies to reduce GHG and has had various support mechanisms to help their development (Biezma and Cristóbal, 2006).

- *Pressure Related Osmosis (PRO)* – This technology was first developed in the 1950s and uses the principle of osmosis to generate electricity (Baker, Lee and Lonsdale, 1981). A permeable membrane separates two solutions with differing salinities. Pressure is applied to the solution with a higher salinity. Through osmosis the movement of water from low to high salinity increases the pressure. This pressure causes the liquid to flow and is channelled into a hydro turbine and thus generates electricity (Achilli, Cath and Childress, 2009). This is very new technology still under development and very few countries have policies that support their deployment.

2.4.7 *Conclusions*

Various technologies exist for generating electricity from renewable energy sources. Each is at a different level of maturity and cost-competitiveness. Hydro power is the most mature and hence most comparable in relation to the cost of fossil fuel generation methods, followed by wind and solar. A key component of RE policy is how it encourages the development and learning curve in innovation, aimed at driving these expensive technologies down to a cost-competitive plain. For the purposes of this research report, only the technologies of wind and solar are considered as these areas have seen the most deployment and technological advances.

The need to improve technology to drive costs down not only drives innovation investment, but also encourages the establishment of manufacturing sector for these technologies. Hence technology improvements have far reaching consequences that can spur economic development and secondary industries. Secondary industries relating to technology and manufacturing can include local skills and engineering training, maintenance needs and material inputs to make the value chain.

2.5 Part 3: Key Factors (drivers) in a RE Sector

In the preceding two sections, high level policy and technology has been discussed as key components to establishing a renewable energy sector. The above literature suggests that a number of factors exist that help shape the RE sector. These are extracted below.

2.5.1 *Other factors*

In order to simplify the factors suggested in the sections above, the factors can be grouped together under six broad categories: local energy constraints; encouraging renewable energy; local conditions; economics; financial and technology. These are tabled below.

a. *Local Energy Constraints*

Local energy constraints refer to the specific energy needs of a country/region and how these needs are driving the renewable energy sector. These are extracted in Table 14 below:

Table 14: Local Energy Constraints

Factor	Explanation	Reference
Diversification	The need to diversify the energy mix away from fossil fuels.	(Boots et al., 1999) (Basterfield et al., 2007) (Pegels, 2010)
Target Capacity	The need to reach the government or regional targets for RE capacity.	
Energy Cost	The need to consider the cost of RE in relation to existing electricity costs.	
Investment Potential	The need to consider the attractiveness of the market size and country specific conditions.	
Age of Existing Infrastructure	The need to consider how new/old the existing infrastructure is.	
Internalisation of Emissions	The need to consider the level of GHGs and how the local policy is incorporating this into the cost of energy.	

b. *Encouraging Renewable Energy*

This category pulls together factors for establishing a renewable sector that based on climate change. These are extracted in Table 15 below:

Table 15: Encourage Renewable Energy

Factor	Explanation	Reference
Environment	The need to protect the environment and preservation of common good items.	(Faber et al., 2001) (Finon et al., 2001) (Busch et al., 2007) (Basterfield et al., 2007) (Pegels, 2010)
Health	The need to recognise that GHGs increase health issues and to mitigate against them.	
Weather	GHGs are affecting global weather patterns and there is a need to reduce GHG emissions to reduce adverse weather. Changing weather patterns have implications of agricultural yield, induced natural disasters etc.	
Energy Security	The need to reduce reliance on imported fossil fuel based energy and to generate electricity locally.	
Market Liberalisation	The need to recognise that energy market liberalisation leads to increased efficiency and competition drives costs down.	

c. *Local Conditions*

This category groups together factors that relate to players involved with establishing a renewable energy sector and how their interaction drives deployment. These are extracted in Table 16below:

Table 16: Local Conditions

Factor	Explanation	Reference
Resistance	Change generates resistance especially when there are cost implications or loss of market share. Resistance can be from consumers bearing the higher energy costs or current generators having to invest in new generation methods or losing market share.	(Faber et al., 2001) (Edkins et al., 2010a) (Pegels, 2010)
Big Players	Depending on the level of liberalisation, monopolies or parastatals may influence the renewable sector and promote their own goals.	
Culture / Mindset	Acceptance of renewable energy generation depends on how accepting and aware local stakeholders are. This feeds into resistance.	
Administration / Bureaucracy	Onerous administrative hurdles may stunt the deployment of renewable generation capacity. The ease of establishing a RE sector is highly influenced by administrative authorities.	
Climate Politics	The goals of governing political bodies may have other national goals that cannot accommodate the growth of this sector. Increasing energy costs can be detrimental to political survival.	
International Opinion / Reputation	International pressure to meet global standards of sustainability which does not align with local policies can see exclusion from trade agreements and reputational damage. This may spur the investment in a RE sector.	
International Policy Agreements	Ratification of international initiatives to reduce GHG emissions and tackle climate change issues may call for deployment of cleaner technologies and thus spur RE.	

d. *Economics*

This category groups together the economic factors of the renewable energy sector. These are extracted in Table 17 below:

Table 17: Economics

Factor	**Explanation**	**Reference**
Employment	Establishing a new sector has various players in the value chain and this has job creation opportunities. Conversely, reducing the fossil fuel based generation sector, can lead to job losses.	(Daniels et al., 2003) (Edkins et al., 2010b) (Pegels, 2010) (Martinot and Sawin, 2010)
Economic Development	Energy is needed to run an economy. Energy is directly related to industry and economic growth. By deploying RE generation capacity, energy security is encouraged and hence the economy can rely on a more stable supply of energy in order to grow.	
Social Development	Access to energy drives up the standard of living and allows people to empower themselves to escape poverty.	
Skills Development	A new sector requires new skills. Deploying new technologies require a new skill set and the adaptation of existing local skills.	
Primary Industry	Existing industries can tailor their services and products to this industry. Additionally, new manufacturing sectors can be established to support the new sector.	
Services	Support services will also receive a boost. This can include legal, financial, advisory, consulting, technical, maintenance etc.	
Non-RE Sector	By establishing a new energy sector, the old energy sector will experience market share loss or the need to evolve their generation methods. Implications include job loss, closing of the concern etc. This can also affect the support services to this sector.	
Engineering Skills	Due to the high level of innovation needed in this sector and the new technicalities required to establish the sector, there is a causal relationship with engineering skills. Will the skills need to be imported and/or developed locally to reduce reliance on foreign supply?	

e. *Financial*

This category groups all factors that relate to financial aspects of the renewable energy sector. These are extracted in Table 18 below:

Table 18: Financial

Factor	Explanation	Reference
Cost of Capital	Renewable energy deployment requires large capital investments. Private sector involvement is a common trend. Depending on the level of risk associated the project the cost of capital can hinder deployment.	(Boots et al., 1999) (Daniels et al., 2003) (Pegels, 2010) (Martinot and Sawin, 2010)
Cost Competitiveness	Renewable energy cost is greater than traditional fossil fuel derived energy. Support is required to bring new technologies and installations to a competitive plain.	
Reliable Profits	The use of private sector and independent power producers need to see reasonable returns to attract their investment. This is major factor in realising RE deployment.	
Risk	The associated risks can be too large to warrant investment. Risk levels have a direct affect on the level of RE deployment.	

f. *Technology*

This category groups together technology related factors. These have been reviewed in depth above. These are extracted in Table 19 below:

Table 19: Technology

Factor	Explanation	Reference
Technology Innovation	The need to drive costs down and make newer technologies viable and drives innovation. This also creates a new industry.	(Busch et al., 2007) (Faber et al., 2007) (Pegels, 2010) (Martinot and Sawin, 2010)
Infrastructure	The issue of grid connection is a crucial one. The availability and willingness of utility companies to assist in connecting IPPs schemes to the national grid. In addition distance to grid is a crucial element.	
Maintenance	Renewable energy plants require less operational inputs and less maintenance compared to traditional power plants. The lower levels of maintenance can encourage the deployment of RE.	
Deployment Time	RE establishment follows shorter timelines and can see larger deployment compared to traditional generations plants.	
Solar	Solar technology is reaching maturity and deployment internationally is growing significantly. This is a common technology choice across countries developing RE capacity.	
Wind	Wind technology is reaching maturity and deployment internationally is growing significantly. This is a common technology choice across countries developing RE capacity.	

2.5.2 *Conclusions*

The factors (drivers) associated with a RE policies have been extracted above. It becomes clear that specific factors need to be considered when choosing or evolving a chosen policy instrument. The above factors need to be considered in the context of a region and no two regions will have identical needs. Broadly speaking, the above are the key factors that have influenced RE policy in countries with more mature RE sectors.

These factors (drivers) form part of the model that has been developed in this research report. It is envisaged that through iteration and model development, drivers could be combined or new drivers added.

2.6 Part 4: South African Energy Sector

This research project will be investigating the plausible future scenarios for the renewable energy sector in South Africa. This section reviews the current energy sector in SA and the fledgling renewable environment. The aim is to establish a context for the regional specific constraints that are shaping the local RE policy environment.

Since the initiation of the research report in late 2010, various developments in the SA RE sector have created the need to update this section and delineate the historic developments. Therefore section 2.6.4 looks at the pre-August 2011 SA RE developments and section 2.6.5 reviews the recent developments (post Aug 2011). Very little academic published literature exists at the time of writing (Dec 2011) and hence most reference is made to media resources.

2.6.1 *Energy Sector of South Africa*

Eskom is the parastatal electricity utility company of SA. Eskom was established in 1923. It supplies over 95% of SA's electricity requirements (40.1 GW), with the balance coming from Independent Power Producers (IPP) (2.8 GW) (Eskom, 2009). The current forecast for peak load is 36 GW. This leaves a current margin of 20%. 90% of the electricity produced comes from coal (Edkins et al., 2010b). Due to this high percentage of primary energy generation coming from coal, this makes SA, Africa's largest emitter of Greenhouse Gases (GHG) (Basterfield et al., 2007).

Eskom is remitted to manage all aspects of supplying SA with electricity and these responsibilities include generation, supply to industry and municipalities (domestic sector), management of expansion projects, connection, and all the secondary activities including environmental aspects, R&D and stakeholder engagement (Eskom, 2009). Added to this mix of responsibilities, Eskom has to deliver the targets set by Government and the National Energy Regulator of SA (NERSA) for reducing carbon emissions and increasing the electricity generated and sourced from renewable sources (Parliament, 2008). One soon begins to realise that Eskom's mandate is 'challenging'. 90% of the energy generated by Eskom through their 27 operational power stations is through traditional coal fired power stations (Edkins et al., 2010b). SA has large coal reserves and therefore this has been the preferred and cheapest primary energy source.

2.6.2 *Current Capacity*

In 2008, the base load capacity margins fell below the internationally recommended 15% leading to SA experiencing shortages of supply (Dithupe, Mahlangu, Molapo, Morumudi, Subramoney and Van Wyk, 2009). This brought home a reality check that SA had not invested in the required base load generating capacity to meet the demand of the economy (Eskom, 2009). This has resulted in a drive to bring back on-line decommissioned coal fired power stations to serve the short term needs and also new build projects (Edkins et al., 2010b). By 2025, SA needs to establish 40 000 MW of new generation capacity, of which 12 476 MW is already under construction (Eskom, 2009). On the 9th April 2010, The World Bank granted a $3.75[1] Billion loan to SA, of which $3.05[2] Billion will be for the building of the Medupi Power station, which is due to come on line in 2013 (WorldBank, 2010). The balance of the loan will be allocated to RE and carbon emission reduction projects (WorldBank, 2010). Another coal fired power station, Kusile, is currently seeking funding.

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[1] Approximately SAR 26 Billion - www.xe.com 30 October 2010
[2] Approximately SAR 21 Billion - www.xe.com 30 October 2010

Together, these projects will increase the base load capacity by 25% (Eskom, 2009). Currently, generation projects and transmission infrastructure account for 86% of the Eskom budget, with the balance allocated to diversifying the energy mix, which includes RE generation. This serves to illustrate the magnitude of the projects needed to restore capacity to the SA electricity generation system. RE generation schemes, while more expensive to establish, can come on line quicker than a traditional power stations. Eskom has stated that it fully supports alternative power generation schemes from IPPs and will support their establishment in whatever way needed (Eskom, 2009).

2.6.3 *Energy Cost*[3]

SA in the past has benefited from the lowest electricity prices in the world, averaging R 25 c/kWh. In 2010, NERSA announced a steep increase in price of 31.3%, which has resulted in an average cost of R 33 c/kWh (Edkins et al., 2010b). This increase in tariff is set to rise until 2013, where the average cost will be R 66 c/kWh (Edkins et al., 2010a). The largest part of this additional revenue will be channelled into Eskom's new build programmes, operations, maintenance and demand side management programmes. The price increase is also a direct result of increasing coal costs and the internalisation of carbon dioxide costs. A small portion has been earmarked by NERSA for IPP and co-generation projects (Edkins et al., 2010a).

2.6.4 *Renewable Sector is SA, pre-August 2011*

Initially, the SA Government had established the Renewable Energy Fund and Subsidy Office (REFSO), aimed at providing support for the RE sector (Edkins et al., 2010a). This is a fiscal instrument and did not have the desired effect. The fund was not significant enough to establish a large RE sector. The only project to qualify under this instrument was the Darling wind farm in the Western Cape. Indeed, with the caps on project sizes and the onerous procedure for making use of this instrument, only R15 Million has been released (Edkins et al., 2010a).

The SA Government favours RE generation schemes and has therefore chosen to deploy a FIT instrument instead, based on a phased competitive bidding process. In effect, a hybrid system. The Government in 2004 set a medium term target of 10 000 GWh to be produced from RE by 2013 (Dithupe et al., 2009; Edkins et al., 2010b). The current target for 2020 is 20%, and this is expected to change with the final publication of the Integrated Resource Plan 2010 (IRP2010) (The IRP is an energy consultation process with all SA stakeholders intended to map out the energy road map of SA, for both the medium and long term needs of SA). IRP2010 document was published in October 2010, which still has a heavy focus on coal. IRP 2 maps out the electricity generation route until 2030 and contains more information on preferred technologies, capacities and generation mix (Edkins et al., 2010a).

The rates proposed for the SA FIT programme are found in Table 20. This table serves to illustrate the different rates offered for different technologies. The difference between rates is based on the maturity of the technology and hence the cost needed to deploy it. Take for example the PV FIT of R3.94/kWh and the wind FIT of R1.25/kWh. This large differential indicates that wind technology is far more mature, developed and with higher efficiencies, while PV is less mature and efficient, thus requiring a higher tariff to recoup investment.

Table 20: FIT tariffs published by NERSA

REFIT Phase	**Technology**	**R/kWh**
Phase 1	CSP	2.10
	Wind	1.25
	Small Hydro	0.94
	Landfill gas	0.90
Phase 2	CSP without storage	3.14
	Large-scale grid connected PV > 1MW	3.94
	Biomass Solid	1.18
	Biogas	0.96
	CSP tower with 6 hours storage	2.32

Source: NERSA Renewable Energy Feed-In Tariffs Phase II

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[3] Electricity price is not to be confused with electricity cost. SA prices may be the one of the lowest in the world, however the cost in terms of GHG emissions, infrastructure, maintenance and efficiency, is far higher when factored in.

The SA FIT instrument has been developed by NERSA with the following founding principles:

- National grid access guaranteed.
- Purchase price of the electricity at the agreed rate for the agreed duration guaranteed.
- Obligations to buy and discharge the electricity generated.
- To share the additional costs of RE generation by all electricity consumers.
- To be a dynamic mechanism that mirrors market, political and economic developments.
- Applicable to new projects that generate reduction in costs and learning effects.
- To possibly cap the maximum subsidy available each year.
- Willing buyer – willing seller principles are applicable.

(Edkins et al., 2010b)

Currently the SA market has only 2% of its grid-connected electricity produced from renewable resources. This comes from two local small hydro-electric installations (Edkins et al., 2010b) and when needed, from imports from Democratic Republic of Congo and Mozambique (Dithupe et al., 2009). Off-grid there is about 5 MW installed serving rural areas (farmsteads and game reserves) (Edkins et al., 2010b). Finally there is 10 MW of installed wind power generation shared by two schemes, the Darling Wind Farm and The Klipheuwel Wind Farm (Edkins et al., 2010b). There are currently no grid-connected solar generating facilities, however solar and wind development projects are nearing financial close, with installation expected in 2011 (Edkins et al., 2010b). Solar projects / facilities that have been installed are very small (25kW) and have been used to demonstrate the technology or to conduct research (Edkins et al., 2010b).

The regulatory environment in SA is still in a fledgling state. The Government, The Department of Energy (DoE), NERSA, Eskom and key stakeholders have been ironing out the details of the policy. A great deal of uncertainty exists around the regulatory framework and this can be seen to detract potential investors. If SA is to realise its RE targets, clear and defined policies need to be established to provide the certainty required by investors, developers, suppliers, IPPs and other stakeholders, to enter the market. A strong signal needs to be sent to the market place showing the commitment of SA that it wants to establish a stable and sustainable RE sector with attractive returns and necessary support. Many lessons can be learnt from developed countries that have mature RE sectors that can be used to map out the route that SA needs to take.

2.6.5 *SA Renewable Sector post-August 2011*

In section 2.6.4 it was noted that SA had chosen to deploy a FIT policy mechanism in 2009, termed REFIT (DoE, 2011). In March 2011, NERSA issued a REFIT Consultation Paper to review the previously published tariffs (Creamer, 2011a; DoE, 2011). Subsequently, with the backing of the Government, NERSA announced that they would abandon the REFIT policy mechanism (Creamer, 2011a). The reason for this turn of events has been cost implications to the economy that is energy intensive in sectors like mining and manufacturing (Creamer, 2011a). Instead a competitive bidding policy mechanism would replace REFIT, with caps on the tariffs for each technology type (Creamer, 2011a; DoE, 2011). The industry has now come to refer to this new procurement programme as ‘REBID’ (Creamer, 2011a). Below in Table 21 are the current technology types, target capacities, and ceiling tariffs. This table illustrates how ceilings to the tariffs from the previous REFIT programme have changed to lower the cost to the consumer:

Table 21: DoE Tariffs Late 2011

Technology	Target Capacity (MW)	Tariff Ceiling (R/MWh)
Onshore Wind	1850	R1150
Concentrated Solar Power	200	R2850
Photovoltaic	1450	R2850
Biomass	12.5	R1070
Biogas	12.5	R800
Landfill Gas	25	R600
Small Hydro (<10MW)	75	R1030
Small Projects (all the above technologies excluding Landfill gas, with a max installed cap on 5MW)	100	TBC

(DoE, 2011)

When these rates are compared to the table 20 above, one can see that the revised tariffs have either move up, remained the same or, in most cases, moved down. One of the most notable has been the tariff for PV with a 27% reduction.

The decision to renege on the REFIT policy was initially met with resistance from the industry players, however, the DoE followed up the revision with a comprehensive Request for Proposals (RFP) in early August 2011 (Creamer, 2011a; DoE, 2011). This document outlines the qualifying criteria and process for the IPP Procurement Programme (DoE, 2011). The DoE is seeking to procure 3725MW of RE generation capacity by 2016 from various sources as set out above and as per the 2010 IRP document (DoE, 2011; Lotter, 2011). The RFP also states that the procurement is planned over 5 bidding rounds, (with a target of 3725MW) with the first complete in early November 2011 and the final planned for August 2013 (DoE, 2011). The RFP does however state that these capacities may be met earlier and the procurement programme will need to be revised for subsequent capacity targets (Creamer, 2011b; DoE, 2011).

Round one Bids were submitted on the 4th November and the DoE received 53 project bids (Creamer, 2011a; DoE, 2011). The Bids have been evaluated and the preferred bidders announced on the 7th December, with 28 preferred bidders. These successful preferred bidders have 6 months to reach financial close and to agree and sign a PPA. The RFP and IPP Procurement programme stipulate that successful projects will need to be operational by 2014 (Creamer, 2011a; DoE, 2011).

A review of how the recently launched RFP process and conditions are beyond the scope of this research report. Suffice to say, the RFP is heavily focused on environmentally sustainable growth, socio-economic development and a kick-off for developing a RE sector in SA (DoE, 2011).This brief review of the SA IPP Procurement Programme also serves to illustrate the infancy of the SA RE sector and the exciting developments that have taken place in the past 12 months. The recently hosted Durban Conference of Parties number 17 (COP17) which is a gathering of international environmental ministers to discuss climate change progress, under the United Nations Framework Convention on Climate Change (UNFCCC), has played a major role in spurring other local initiatives and climate change awareness (UN, 2011). Such new developments that feed into the sustainability field are briefly highlighted below:

- *NPC National Development Plan Vision 2030* (NCP, 2011): The specially established commission by the President has been established to map out the development strategy for SA until 2030 and is led by Trevor Manuel. This planning commission has consulted all South Africans and is aimed at reducing inequality and poverty. The commission has looked at the key areas of job creation, infrastructure, education, healthcare, spatial transformation, boosting government ability, reducing corruption and crime, and uniting the nation. One further area looked at has been transition to a low carbon economy. The plan talks heavily to moving SA away from the carbon intensive one to a more sustainable economy, and amongst other initiatives, renewable energy is cited as a key component in reaching this goal. The plan also references the 2010 IRP that currently sets out a target capacity of 21 500MW from renewable resources by 2030. The NDP was published on 11th November (NCP, 2011).

- *The Green Economy Accord* (Lotter, 2011): This accord is an agreement between Government, Labour, Business, Industry Associations and social bodies to work towards a green economy that can present the opportunities to meet national goals to create jobs, as per the New Growth Path. This Path sets a target of 5 Million jobs to be created by 2020 and the opportunities in the green economy can see 300 000 jobs created. In addition this accord is a step towards a Low Carbon Economy and aligns with the NDP. The accord sets out 12 commitment areas of the green economy that can be targeted and how specifically it can be used. Renewable Energy features as one of these commitments. It specifically references local manufacture of components needed for large RE facilities (turbine blades, PV panels etc), as well as components for smaller, domestic installations like solar water heaters. The accord was signed 17th of November and is further evidence that a path is being forged to deploy RE and its benefits in SA. (Ensor, 2011; Hweshe, 2011; Lotter, 2011).

- *South African Renewable Initiative* (SARi) (SARi, 2011): SARi is a Government initiative to establish the financial mechanisms to make large scale deployment of RE capacity less impactful on SA consumers. The SARi initiative was started at COP16 in Cancun 2010 and has been through a whole year of planning. The initiative is a partnership between Government, the local public and private sectors and the international partners to formulate blended financial instruments to help establish a new Renewable Energy sector in a country that has high capital costs because of technology and country risk. SA has set ambitious RE generating through the IRP 2010 and in order to achieve these targets the cost burden needs to be managed and

SARi is seen as a key component to achieving this. Current involved parties include the DoE, DTi, National Treasury, Department of Environmental Affairs, Development Bank of South Africa (DBSA), Industrial Development Corporation (IDC), Governments of The UK, Germany, Norway, Denmark, European Investment bank and others. Due to the capital intensive deployment and long term infrastructure investments, managing the capital costs is seen as critical to achieving the climate and energy goals of SA. Initial estimates show that such financial instruments and low cost loans can reduce the average annual incremental costs by 25% (SARi, 2011).

- *Industry Associations*: Three key industry associations have been formed in SA that is geared at pooling the collective power of players within the various technologies. One key role they play is lobbying the authorities to make the informed decisions to establish a sustainable renewable energy sector. The three key associations are *The South African Wind Energy Association* (SAWEA) (SAWEA, 2011); The *South African Photovoltaic Industry Association* (SAPVIA) (SAPVIA, 2011) and *The South African Solar Thermal Electricity Association* (SASTELA, 2011). These groups have been extremely influential in shaping the current developments in SA.

2.6.6 *Key Issues with the Current RE Environment*

Key issues that have been raised thus far regarding the RE policy system for SA are as follows:

- Eskom is a *de facto* monopolistic power supplier. The development of a RE sector will be in conflict with their core business. Questions have been raised regarding how supportive Eskom will be with IPPs (Edkins et al., 2010a; Edkins et al., 2010b; Pegels, 2010).

- RE targets are not perceived to be substantial enough to encourage the development of a local RE industry, including manufacturing, development etc (Edkins et al., 2010b).

- Too many agencies exists (NERSA, DME, DEAT, DWAF, Provincial and Local authorities). This leads to onerous approval periods (Edkins et al., 2010a).
- Environmental approvals are long and restrict planning and application for PPAs. In addition they add to the project development costs (Edkins et al., 2010a).
- Financial constraints: these include the identification of suitable lenders; identifying the grants that are available; acquiring equity partners and finally insurance mechanisms (Edkins et al., 2010a).
- NERSA's announcement that electricity costs will be increased until 2013, has been met with great resistance from the public. How will the FIT rates be accepted by the public, which are considerably higher? How will the political arena handle this (Pegels, 2009; Edkins et al., 2010a)?

The above concerns are key areas that need to be addressed. Transparency of the policies and how the above will be handled is crucial for instilling confidence in both developers and financiers to facilitate the deployment of RE generation capacity in South Africa (Daniels et al., 2003).

2.6.7 *Conclusions*

The SA energy market has been dominated by a *de facto* monopolistic utility, Eskom. The main generation source has been coal and renewable energy capacity development has been virtually nil. In addition, SA is experiencing an energy crisis as investment had not been made to cater for forecast economic demand. SA is currently implementing the first procurement round for RE generation capacity through the IPP Procurement Programme, by using a hybrid system of a capped FIT and competitive bidding system.

The developing economy of SA also introduces a number of local barriers that have a significant influence on the sector. These include institutional, legal, socio-economic and financial barriers. The goals of national government to establish equality amongst all its citizens, which includes eliminating energy poverty, suggest that these barriers are not likely to be overcome without some sort of political repercussion.

Various other national plans (NDP); green and low carbon economy initiative (Green Accord); financial assistance plans (SARi) and industry associations have started to take shape that will work with the REBID system to achieve the RE target capacities set out in the IRP 2010. The SA RE sector is in its infancy and developments will need to be monitored to measure effectiveness.

2.7 Part 5: Conclusion of Literature Review

The literature review has looked at the renewable energy policies deployed in countries with a developing RE sector. There are broadly speaking ten, which have been analysed. Of the ten, 5 have been chosen to be included in the FCM as policy nodes and these include FITs, TGCs, bidding/tendering, RPS and a broad category of fiscal measures. Of these, the most successful instrument for spurring significant growth in a RE sector has been the FIT policy.

Next the literature review looked at the available technologies. Various technologies at different levels of competitiveness and maturity were investigated. Due to the infancy of these technologies, support is required to allow them to be developed and to become commercially viable. This is where the link to policy occurs, as policy protects their development through legislation and regulation. Of all the technologies looked at, large scale hydro is deemed to be the most mature and most competitive. In most RE policy instruments, large scale hydro is not supported. On the other end of the spectrum, wind and solar are experiencing learning curve effects and being deployed on a large scale globally. Other technologies are still in the development phase and will require continued support to bring them to market.

Throughout the technology literature review, various factors associated with technology, became evident. These factors have been extracted as key nodes that will form part of the model. These factors have been grouped into the following six categories: Local Energy Constraints; Encouraging Renewable Energy; Local Conditions; Economics; Financial and Technology. These factors are influenced by the policy measures and will form part of the model.

Finally, a review of the South African electricity generation landscape was conducted. The key points emerging from this is that SA is currently experiencing an energy crisis, in an emerging economy that has socio-economic drivers that may be in conflict with developing a RE sector. The SA authorities have chosen a hybrid system (capped FIT with competitive bidding) to replace an ineffective subsidy to be the main mechanism that will attract developers, IPPs and finance to help create a larger RE capacity. To date, no large grid connected RE projects have been awarded or deployed.

2.7.1 *Proposition 1: Deploying different RE policies*

Proposition 1: FIT policy has demonstrated the largest growth of a renewable energy sector.

Under this proposition, various scenarios will be investigated. At this point, no drivers will be used, relying purely on the policy type, without any drivers required. I.e. all driver nodes will be left in the inactive start-up position. The following scenarios will be investigated:

Scenario 1: To investigate the affect on a renewable energy sector if no high level policy is chosen for a country or region.

Scenario 2: To investigate the affect on a renewable energy sector if only a FIT instrument is deployed.

Scenario 3: To investigate the affect on a renewable energy sector if only a TGC system is deployed.

Scenario 4: To investigate the affect on a renewable energy sector if only a bidding/tendering instrument is deployed.

Scenario 5: To investigate the affect on a renewable energy sector if only a RPS instrument is deployed.

Scenario 6: To investigate the affect on a renewable energy sector if only fiscal instruments are deployed.

Scenario 7: To investigate the affect on a renewable energy sector if a combination of policies are deployed. Combinations as follows:

- FIT with TGC,
- FIT with TGC and Bidding Tendering,
- FIT with TGC, Bidding/Tendering and RPS,
- All polices at the same time.

2.7.2 *Proposition 2: Divers of RE sector*

Proposition 2: Policy choice relies on various country specific conditions to drive their effectiveness and feature the categories of Local Energy Constraints; Encouraging Renewable Energy; Local Conditions; Economics; Financial and Technology most commonly.

The effectiveness and influence of the various drivers identified in the literature review will be incorporated into a model to analyse the effect on an RE sector when deployed within a FIT policy mechanism.

The following scenarios have been formulated:

Scenario 1: To investigate the affect on a renewable energy sector if only the ‘Local Energy Constraints’ drivers are activated with a FIT policy.

Scenario 2: To investigate the affect on a renewable energy sector if only the ‘Encouraging an RE Industry’ drivers are activated with a FIT policy.

Scenario 3: To investigate the affect on a renewable energy sector if only the ‘Local Conditions’ drivers are activated with a FIT policy.

Scenario 4: To investigate the affect on a renewable energy sector if only the ‘Economic’ drivers are activated with a FIT policy.

Scenario 5: To investigate the affect on a renewable energy sector if only the ‘Financial’ drivers are activated with a FIT policy.

Scenario 6: To investigate the affect on a renewable energy sector if only the ‘Technical’ drivers are activated with a FIT policy.

2.7.3 *Proposition 3: Policy choice for SA*

Proposition 3: A FIT system can be applied to reap the growth needed to diversify and secure energy for future generations rather than the alternatives of fiscal, bidding, RPS and Tradable Green Certificate systems.

Once the model is validated using country specific examples, the model will be used to investigate if SA’s choice of support mechanism will lead to a sustainable RE sector. The initial choice to deploy a FIT (2008) will be compared with the current (2011) choice of a hybrid system of a capped FIT with a competitive bidding system.

3 RESEARCH METHODOLOGY

This section outlines the methodology that is used to conduct this research. The above sections have looked extensively at a body of literature. The literature has been sourced from journal articles, electronic reports, websites and books. This section will firstly justify the type of research methodology that has been chosen and will then provide a brief literature review of the chosen methodology. This research will employ qualitative methods in analysing the data researched in the literature review above.

3.1 Research Method Selection

The area of renewable energy creation is a new and a limited amount of published literature exists. RE involves both traditional, measurable factors like financial and economic metrics, but also involves social attributes like culture and mindset that are difficult to quantify. RE policy development can be seen as a dynamic system, involving both measurable attributes and more subjective facets, with developments occurring on a continual basis. A dynamic system can be difficult to model using computational methods (Aguilar, 2005). In addition, using mathematical models can be costly or may not be possible (Aguilar, 2005). Applying these instruments may produce simpler quantified results, but can fall victim to several pitfalls. These pitfalls include:

- Specialised knowledge required which may need an expert and be time consuming.
- A quantitative model may not be the best instrument when relationships are non-linear and complicated.
- Numerical data may be hard to come by.

(Aguilar, 2005)

This research report is aimed at creating an understanding of how policy decisions can establish a sustainable and effective RE sector, by looking at all the drivers. For this reason Fuzzy Cognitive Mapping (FCM) has been chosen as the instrument for this research, as it looks at causal links between drivers both empirical and subjective. FCMs are qualitative method alternative to dynamic systems. The main advantage is that the whole system can be observed quickly, and without needing a research expert (Aguilar, 2005). A mixed methodology research approach would involve a more detailed and focused approach over a large subject area, where overlapping influences may be difficult and timely to identify. The intention here is to look at effectiveness across all the identified drivers of a RE sector.

The model that is developed uses the information gained from the literature review. It is assumed that the literature will have enough information to construct the model and that enough country examples exist to validate the model. The model will be used to model a series of scenarios for renewable energy policy in South Africa.

3.2 Fuzzy Cognitive Mapping

Cognitive maps were first practically applied by Alexlrod in 1976 to show causal relationships when modelling politics (Mls, 2004). Cognitive maps are made up of a set of concepts (nodes) and a set of causal links (arcs/edges) (Mls, 2004). (For the purpose of this research report, the term “node” will represent “values” or “concepts”, and the term “edge” will represent “causal links” or “arcs”.) A node can influence another node through an edge (Mls, 2004). The edge may have a positive or negative influence on the following node. Intuitively if there is no relationship between nodes, there can be no influence (Mls, 2004). In a complex network of nodes and edges, where both positive and negative edges are found, it is hard to determine the weighted influence of the preceding edges (Calais, 2008). In essence the model cannot cater for the build up of knowledge through the model as causality is in itself ‘fuzzy’ as it has intrinsic vagueness (Calais, 2008). Cognitive maps have been used for decision-making and to examine how people perceive certain social situations/systems (Özesmi and Özesmi, 2004). Cognitive maps have also been used for modelling in the political and psychological fields (Kosko, 1993).

Later, Kosko (1986) developed cognitive maps into fuzzy cognitive maps (FCMs), which depict a causal picture (Kosko, 1993). FCMs connect “facts and things and processes to values and policies and objectives. And it lets you predict how complex events interact and play out" (1993 :104). FCMs have improved on traditional cognitive mapping so the imprecise and fuzzy can be accommodated through partial activation of nodes (Mls, 2004). Kosko developed FCMs to model dynamic systems (Calais, 2008) and to provide feedback loops within cycles (Kosko, 1993). In its basic form, FCMs follow the same make up as cognitive maps. A series of nodes are connected through edges to other nodes. Nodes represent actions, events, goals, policies, processes which are the variables within the system being modelled (Calais, 2008). The edges represent the relationship between any two nodes (Calais, 2008). The edges can connect to multiple nodes or indeed back on itself (Calais, 2008). A node with no incoming edge(s) is called a policy node (Kosko, 1993). The edges can have a positive or negative influence on the follow on node. If the preceding node is activated and there is a positive influence, then the next node will increase. The opposite holds true. The difference between cognitive maps and FCMs comes in, through the degree to which both the nodes and edges influence each other (Kosko, 1993). In other words there is a weighted degree to which the one can activate the others. Edges can be assigned a weight between -1 and 1, or qualitative values like "some", "a little" or "more or less" (1993: 104). It is also possible to have no causal link, which is represented by a 0. In addition nodes can be assigned a degree to which it can be activated. This can be a value between 0 and 100% (Kosko, 1993). Through this feature of weighting, a FCM can monitor the influence the preceding nodes, through the edges, have on the model. By changing the weightings of the nodes, the affect on the whole FCM can be modelled (Calais, 2008). The policy nodes are what is controlled by the modeller, whereby they can turn them on or off, and also decide to what degree they are activated (Kosko, 1993). The policy nodes can be activated individually or in combination to see what the outcome of the model will be (Kosko, 1993). This control allows the modeller to look at different scenarios. Once the model is activated, the nodes and edges interact according to the settings, and the relationships are processed. The model runs along the various loops and many cycles are possible, with feedback loops. The model can result in one of three states:

- *Equilibrium state*: This is when the system reaches a final point and is said to be stable (Calais, 2008).

- *Limit cycle state*: This is where the system does not come to a final point, but stabilises into a repeating pattern (Kosko, 1993).

- *Chaotic state*: This is when the system does not come to a final point nor does it produce a stable pattern or period (Kosko, 1993).

Analysis of a FCM can be done either though geometric or numerical avenues (Bowles and Enrique Pel ez, 1996). Simpler FCMs with fever nodes can be analysed by following the paths as depicted in a diagram. However as the number of nodes increase, a mathematical model using vectors and matrices to represent nodes and edges respectively can be used (Bowles and Enrique Pel ez, 1996). A FCM that will be developed will use mathematical principles to deal with the qualitative data (Kosko, 1993).

FCMs have been used to model electrical circuits, organisational behaviour, job satisfaction and virtual worlds of dolphins, sharks and fish and economics and demographics of the world (Özesmi and Özesmi, 2004).

A comparison between the advantages and disadvantages of using FCM is found in the Table 22.

Table 22: Advantages and Disadvantages of using FCM*.

No.	Advantages	Disadvantages
1	Easy to apply without having to source/generate empirical data. With this sector being in its infancy, the data does not exist.	The approach is somewhat subjective and other opinions may produce varying results.
2	No expert models required.	The model will be developed using various iterations and focus may be lost.
3	Literature exists that will help justify the causal links.	Delimitation is crucial. If the model is not delimited thoroughly, this could lead to unnecessary additional work.
4	Effects can be modelled using matrix operations, rather than strict IF / THEN rules. This allows flexibility in turning nodes on partially.	The imprecise nature of FCM may leave the results open to scrutiny and other opinions may vary on the inputs/drivers/policy nodes.
5	The feedback feature is useful to see if there are any cyclical affects.	
6	Sufficient countries have implemented the various policy types and this can be used to validate the model.	

**This table has been created to summarise the body of literature above.*

A RE sector is made up of hard and many soft issues. In SA, the development of the RE policy environment started in 2003 and it is only in 2011 that the first projects are progressing past the development stage. As referenced in the literature review, SA experienced rolling black-outs as the spare capacity margins were reached back in 2008. Hence policy development to policy implementation has taken too long. Using a FCM to model policy choice provides a format for understanding how the soft and hard issues play out in a RE sector (and energy sector) and will help accelerate understanding and decision making by understanding the key drivers. Hence the choice to use a FCM tool for this research.

3.3 Research design

This section outlines how the chosen methodology of FCMs will be constructed and validated. As discussed in the previous section, FCMs form a suitable methodology for the modelling of causal relationships within policy environments. The research will follow a qualitative method, where the casual relationships will be drawn from the literature review. Validation of the model to show that it does reflect reality will be done through country specific examples, which can be found in section 4. If there are insufficient grounds for validation from these countries, external validation will be conducted using experts in the field.

A draft FCM has been drawn up and this model will be adapted as the research progresses. This draft model can be found in section 4.3. The model has been developed from the literature review in section 2.

Below is a list of research considerations that are discussed within the context of renewable energy policy and the draft model.

3.3.1 *Data Collection*

The model has been developed from only the available literature. The biggest contributors have been world reports on the global renewable sector, like in *Renewables 2010 Global Status Report* (Martinot and Sawin, 2010) and from specific country journal articles, like *Renewable energy in South Africa: Potentials, barriers and options for support* (Pegels, 2010). Country specific examples, which will be used to validate the model, have been chosen based on reference to the notable growth in their renewable sectors, in other articles and empirical annual reports.

As mentioned previously, if the above body of literature is insufficient for validation, the model will be presented to external experts, both local and international, to provide the necessary input to validate the data being modelled.

3.3.2 *Data analysis and interpretation*

The development and analysis of the model will follow an iterative process. Data from the literature review will be used to establish and refine the FCM. The draft FCM will be adapted to suite a representative model and then validated by applying country specific examples. Once the model has been validated, the propositions and problem statements will be analysed and predictions made. Conclusions will be drawn to close out the main problem statement and identify which high level policy will drive the factors that lead to a sustainable renewable energy sector.

Specifically, the FCM will run to see what states are produced by activating the various policy nodes. The model will produce one of the following three states, equilibrium state, limit cycle state or a chaotic state (Kosko, 1993; Calais, 2008). This will in turn be interrupted in relation to the available literature to make sense of the results the model has produced.

3.3.3 *Validity and reliability*

Any research needs to install measures that scrutinise the worth of the research being conducted. For this reason the concepts of validity and reliability have been established to provide creditworthiness. Validity determines whether the research does indeed measure what it has been deployed to do so (Joppe, 2000). Reliability refers to the consistency of the results being repeated over a period of time and accuracy with which they are repeated (Joppe, 2000). These two tools can be thought of as a way of assessing the quality of the research (Golafshani, 2003).

This research project will deploy a FCM method as the instrument to analyse the propositions and problem statements. As mentioned above, FCMs are a qualitative instrument. Validity and reliability differ between quantitative and qualitative research methologies (Golafshani, 2003). Quantitative methods use facts in a numerical form along with mathematical analysis to express results in statistical terminology (Golafshani, 2003). Validity here measures whether the model does measure what it is intended to measure and its accuracy Reliability here indicates whether the results are replicable (Golafshani, 2003). On the other hand, qualitative research that has results that are gained through non-statistical or non-numerical methods. Validity here refers to the rigor or trustworthiness of the results and reliability refers to the quality and understanding of the results (Golafshani, 2003). While these differences may seem subtle, it is important to understand that validity and reliability do differ between methodologies, and establishing these two criteria under qualitative research eliminates the researches bias and increases the trustworthiness of the results (Golafshani, 2003). This is especially applicable to FCM and this research report.

a. *External validity*

External validity refers to the applicability of the results to a larger population and differing time periods (Neuendorf, 2002). This research does not define a sample, except for the country specific examples that will be used to validate the model. The literature review has established the drivers for effective RE policy. Once the causal links have been established in the model, the model will be validated using the literature from two countries that have established RE sectors. These include Denmark and The UK. It is envisaged that enough literature exists through case studies and reports that will validate the model. If this does not work or to add extra validation to the research, external experts have been earmarked to validate the model. Once validated, the model should be applicable to a specific country, e.g. South Africa.

b. *Internal validity*

Internal validity or face validity looks to establish if there is sufficient coverage of the topic being investigated. This is a measure of the marriage between concept and operation (Neuendorf, 2002). The literature review has purposefully looked at the full breadth of drivers within the RE policy field. As casual links are established during model development, certain drivers will, in comparison be deemed less significant and through iteration, the model will be refined, by omitting these less significant drivers. In addition, three scenarios will be tested, where policy nodes are activated in isolation for which outcomes are known. These are:

1. No policy node is active and hence no sustainable RE sector growth is reached.

2. Only the FIT policy node is activated and should lead to a significant growth in the RE sector, and

3. Only the TGC or Bidding/Tendering nodes is activated leading to a middle of the road outcome that is in between 1) and 2) above which indicates some growth, but nothing significant.

Once again, should the above be insufficient, expert input will be sort.

c. *Reliability*

Reliability refers to the applicability of this model to any country in the world and that the results can be repeated and understood (Golafshani, 2003). This will initially be achieved through the country specific validation as mentioned above and then the South African sector will be modelled. Based on this and their outcomes, other researches should be able to re-establish the same casual links and hence replicate the model.

3.3.4 *Limitations of the study*

- This model is limited in its applicability to a developing country where social upliftment goals are in conflict with expensive RE generation.
- Certain drivers that are less significant in developed countries may become more significant in developing countries and affect global applicability.
- Policy evolution cannot be incorporated into the model as policy nodes cannot accommodate incoming casual links.
- The objective nature of some of the casual links may not reach agreement between individuals applying the model and hence affect validity.
- Weighted links may be needed to smooth out absolute inclusion or exclusion. This may require additional work that may render the model too complicated and require more specific focus and alternative methodologies.
- Non-response from experts during the validation phase could possibly leave the model filled with researchers' bias, if insufficient literature exists around the case study validation method. As experts are few in this field, at least three in-depth responses should create a good validation.

3.4 Research Process

This section has been included to provide a process overview of the method the research has followed. The first section shows diagrammatically (Figure 3) what the process is. The following section expands on this in table format to explain what is involved in each step and what the outcomes were expected.

3.4.1 *Process Map*

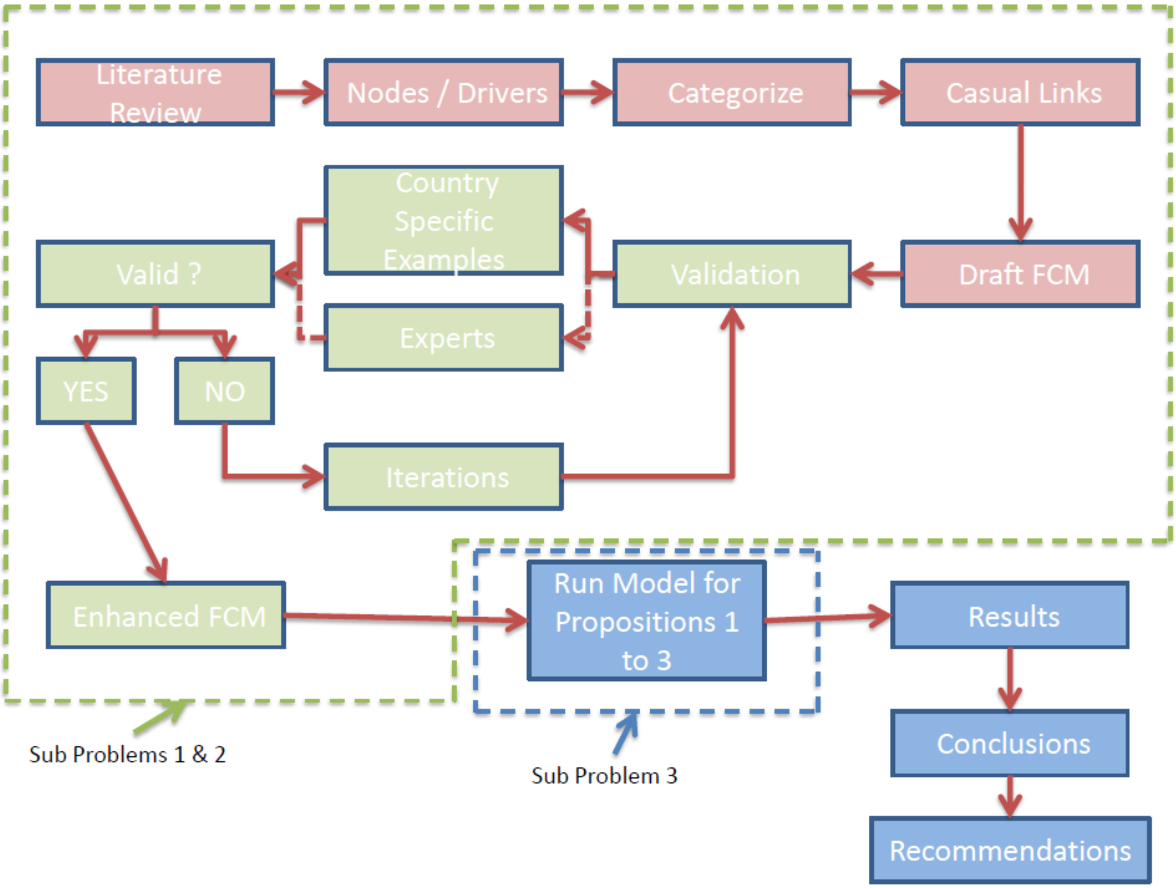


Figure 3: Research Process Map

3.4.2 *Process Table*

Table 23 below expands on the process map above and details what hashappened during this research project.

Table 23 Research Process Table

	Model Development		Model Finalisation			Modeling		
Steps	Identify drivers	Develop Model	Country Specific Examples	Model IS not properly validated.	Finalize Model	Run Model	Conclusions	Recommendations
Process	Literature Review	Extract nodes and drivers; Categorise; Establish causal links.	Run the model with the 2 country examples.	Approach external experts and incorporate comments.	Incorporate all comments and refine model.	Apply the model to formulated propositions.	Close the loop from outputs from validated model with the propositions and sub-problems.	Identify gaps and questions that have been formed as a result from the modeling.
Outcome Expected	Full suite of drivers uncovered.	Draft FCM Model	The model functions as envisaged.	Model is finally validated.	Final FCM.	Output data from the model to comment on formulated propositions	Sufficient outcomes to draw conclusions on the Main Sub problem of this research.	Make recommendations for future research that will add to the body of work done in this field.
Ch	Ch 2	Ch 4	Ch 4	Ch 4	Ch 4	Ch 5	Ch 6	Ch 6

4 MODEL DEVELOPMENT

4.1 Nodes

Nodes can be divided into two distinct categories: Policy nodes and Non-policy nodes. Policy nodes are nodes with no incoming links and are the nodes that are controlled by the researcher. Non-policy nodes are the opposite of the policy nodes and these nodes have links to them. Below these separate categories are sectioned and expanded upon.

4.1.1 *Policy Nodes*

Countries are free to chose which policy is to be deployed to encourage the establishment of a RE sector. From the literature review, ten different policy mechanisms were identified. These ten have been condensed into five main policies and are shown in Figure 4 These form the policy nodes in the FCM.

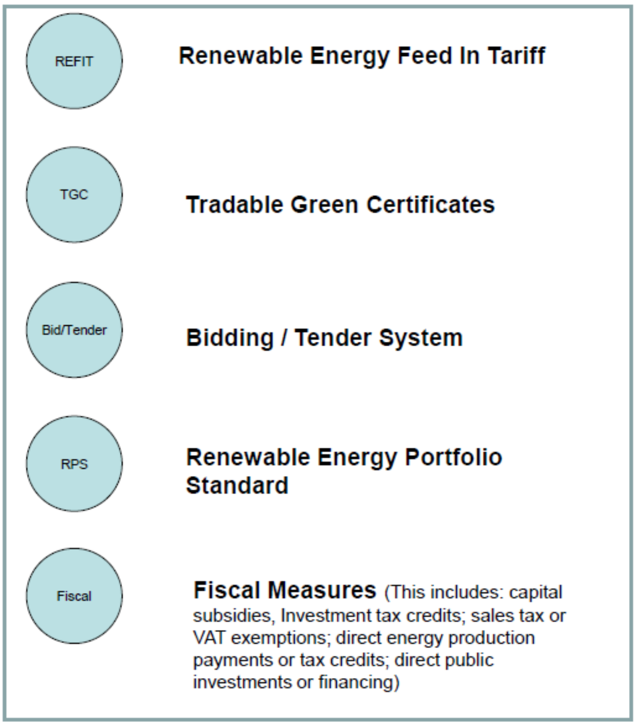


Figure 4: FCM Policy Nodes

4.1.2 *Non-Policy Nodes*

From the literature review, thirty six driver nodes have been identified. These have been categorised into six general fields for ease of analysis. These can be found below in Figure 5 to Figure 10. The explanation for each driver is found in Chapter two. Model development has been iterative, with drivers being grouped and/or added.

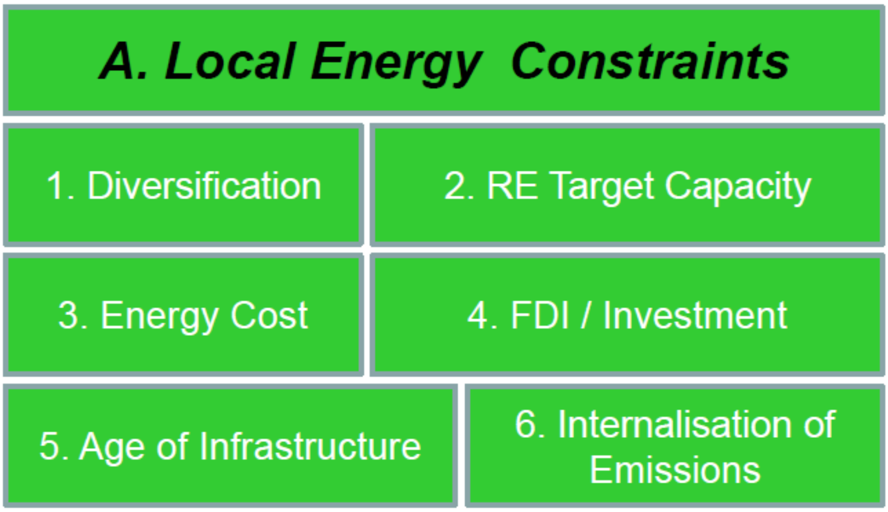


Figure 5: Local Energy Constraint Drivers

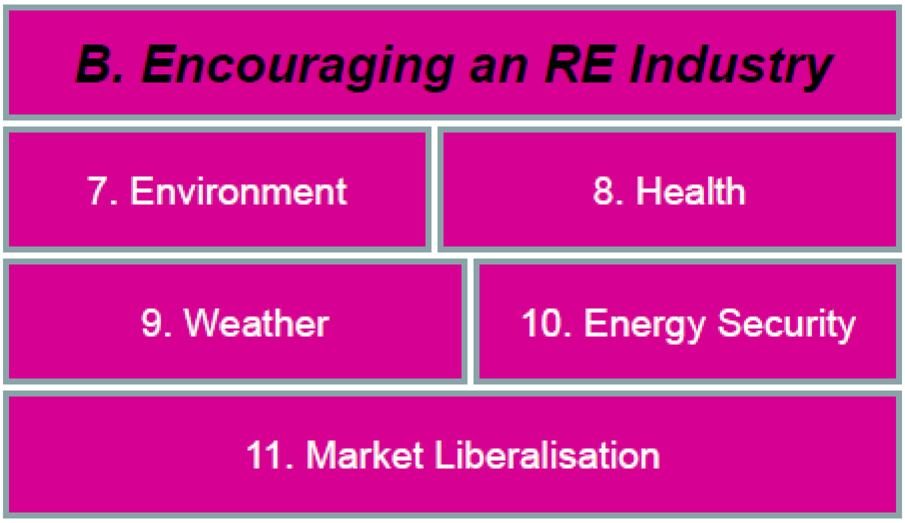


Figure 6: Encouraging an RE Industry Drivers

C. Local Conditions

12. Resistance

13. Big Players

14. Culture / Mindset

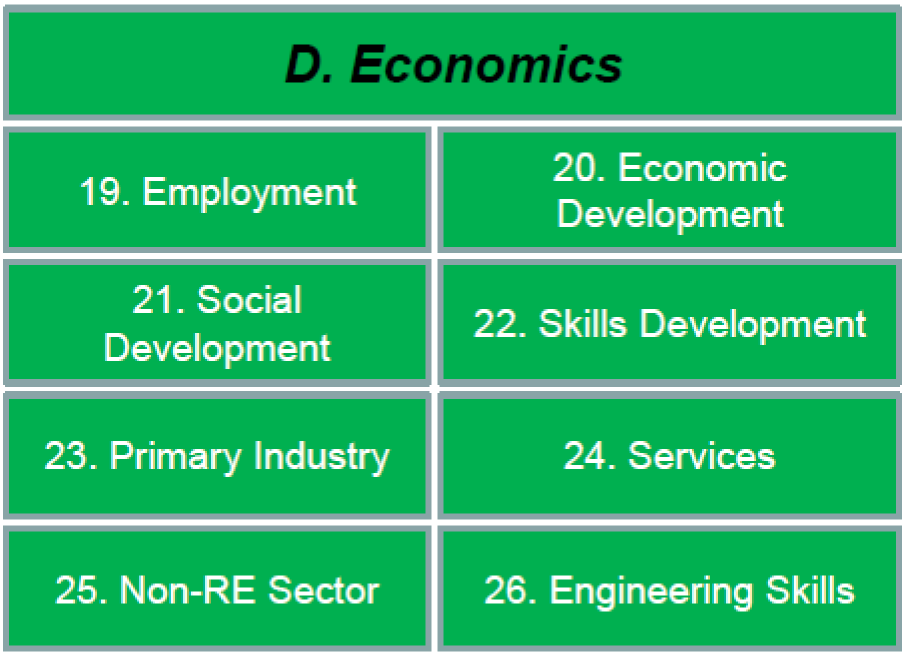
15. Administration / Bureaucracy

16. Climate Politics

17. International Opinion / Reputation

18. International Policy Agreements

Figure 7: Local Conditions Drivers



D. Economics

19. Employment

20. Economic Development

21. Social Development

22. Skills Development

23. Primary Industry

24. Services

25. Non-RE Sector

26. Engineering Skills

Figure 8: Economic Drivers

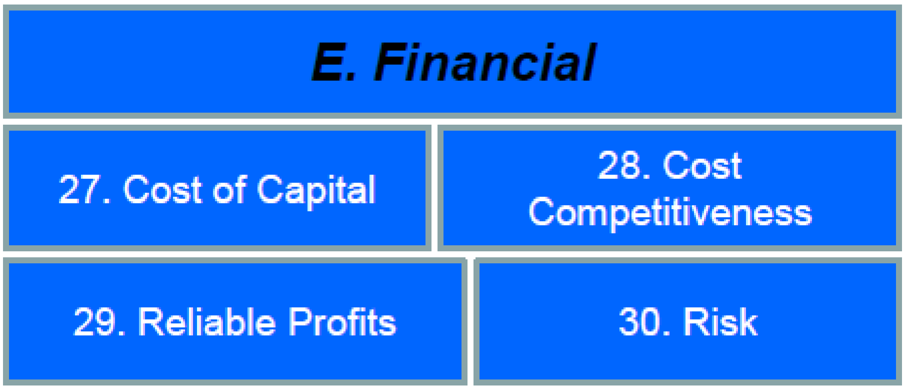


Figure 9: Financial Drivers

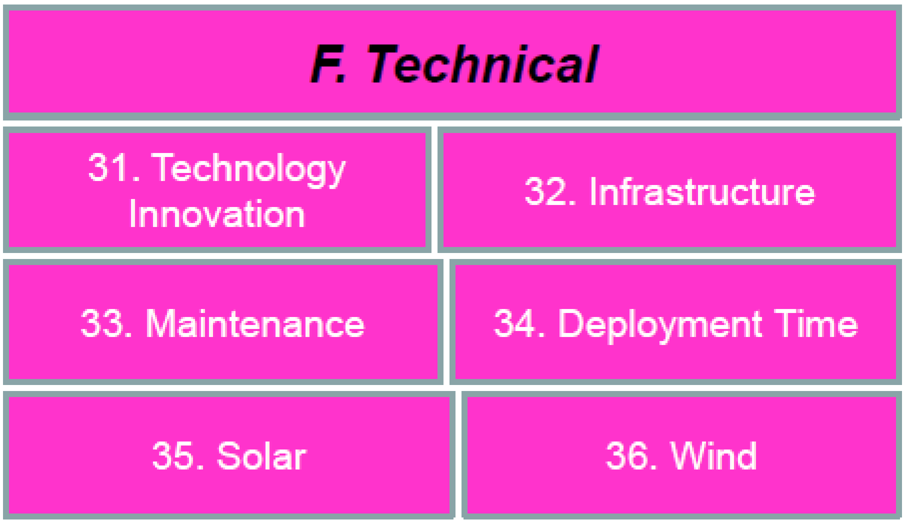


Figure 10: Technical Drivers

4.2 Influence: Edges

4.2.1 *Policy Nodes*

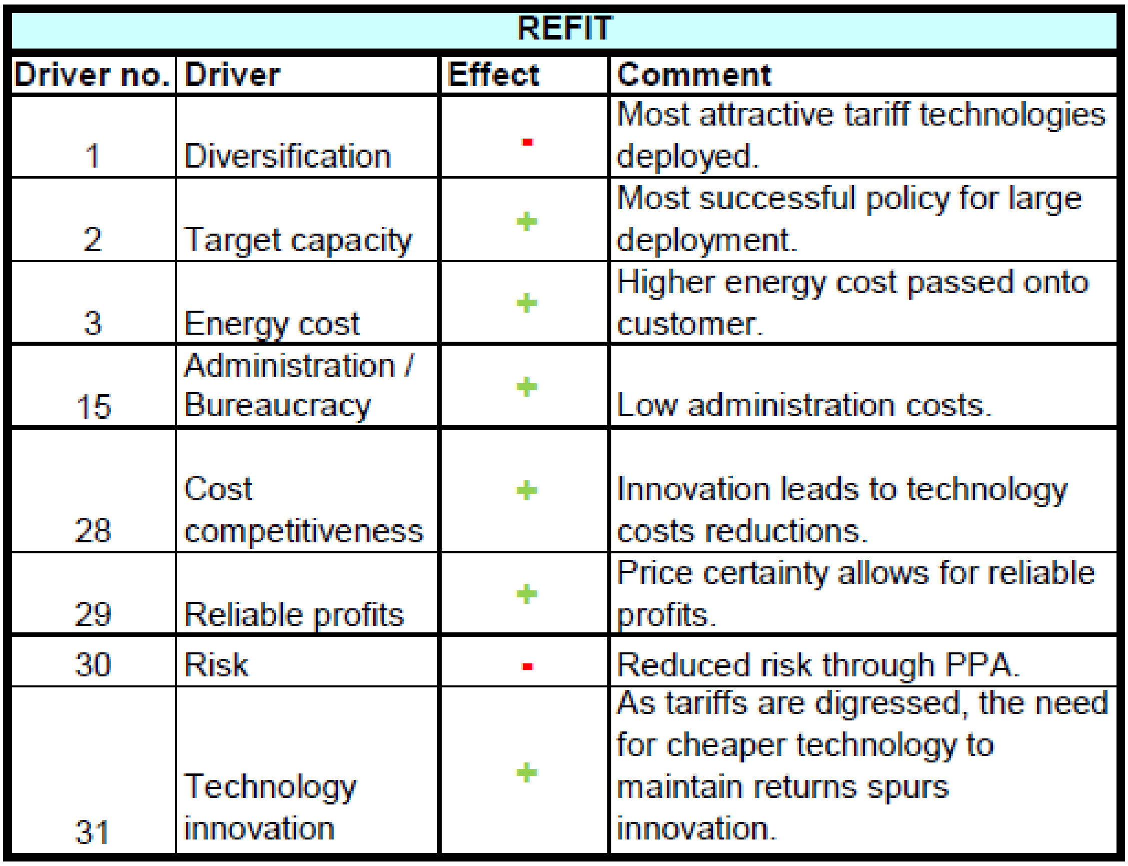
The causal links originating from the five policy nodes has been extracted from the advantages and disadvantages tables in Chapter two. Indeed three possible states can exist:

1. A positive causal link indicated by a **Green "+",**
2. A negative causal link indicated by a **Red "-",** or

3. No causal link indicated by a **“0”**. This has been omitted for simplicity.

Table 24 to Table 28 can be read as follows, under REFIT, Diversification is not encouraged as IPPs generally develop projects with the highest tariff and lowest technology cost. Hence a negative casual link. Or, Cost-Competitiveness is increased under a bidding/tendering system, hence a positive casual link. Each policy node has been extracted separately and shown individually from Table 24 to Table 28.

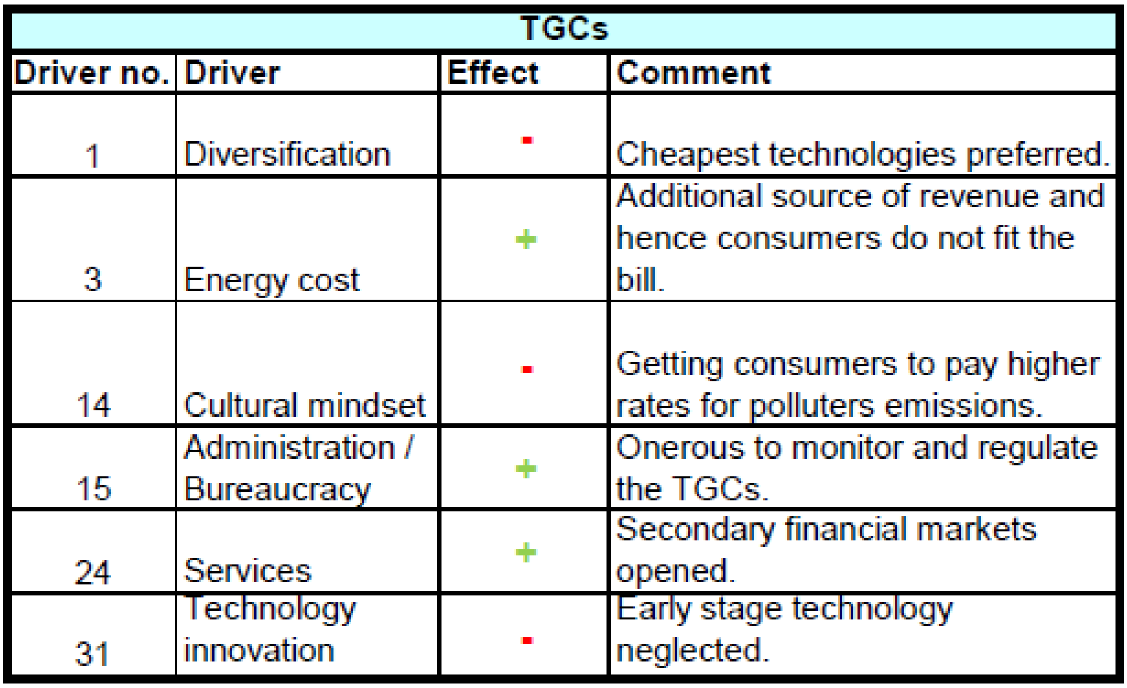
Table 24: Casual linkages from the REFIT Policy Node



REFIT

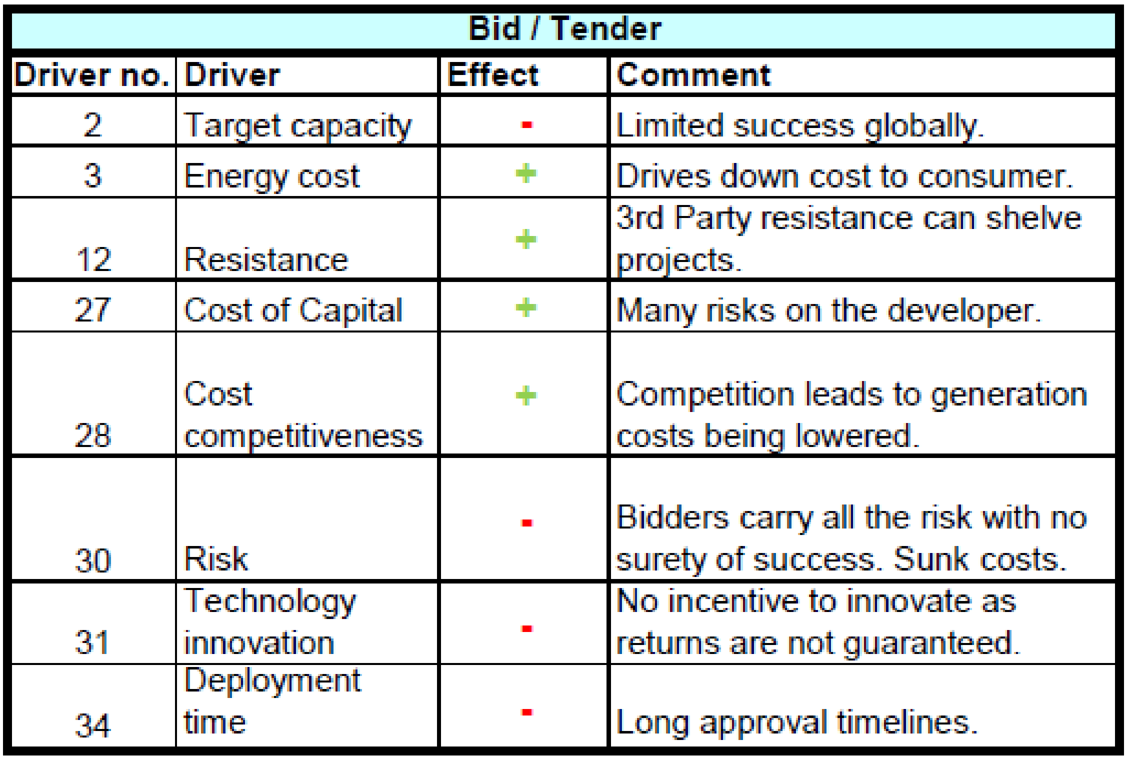
Driver no.	Driver	Effect	Comment
1	Diversification	-	Most attractive tariff technologies deployed.
2	Target capacity	+	Most successful policy for large deployment.
3	Energy cost	+	Higher energy cost passed onto customer.
15	Administration / Bureaucracy	+	Low administration costs.
28	Cost competitiveness	+	Innovation leads to technology costs reductions.
29	Reliable profits	+	Price certainty allows for reliable profits.
30	Risk	-	Reduced risk through PPA.
31	Technology innovation	+	As tariffs are digressed, the need for cheaper technology to maintain returns spurs innovation.

Table 25: Casual linkages from the TGC Policy Node



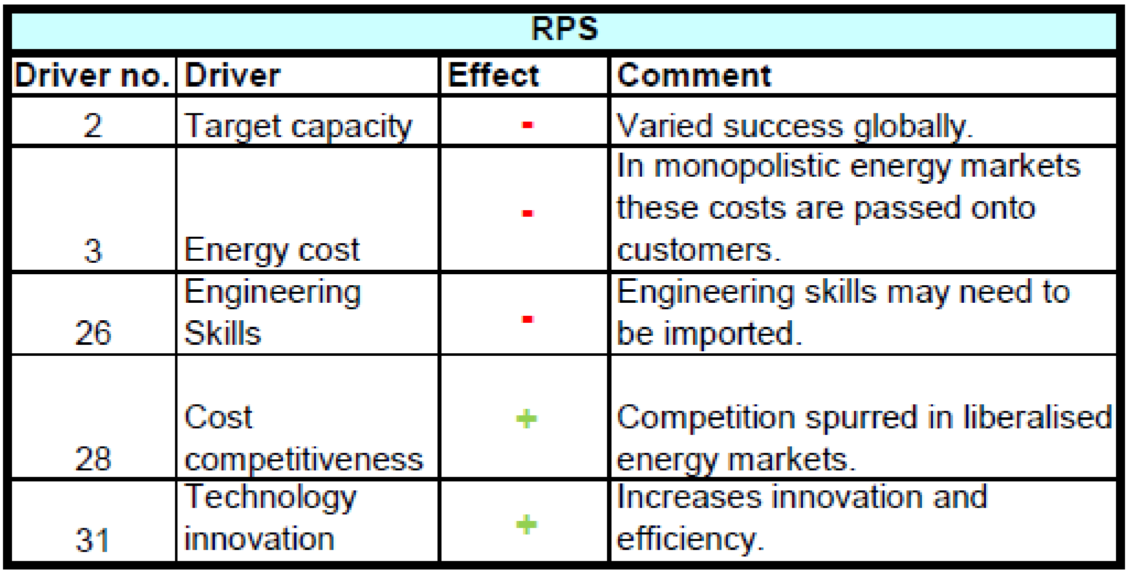
TGCs			
Driver no.	**Driver**	**Effect**	**Comment**
1	Diversification	-	Cheapest technologies preferred.
3	Energy cost	+	Additional source of revenue and hence consumers do not fit the bill.
14	Cultural mindset	-	Getting consumers to pay higher rates for polluters emissions.
15	Administration / Bureaucracy	+	Onerous to monitor and regulate the TGCs.
24	Services	+	Secondary financial markets opened.
31	Technology innovation	-	Early stage technology neglected.

Table 26: Casual linkages from the Bid / Tender Policy Node



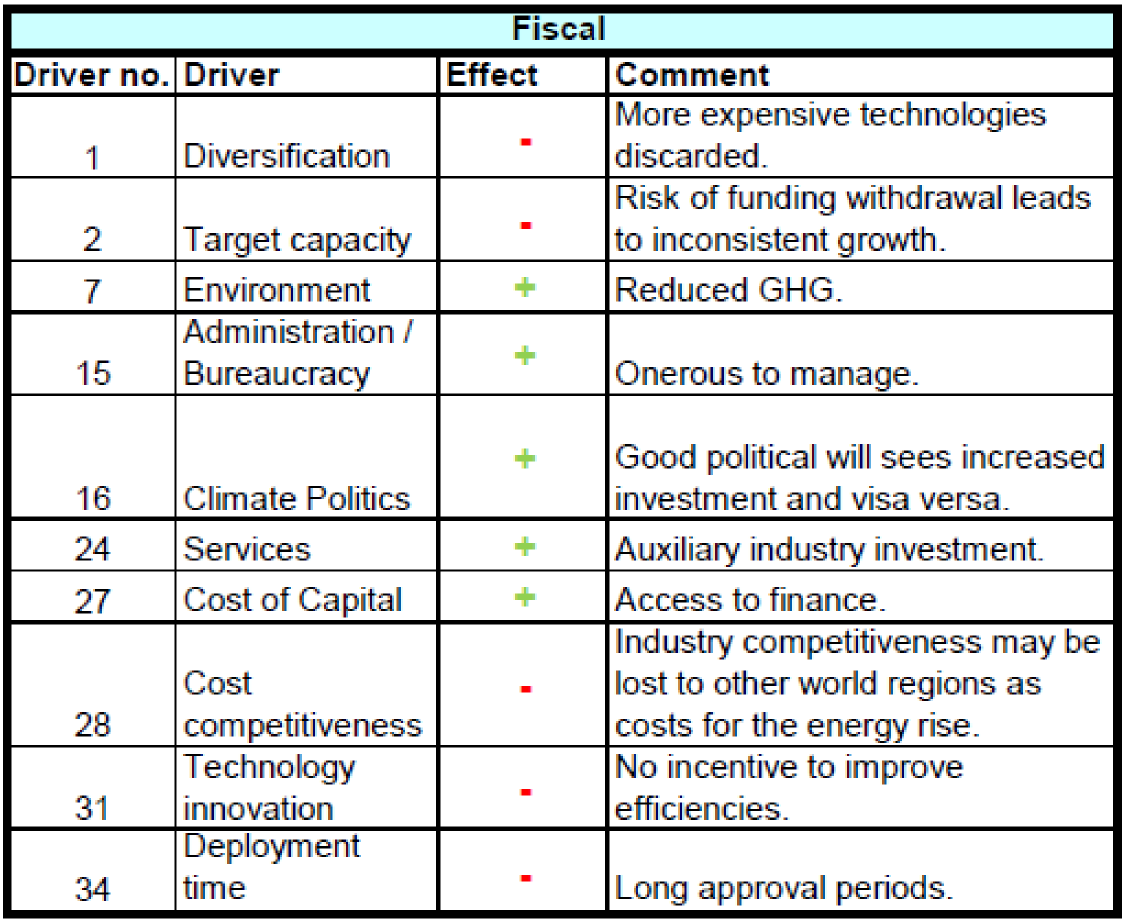
Bid / Tender			
Driver no.	**Driver**	**Effect**	**Comment**
2	Target capacity	-	Limited success globally.
3	Energy cost	+	Drives down cost to consumer.
12	Resistance	+	3rd Party resistance can shelve projects.
27	Cost of Capital	+	Many risks on the developer.
28	Cost competitiveness	+	Competition leads to generation costs being lowered.
30	Risk	-	Bidders carry all the risk with no surety of success. Sunk costs.
31	Technology innovation	-	No incentive to innovate as returns are not guaranteed.
34	Deployment time	-	Long approval timelines.

Table 27: Casual linkages from the RPS Policy Node



RPS			
Driver no.	**Driver**	**Effect**	**Comment**
2	Target capacity	-	Varied success globally.
3	Energy cost	-	In monopolistic energy markets these costs are passed onto customers.
26	Engineering Skills	-	Engineering skills may need to be imported.
28	Cost competitiveness	+	Competition spurred in liberalised energy markets.
31	Technology innovation	+	Increases innovation and efficiency.

Table 28: Casual linkages from the Fiscal Policy Node



Fiscal			
Driver no.	**Driver**	**Effect**	**Comment**
1	Diversification	-	More expensive technologies discarded.
2	Target capacity	-	Risk of funding withdrawal leads to inconsistent growth.
7	Environment	+	Reduced GHG.
15	Administration / Bureaucracy	+	Onerous to manage.
16	Climate Politics	+	Good political will sees increased investment and visa versa.
24	Services	+	Auxiliary industry investment.
27	Cost of Capital	+	Access to finance.
28	Cost competitiveness	-	Industry competitiveness may be lost to other world regions as costs for the energy rise.
31	Technology innovation	-	No incentive to improve efficiencies.
34	Deployment time	-	Long approval periods.

4.2.2 *Casual links between non-policy nodes*

As with the policy nodes, the causal links can be extracted for each of the thirty six identified drivers. The three possible states that can exist are:

1. A positive causal link indicated by a **Green "+",**
2. A negative causal link indicated by a **Red "-",** or
3. No causal link indicated by a **"0"**. This has been omitted for simplicity.

The approach taken here has to be to table each non-policy node (driver) against ***all*** other drivers, excluding the originating driver. Each casual link that has been established has been in the context of the affect it has on a RE sector and its deployment i.e. what affect does drive X have on drive Y in terms of deploying a RE sector. Below is leading question, written in the positive sense mostly, that helps focus the possible casual links between each driver.

The results of all these casual links can be found in Appendix B – Non-Policy Drivers Casual Links for Draft Model..

a. ***Local Energy Constraints***

i. **Diversification**

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 35 other drivers?

ii. **RE Target Capacity**

By setting capacity targets for RE generation, what casual links are evident to the other 35 drivers?

iii. **Energy Cost**

By increasing energy cost through the deployment of RE generating capacity, what casual links are evident on the other 35 drivers?

iv. **FDI / Investment**

By attracting FDI / Investment as a result of increased RE generation capacity needs, what casual links are evident on the other 35 drivers?

v. **Age of Existing Infrastructure**

When existing energy generation facilities reach their end of their design and operating life, and RE generation deployment is an option, what casual links are evident on the other 35 drivers?

vi. **Internalisation of Emissions**

When climate change agreements legislate the reduction of GHG emissions, through internalisation, and RE generation capacity becomes an attractive offset option, what casual links are evident on the other 35 drivers?

b. ***Encouraging a local RE Sector***

i. **Environment**

When increased RE generation capacity reduces GHG emissions and has positive effects on the environment, what casual links are evident on the other 35 drivers?

ii. **Health**

When increased RE generation capacity reduces GHG emissions and has positive effects on health, what casual links are evident on the other 35 drivers?

iii. **Weather**

When increased RE generation capacity reduces GHG emissions and reduces adverse weather conditions and patterns, what casual links are evident on the other 35 drivers?

iv. **Energy Security**

When increased localised RE generation is deployed and energy security is increased, what casual links are evident on the other 35 drivers?

v. Market Liberalisation

When RE target capacities attract IPPs and energy monopolies experience competition, what casual links are evident on the other 35 drivers?

c. *Local Conditions*

i. Resistance

When the cost of RE generation to the consumer or loss of market share from existing power producers, increases resistance, what casual links are evident on the other 35 drivers?

ii. Big Players

When increases in RE generation leads to the loss of market share for big players, what casual links are evident on the other 35 drivers?

iii. Culture and Mindset

When RE generation sets to change the energy mix and is met with a positive attitude and mindset, what casual links are evident on the other 35 drivers?

iv. Administration / Bureaucracy

When increased RE generating capacity is deployed and policy mechanisms require increased administration and bureaucratic hurdles, what casual links are evident on the other 35 drivers?

v. Climate Politics

When RE generation capacity is increased and proponents/opponents to RE generation increase pressure on political leaders, what casual links are evident on the other 35 drivers?

vi. International Opinion / Reputation

When a country adopts and deploys RE generating capacity and international opinion improves, what casual links are evident on the other 35 drivers?

vii. International Policy Agreements

When a country ratifies an international climate change agreement and results in increased RE generating capacity being deployed, what casual links are evident on the other 35 drivers?

d. *Economics*

i. Employment

With increased RE generating capacities set and deployed, and employment opportunities increasing, what casual links are evident on the other 35 drivers?

ii. Economic Development

With increased RE generating capacities set and deployed, and economic development increasing, what casual links are evident on the other 35 drivers?

iii. Social Development

With increased RE generating capacities set and deployed, and social development increasing, what casual links are evident on the other 35 drivers?

iv. Skills Development

With increased RE generating capacities set and deployed, and skills development increasing, what casual links are evident on the other 35 drivers?

v. Primary Industry

With increased RE generating capacities set and deployed, and primary RE related industry increasing, what casual links are evident on the other 35 drivers?

vi. Services

With increased RE generating capacities set and deployed, and RE service related industry increasing, what casual links are evident on the other 35 drivers?

vii. Non-RE Sector

With increased RE generating capacities set and deployed, and the non-RE related industry decreasing, what casual links are evident on the other 35 drivers?

viii. Engineering Skills

With increased RE generating capacities set and deployed, and RE engineering related skills increasing, what casual links are evident on the other 35 drivers?

e. *Financial*

i. Cost of Capital

When RE generating capacity targets are being financed and the cost of the finance is high or low, what casual links are evident on the other 35 drivers?

ii. Cost Competitiveness

When RE projects/installations are deployed and become cost competitive with traditional generation methods, what casual links are evident on the other 35 drivers?

iii. Reliable Profits

When RE generation projects/installations are deployed and a reliable stream of income and profit is generated over the operational life span, what casual links are evident on the other 35 drivers?

iv. Risk

When RE generating capacity is deployed and risks leading to this deployment have been minimised (country, political, financial, economic etc), what casual links are evident on the other 35 drivers?

f. *Technical*

i. Technology Innovation

When RE generating capacity is deployed and an industry is grown, with ever increasing competition and reducing tariffs, the increased technological innovation to maintain profit margins increase. What casual links are evident on the other 35 drivers?

ii. Infrastructure

When RE generating capacity is deployed where good grid and access infrastructure exists, what casual links are evident on the other 35 drivers?

iii. Maintenance

When RE generating capacity is deployed and facilities start generating, RE technology maintenance needs increase, what casual links are evident on the other 35 drivers?

iv. Deployment Time

When RE generating capacities are set and a need to bring new facilities on line quicker than traditional generation methods and deployment times decrease, what casual links are evident on the other 35 drivers?

v. Solar

When RE generating capacity is increased and solar technology is widely deployed, what casual links are evident on the other 35 drivers?

vi. Wind

When RE generating capacity is increased and wind technology is widely deployed, what casual links are evident on the other 35 drivers?

Below in Table 29 is an example of the process used to form the casual links per driver. A table is formed for each driver and then the casual effect on each other node is deduced and an explanation is included. The rest of the 34 tables are located in Appendix B.

Table 29: Example of Casual links between non-policy nodes

A. Local Energy Constraints

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 35 other drivers?

1. Diversification			
Driver No:	**Driver**	**Effect**	**Comment**
2	RE Target Capacity	+	A move away from fossil fuels.
3	Energy Cost	+	Greater use of expensive RE is initially at a higher cost.
4	FDI / Investment	+	Attracts investment in new projects.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Reduced GHG emissions leads to less negative impact on the environment.
8	Health	+	Reduced GHG emissions leads improved health.
9	Weather	+	Reduced GHG emissions leads to less adverse weather conditions and patterns.
10	Energy Security	+	Less reliance on imported energy.
11	Market Liberalisation	+	RE induced Independent Power Producers and can dilute previously monopolistic markets.
12	Resistance	0	
13	Big Players	-	New generation methods reduce market share of existing power producers.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	Increased power generation pool requires greater administration and hence bureaucracy.
16	Climate Politics	+	Increased lobbying for and against RE generation will be experienced.
17	International Opinion / Reputation	+	Reducing reliance on fossil fuels is seen in a positive light as it reduces the tragedy of the commons phenomenon.
18	International Policy Agreements	+	Reducing emissions through greater RE generation, is moving towards compliance with international agreements like Kyoto etc.
19	Employment	+	New generation methods provide employment opportunities throughout the project life cycle, from development to operation.
20	Economic Development	+	Greater dependability on energy resource and increased employment opportunities corresponds with increases in economic activity.
21	Social Development	+	Through a new industry, new opportunities present themselves to unite and uplift forgotten pockets of society. Geographically and generally, RE facilities are located in rural areas, where social development may be a priority.
22	Skills Development	+	Through a new industry, a new skill set is required and this will drive skills training and development.
23	Primary Industry	+	A new industry requires the value chain to be established, depending on the local capacity. Generally, opportunities exist to grow primary industry involved with manufacturing and deployment of RE technology.
24	Services	+	Support services needed to carry out development, research, funding and management etc are required throughout the life cycle of RE projects and by the industry itself.
25	Non-RE Sector	-	Increasing diversification can lead to traditional generators losing market share.
26	Engineering Skills	+	RE is reliant on technology for development and deployment. Technical aspects require traditional and new engineering skills.
27	Cost of Capital	0	
28	Cost Competitiveness	-	Initially, RE technology is not cost competitive with traditional generation methods.
29	Reliable Profits	0	
30	Risk	-	A new industry / sector brings uncertainty and therefore greater risk.
31	Technology Innovation	+	New generation methods need to mature and there is scope to improve and refine them. Hence new technological developments are spurred by diversification.
32	Infrastructure	+	Connecting new RE generation facilities to the grid will require existing and new infrastructure to be built/adapted.
33	Maintenance	+	New generation capacity using RE technology will require new maintenance regimes and skills.
34	Deployment Time	0	
35	Solar	+	A maturing technology that is chosen when diversifying energy mixes.
36	Wind	+	A maturing technology that is chosen when diversifying energy mixes.

4.3 FCM – Draft

Table 30 below shows the draft FCM. The causal links that have been extracted from above are shown in the modelling format.

Table 30: Draft FCM Model

"Receptors"

Transmitter	Diversification	RE target capacity	Energy cost	FDI / Investment	Age of existing infrastructure	Internalisation of emissions	Environment	Health	Weather	Energy security	Market liberalisation	Resistance	Big players	Culture / Mindset	Administration / Bureaucracy	Climate politics	International opinion / Reputation	International policy agreements	Employment	Economic development	Social development	Skills development	Primary industry	Services	Non-RE sector	Engineering skills	Cost of capital	Cost competitiveness	Reliable profits	Risk	Technology innovation	Infrastructure	Maintenance	Deployment time	Solar	Wind	REFIT	TGC	Bid/Tender	RPS	Fiscal
Diversification		1	1	1			1	1	1	1	1		-1		1	1	1	1	1	1	1	1	1	1	-1	1		-1		-1	1	1	1		1	1					
RE target capacity	1		-1	1			1	1	1	1	1		-1			1	1	1	1	1	1	1	1	1	-1	1	-1	1	1		1	-1	1		1	1					
Energy cost	-1	-1		1			-1	-1	-1	-1	-1	1	-1			1				-1	-1	-1	-1	-1	1	-1		-1													
FDI / Investment	1	1								1	1					1			1	1	1	1	1	1	-1	1	1			-1	1			1							
Age of existing infrastructure	1		-1	1			1	1	1	1	1	-1	-1			1			1	1	1	1	1	1	-1	1					1		-1		1	1					
Internalisation of emissions	1	1	-1	1	-1		1	1	1	1	1	-1	-1		-1	1	1	1					1	1	-1	1		1			1				1	1					
Environment	1	1						1	1					1	1	1	1	1	1	1	1	1	1	1	-1																
Health	1	1				1	1							1		1				1	1				-1																
Weather	1	1				1	1	1		1				1		1				1	1						1			1			1								
Energy security			1								1		1			1	1	1	1	1	1	1	1	1	-1	1	1	-1		-1	1				1	1					
Market liberalisation	1	1	-1	1						1		-1	1		1	-1	1	1	1	1	1	1	1	1	-1	1	1			-1	1				1	1					
Resistance	-1	-1	1				-1	-1	-1	-1	-1		1			1			-1	-1	-1	-1	-1	-1		-1															
Big players	-1	-1				-1				-1	-1	1				1									1						1										
Culture / Mindset	1	1		1			1	1	1	1	1	-1				1		1												-1											
Administration / Bureaucracy	-1	-1	1	-1						-1	-1								-1	-1	-1	-1	-1	-1		-1	1			1				1							
Climate politics	1	1	-1	1		1	1	1	1	1	1	1	1	1			1	1					1	1	-1																
International opinion / Reputation				1												1											1			-1											
International policy agreements	1	1	1	1			1	1	1	1	1		1			1	1						1	1			1			-1											
Employment													-1			1				1	1	1			-1	1				-1											
Economic development				1				1			1					1	1		1		1	1	1	1		1	1			-1											
Social development				1			1	1	1				1		-1	1	1	1	1	1		1			1	1				-1											
Skills development																1	1	1	1	1	1		1		1	1	1			-1	1		1								
Primary industry				1						1	1	1	-1		1	1		1	1	1	1	1		1	-1	1	1	1		-1	1			1	1	1					
Services															1			1	1	1	1	1	1								1										
Non-RE sector		1	-1				-1	-1	-1	-1	-1	1	1			1	1	1	1	1	1	1				1	1					1		1							
Engineering skills	1		1				1	1	1	1	1								1				1		-1			1		-1	1	1	1	1	1	1					
Cost of capital	1			1						1	1								-1	1	1	1	1		-1			-1	1	1	1										
Cost competitiveness	1	1	1				1	1	1	1	1	-1	-1	1		1			1	1	1	1	1		-1	-1	1		1	-1	-1										
Reliable profits	1	1	1	1			1	1	1	1	1	1	-1		1	1			1	1	1	1	1	1	-1	1	1	1		-1	1										
Risk	-1	-1	-1	-1			-1	-1	-1	-1	-1					1		-1	-1	-1	-1	-1	-1	-1	1	-1	-1		-1												
Technology innovation	1		1	1			1	1	1	1	1								1	1	1	1	1	1		1	1	1	1	-1				1	1	1					
Infrastructure	1									1	1								1	1	1	1	1			1		1	1	-1	1										
Maintenance					1					1									1	1	1	1				1					1										
Deployment time	1	1			1		1	1	1	1	1		-1			1	1	1									1		1	-1	1	1									
Solar	1		1			1	1	1	1	1	1	1							1	1	1	1	1	1	-1	1	1				1		1								
Wind	1		1			1	1	1	1	1	1	1							1	1	1	1	1	1	-1	1	1				1		1								
REFIT	-1	1	1												1													1	1	1	1										
TGC	-1		1											-1	1									1							-1										
Bid/Tender		-1	1									1															1	1		-1	-1			-1							
RPS		-1	-1																							-1		1			1										
Fiscal	-1	-1					1								1	1								1			1	-1			-1			-1							

From the above it is evident that there are a number of interrelated casual links. For this reason, a diagrammatical version of the model has not been drawn. The above, with the tables in Appendix B show there a number of trends exist. For example, the drivers of economic, social and skills development follow common casual links. For this and other drivers, the model can be simplified. The following section draws out these commonalities and a simpler model is presented.

4.4 FCM simplification

The following parts of the draft FCM can be simplified. Drivers, where redundancy exists has been extracted and simplified. Reasons are also provided.

4.4.1 *Local Energy Constraints*

Under this section, 2 drivers need to be revised. These are:

- Driver 5: Age of existing Infrastructure – This driver holds great resemblance to driver 32 “Infrastructure” and hence the two will be combined. This combination will encompass any and all issues related to current fossil fuel generating infrastructure, transmission and distribution networks. The new driver will be called “Existing Infrastructure”.
- Driver 6: Internalisation of Emissions – This driver will be removed altogether from the model as it is not seen as a key driving force when a country deploys a policy to start a renewable energy sector. This may become a driver in future models when international climate change agreements like Kyoto, are revised.

4.4.2 *Encouraging a local RE Sector*

Under this section, 3 drivers can be grouped together. These are:

- Driver 7: Environment
- Driver 8 :Health
- Driver 9: Weather

All these drivers follow the same causal relationships. Indeed, all 3 are related and can thus be lumped together. The new driver will be called “Common Good Elements”

4.4.3 *Local Conditions*

Under this section, the following 2 simplifications can be made:

- Driver 12: Resistance and Driver 14: Culture / Mindset can be lumped into one driver. These two individual drivers are very similar and follow similar casual patterns. Hence they will be married under a new driver name of “Resistance”.

- Driver 17: International Opinion/Reputation and Diver 18: International Policy Agreements will also be lumped together as they are essentially the same and follow the same casual relationships. The new driver will be called “Climate Change Initiatives”.

4.4.4 *Economics*

Under this section, 6 drivers can be simplified to 3. These are:

- Driver 20: Economic Development and Driver 21: Social Development can be lumped together. These are interrelated drivers and encompass the same trends. The new driver will be called “Socio-Economic Development”.

- Driver 22: Skills Development and Driver 26: Engineer Skills can be lumped together. Again, skills development, in different fields can be broadly placed under one banner. The new driver will be called “Skills Enhancement”.

- Driver 23: Primary Industry and Driver 24: Services can be lumped together. They both follow the same trends and causal relationships. The new driver will be called “Industry Development”.

4.4.5 *Financial*

No simplification can be mad under this section.

4.4.6 *Technology*

Under this section, 2 drivers need to e revised. These are:

- Driver 33: Maintenance will be removed altogether. This driver, when considered from an employment perspective, can fall under the employment driver. From the point of view that renewable energy being chosen as it will be have a lower need for maintenance in relation to traditional generation methods, the simple conclusion is that maintenance will never be completed nullified, therefore this driver becomes less important to the choice of renewable energy policy deployed. Hence it is being removed.
- Driver 35: Solar and Driver 36: Wind is also being removed altogether. The reasoning being that the choice of which technology to deploy in a specific country will be a direct result of the chosen renewable energy policy and the available resource. The model is aimed at developing a renewable energy sector and not specifying which technology will be best. There are also other forms of renewable energy generating resources, like biomass, tidal, geothermal etc that would also need to be included, that would make the model more complex and diverge off the aim of the model to identify effective drivers of renewable energy policy. Hence these two have been omitted.

From the above it can be concluded that from the original 36 identified drivers, now we have 24.

4.5 Reworking of Sections 4.1 and 4.2

This section takes the simplifications of section 4.3 and works it into the work already done in sections 4.1 and 4.2. This is done for clarity and unless the reader wishes to check this, please goes straight to the revised FCM at the end of this section.

4.5.1 *Revised Drivers*

The non-policy nodes have been simplified accordingly:

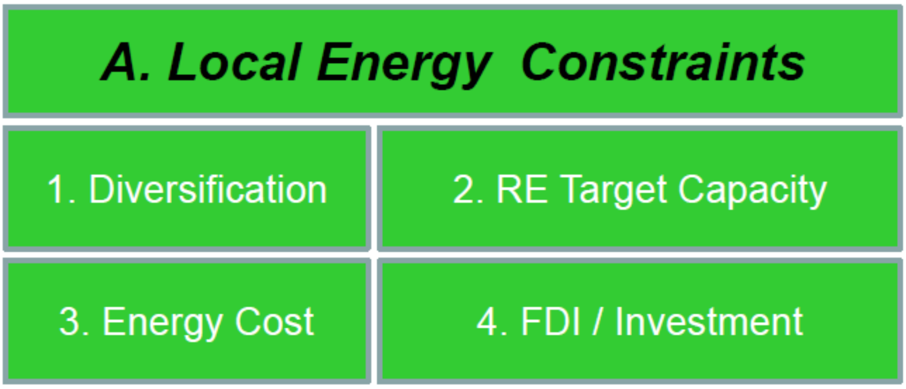
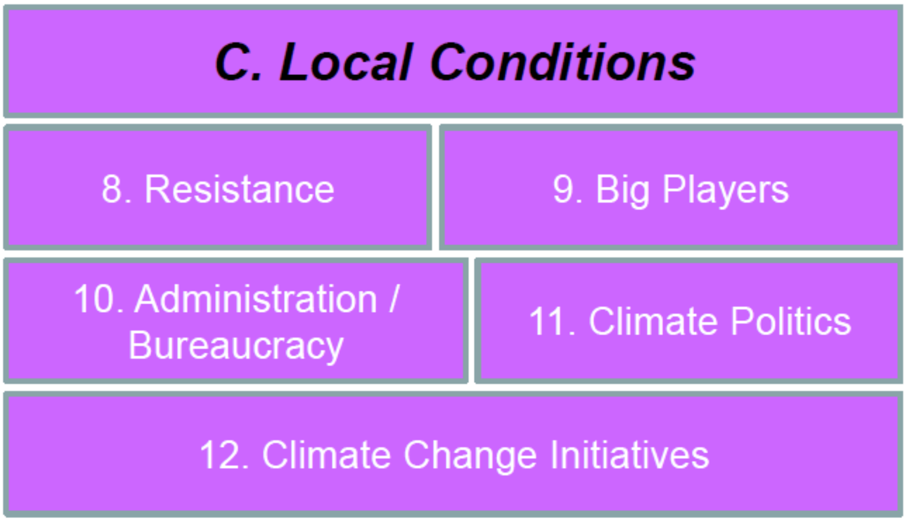


Figure 11: Revised Local Energy Constraints Drivers

Figure 12: Revised Encouraging an RE Industry Drivers



C. Local Conditions

8. Resistance

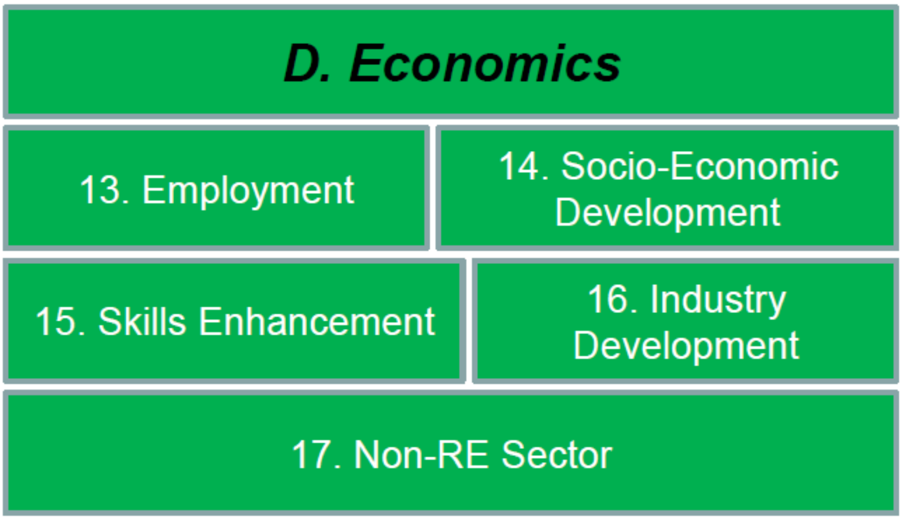
9. Big Players

10. Administration / Bureaucracy

11. Climate Politics

12. Climate Change Initiatives

Figure 13: Revised Local Conditions Drivers



D. Economics

13. Employment

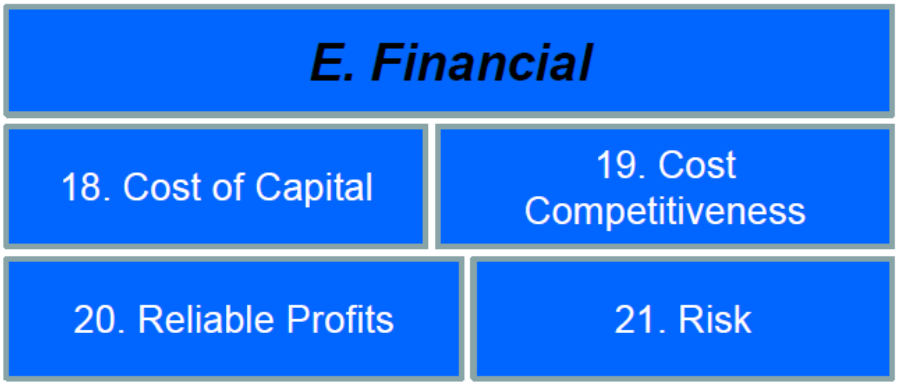
14. Socio-Economic Development

15. Skills Enhancement

16. Industry Development

17. Non-RE Sector

Figure 14: Revised Economic Drivers



E. Financial

18. Cost of Capital

19. Cost Competitiveness

20. Reliable Profits

21. Risk

Figure 15: Revised Financial Drivers

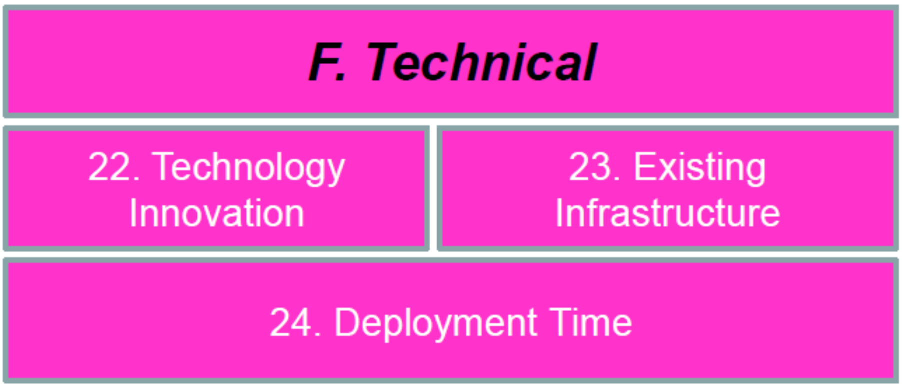
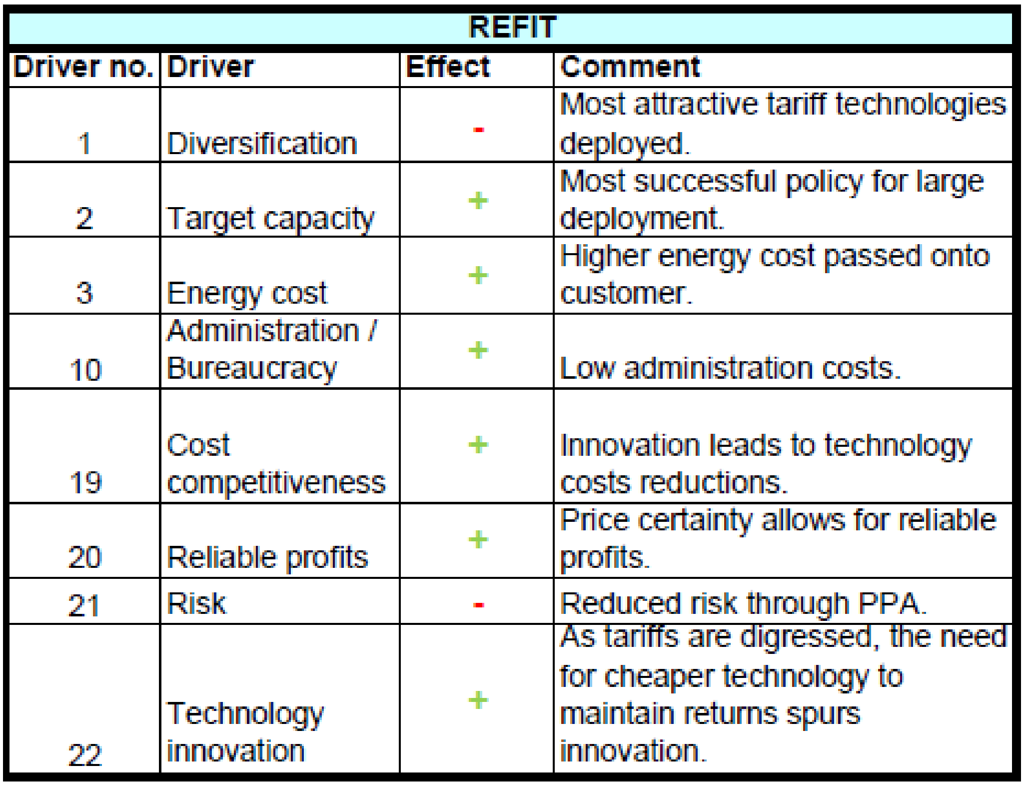


Figure 16: Revised Technical Drivers

4.5.2 *Revised Policy Nodes Casual Links*

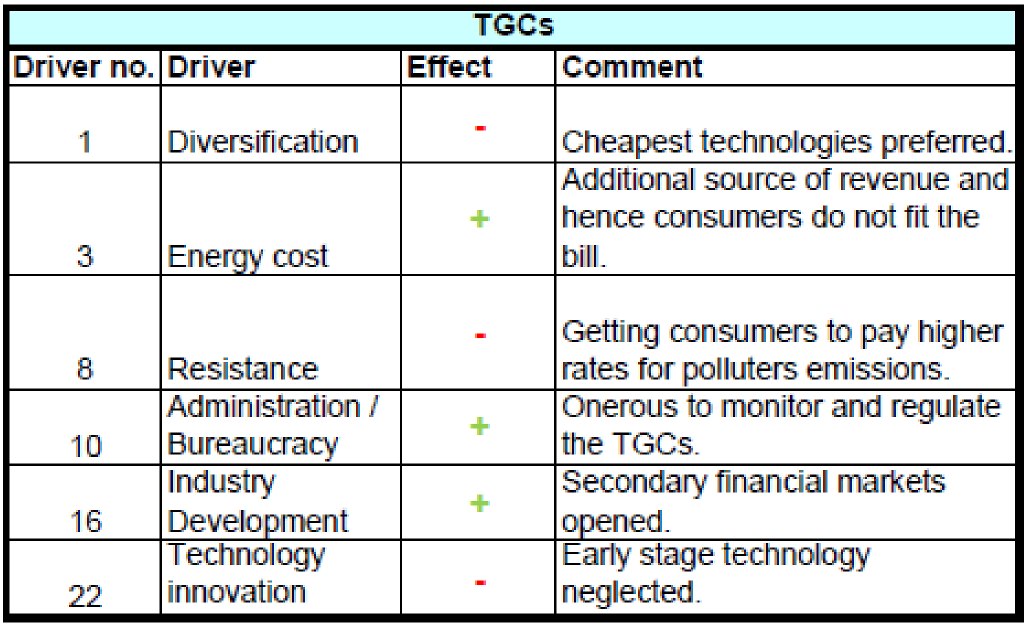
The policy nodes' casual links have been updated accordingly:

Table 31: Revised Casual linkages from the REFIT Policy Node



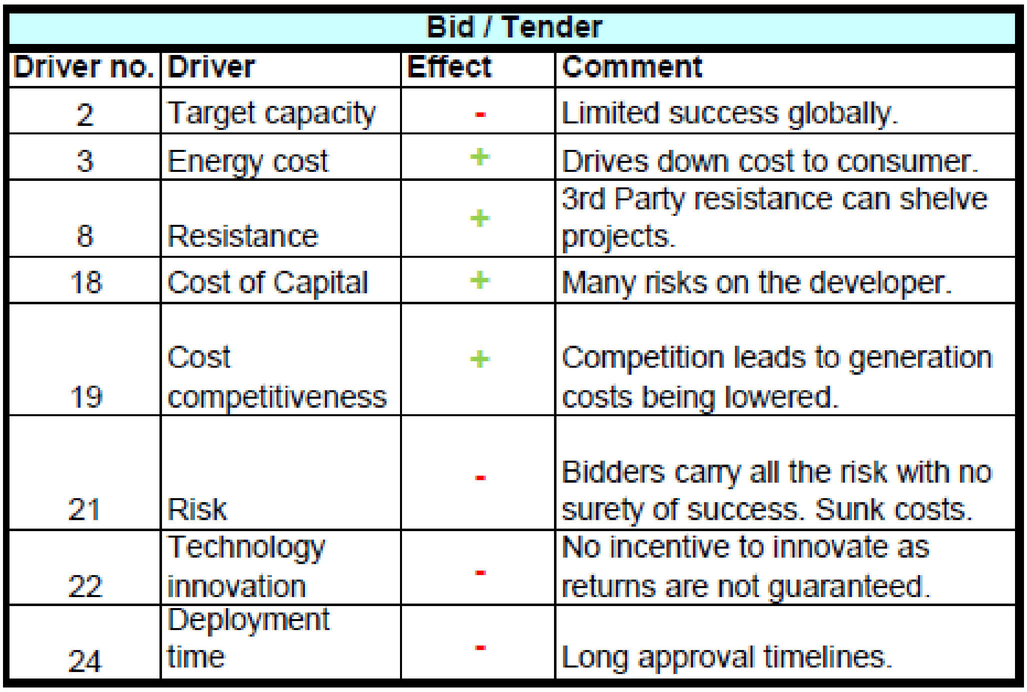
REFIT			
Driver no.	**Driver**	**Effect**	**Comment**
1	Diversification	-	Most attractive tariff technologies deployed.
2	Target capacity	+	Most successful policy for large deployment.
3	Energy cost	+	Higher energy cost passed onto customer.
10	Administration / Bureaucracy	+	Low administration costs.
19	Cost competitiveness	+	Innovation leads to technology costs reductions.
20	Reliable profits	+	Price certainty allows for reliable profits.
21	Risk	-	Reduced risk through PPA.
22	Technology innovation	+	As tariffs are digressed, the need for cheaper technology to maintain returns spurs innovation.

Table 32: Revised Casual linkages from the TGCs Policy Node



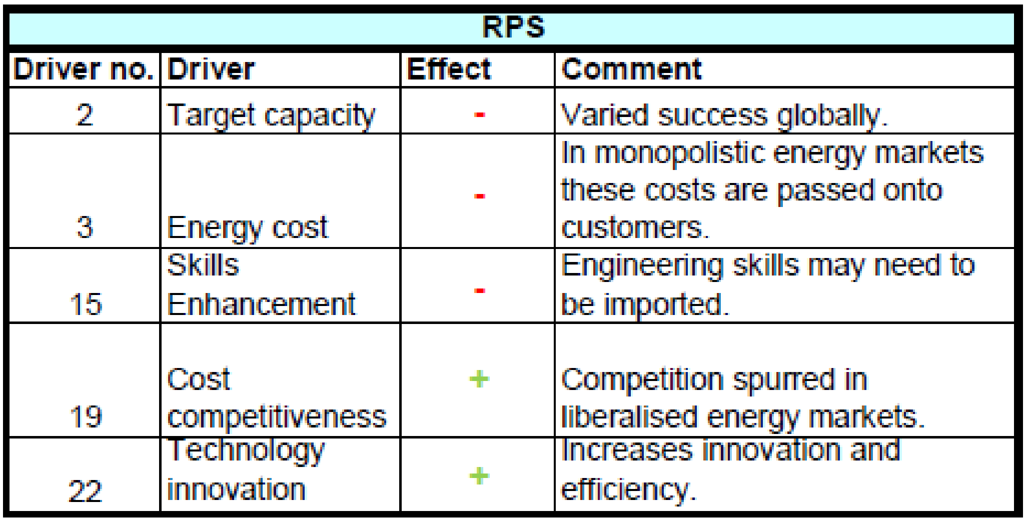
TGCs			
Driver no.	**Driver**	**Effect**	**Comment**
1	Diversification	-	Cheapest technologies preferred.
3	Energy cost	+	Additional source of revenue and hence consumers do not fit the bill.
8	Resistance	-	Getting consumers to pay higher rates for polluters emissions.
10	Administration / Bureaucracy	+	Onerous to monitor and regulate the TGCs.
16	Industry Development	+	Secondary financial markets opened.
22	Technology innovation	-	Early stage technology neglected.

Table 33: Revised Casual linkages from the Bid/Tender Policy Node



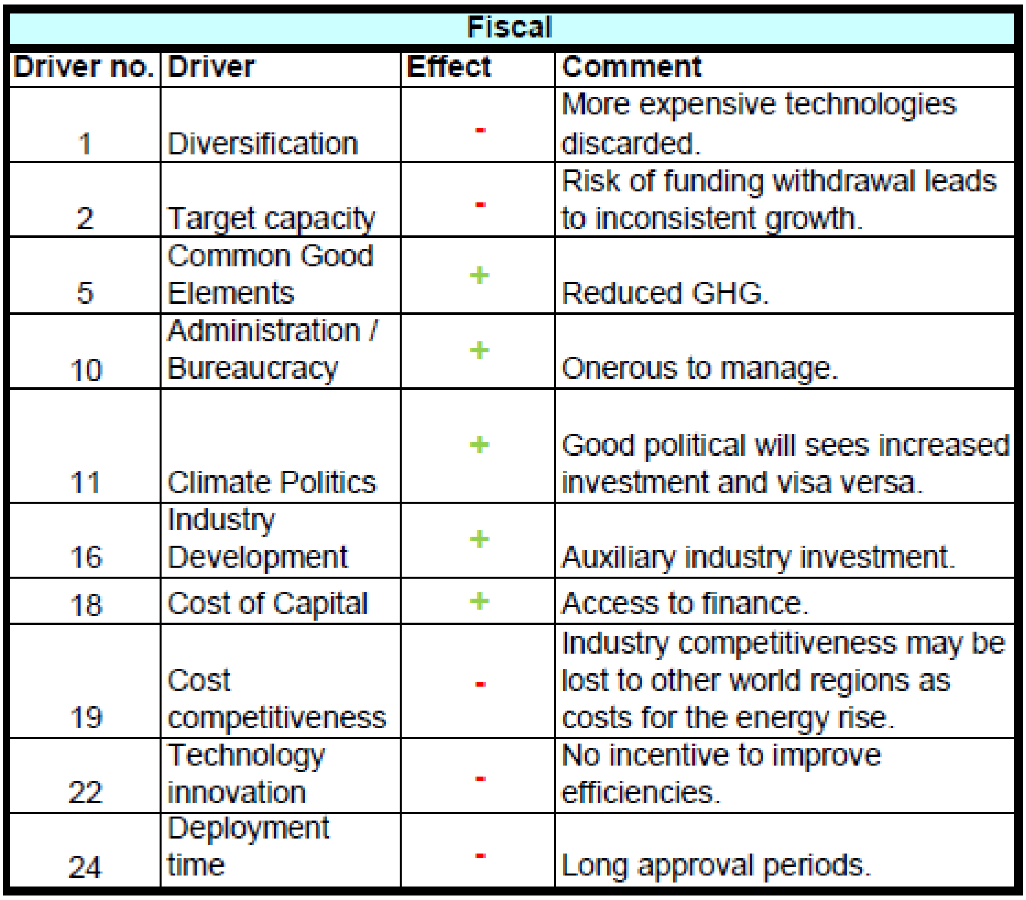
Bid / Tender			
Driver no.	**Driver**	**Effect**	**Comment**
2	Target capacity	-	Limited success globally.
3	Energy cost	+	Drives down cost to consumer.
8	Resistance	+	3rd Party resistance can shelve projects.
18	Cost of Capital	+	Many risks on the developer.
19	Cost competitiveness	+	Competition leads to generation costs being lowered.
21	Risk	-	Bidders carry all the risk with no surety of success. Sunk costs.
22	Technology innovation	-	No incentive to innovate as returns are not guaranteed.
24	Deployment time	-	Long approval timelines.

Table 34: Revised Casual linkages from the RPS Policy Node



RPS			
Driver no.	**Driver**	**Effect**	**Comment**
2	Target capacity	-	Varied success globally.
3	Energy cost	-	In monopolistic energy markets these costs are passed onto customers.
15	Skills Enhancement	-	Engineering skills may need to be imported.
19	Cost competitiveness	+	Competition spurred in liberalised energy markets.
22	Technology innovation	+	Increases innovation and efficiency.

Table 35: Revised Casual linkages from the Fiscal Policy Node



Fiscal			
Driver no.	**Driver**	**Effect**	**Comment**
1	Diversification	-	More expensive technologies discarded.
2	Target capacity	-	Risk of funding withdrawal leads to inconsistent growth.
5	Common Good Elements	+	Reduced GHG.
10	Administration / Bureaucracy	+	Onerous to manage.
11	Climate Politics	+	Good political will sees increased investment and visa versa.
16	Industry Development	+	Auxiliary industry investment.
18	Cost of Capital	+	Access to finance.
19	Cost competitiveness	-	Industry competitiveness may be lost to other world regions as costs for the energy rise.
22	Technology innovation	-	No incentive to improve efficiencies.
24	Deployment time	-	Long approval periods.

4.5.3 *Revised Non-Policy Nodes Casual Links*

The leading questions from above, have been revised to reflect the simplification of the model from 36 drivers to 24 drivers. These questions were once again used to formulate the casual links and update the FCM. The results can be found in Appendix C.

g. ***Local Energy Constraints***

i. **Diversification**

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 23 other drivers?

ii. **RE Target Capacity**

By setting capacity targets for RE generation, what casual links are evident to the other 23 drivers?

iii. **Energy Cost**

By increasing energy cost through the deployment of RE generating capacity, what casual links are evident on the other 23 drivers?

iv. **FDI / Investment**

By attracting FDI / Investment as a result of increased RE generation capacity needs, what casual links are evident on the other 23 drivers?

h. ***Encouraging a local RE Sector***

i. **Common Good Elements**

When increased RE generation capacity reduces GHG emissions and has positive effects on the environment, health and weather, what casual links are evident on the other 23 drivers?

ii. **Energy Security**

When increased localised RE generation is deployed and energy security is increased, what casual links are evident on the other 23 drivers?

iii. **Market Liberalisation**

When RE target capacities attract IPPs and energy monopolies experience competition, what casual links are evident on the other 23 drivers?

i. ***Local Conditions***

i. **Resistance**

When the cost of RE generation to the consumer or loss of market share from existing power producers, increases resistance, what casual links are evident on the other 23 drivers?

ii. **Big Players**

When increases in RE generation leads to the loss of market share for big players, what casual links are evident on the other 23 drivers?

iii. **Administration / Bureaucracy**

When increased RE generating capacity is deployed and policy mechanisms require increased administration and bureaucratic hurdles, what casual links are evident on the other 23 drivers?

iv. **Climate Politics**

When RE generation capacity is increased and proponents/opponents to RE generation increase pressure on political leaders, what casual links are evident on the other 23 drivers?

v. **Climate Change Initiatives**

When a country adopts international climate change policies and as a result deploys renewable energy generating capacity, what casual links are evident on the other 23 drivers?

j. ***Economics***

i. **Employment**

With increased RE generating capacities set and deployed, and employment opportunities increasing, what casual links are evident on the other 23 drivers?

ii. **Socio-Economic Development**

With increased RE generating capacities set and deployed, and socio-economic development increasing, what casual links are evident on the other 23 drivers?

iii. **Skills Enhancement**

With increased RE generating capacities set and deployed, and skills development (including engineering) increasing, what casual links are evident on the other 23 drivers?

iv. **Industry Development**

With increased RE generating capacities set and deployed, and both primary and support service RE related industry increasing, what casual links are evident on the other 23 drivers?

v. **Non-RE Sector**

With increased RE generating capacities set and deployed, and the non-RE related industry decreasing, what casual links are evident on the other 23 drivers?

k. *Financial*

i. Cost of Capital

When RE generating capacity targets are being financed and the cost of the finance is high or low, what casual links are evident on the other 23 drivers?

ii. Cost Competitiveness

When RE projects/installations are deployed and become cost competitive with traditional generation methods, what casual links are evident on the other 23 drivers?

iii. Reliable Profits

When RE generation projects/installations are deployed and a reliable stream of income and profit is generated over the operational life span, what casual links are evident on the other 23 drivers?

iv. Risk

When RE generating capacity is deployed and risks leading to this deployment have been minimised (country, political, financial, economic etc), what casual links are evident on the other 23 drivers?

l. *Technical*

i. Technology Innovation

When RE generating capacity is deployed and an industry is grown, with ever increasing competition and reducing tariffs, the increased technological innovation to maintain profit margins increase. What casual links are evident on the other 23 drivers?

ii. Existing Infrastructure

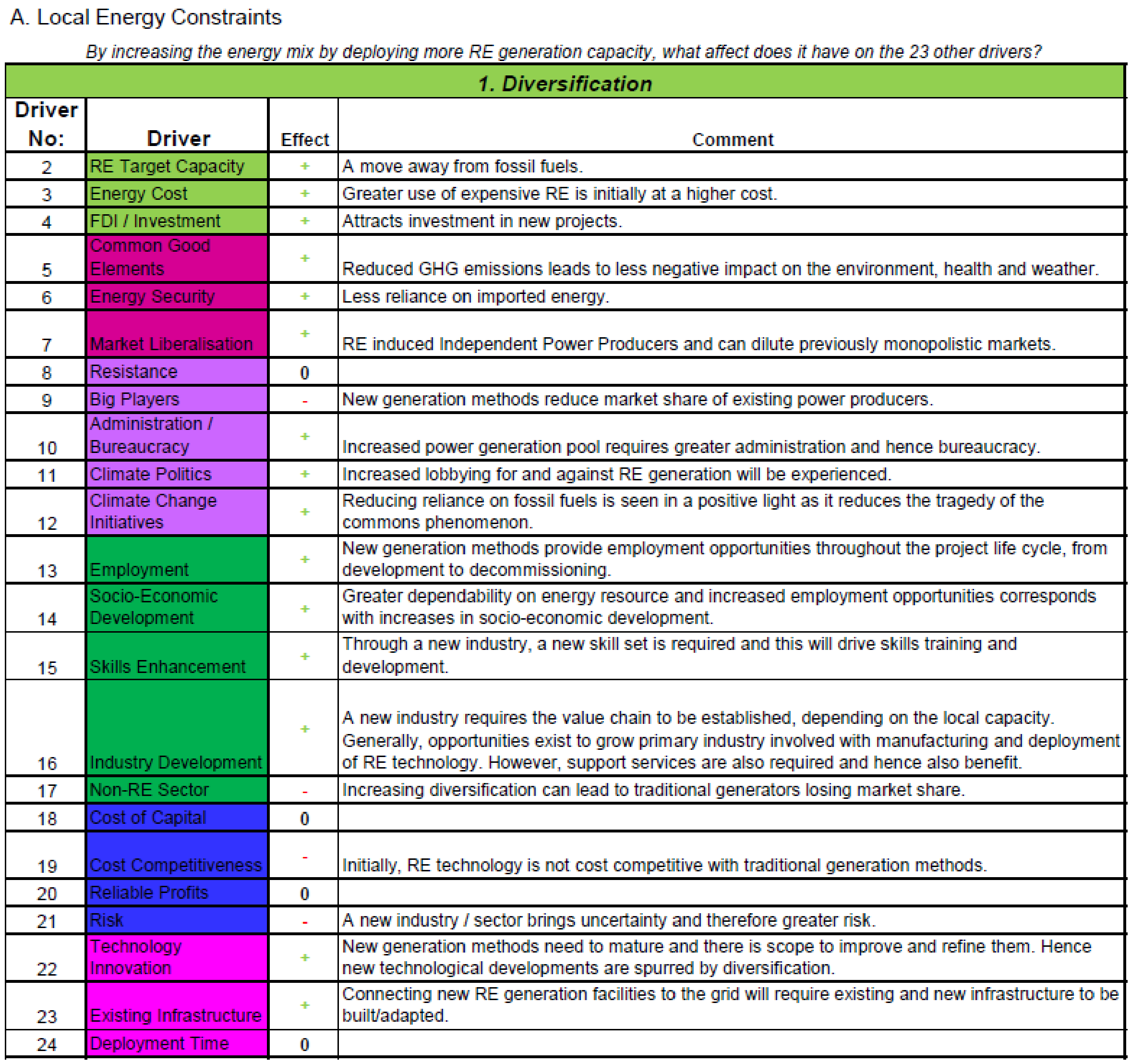
When RE generating capacity is deployed where good grid and access infrastructure exists, what casual links are evident on the other 23 drivers?

iii. Deployment Time

When RE generating capacities are set and a need to bring new facilities on line quicker than traditional generation methods and deployment times decrease, what casual links are evident on the other 23 drivers?

Below is an example of the process used to form the casual links per driver for the revised set of drivers. A table is formed for each driver and then the casual effect on each other node is deduced and an explanation is included. The rest of the 23 tables are located in Appendix C – Revised Non-Policy Drivers Casual Links for Draft Model.

Table 36: Example of revised Casual links between non-policy nodes



A. Local Energy Constraints

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 23 other drivers?

1. Diversification			
Driver No:	**Driver**	**Effect**	**Comment**
2	RE Target Capacity	+	A move away from fossil fuels.
3	Energy Cost	+	Greater use of expensive RE is initially at a higher cost.
4	FDI / Investment	+	Attracts investment in new projects.
5	Common Good Elements	+	Reduced GHG emissions leads to less negative impact on the environment, health and weather.
6	Energy Security	+	Less reliance on imported energy.
7	Market Liberalisation	+	RE induced Independent Power Producers and can dilute previously monopolistic markets.
8	Resistance	0	
9	Big Players	-	New generation methods reduce market share of existing power producers.
10	Administration / Bureaucracy	+	Increased power generation pool requires greater administration and hence bureaucracy.
11	Climate Politics	+	Increased lobbying for and against RE generation will be experienced.
12	Climate Change Initiatives	+	Reducing reliance on fossil fuels is seen in a positive light as it reduces the tragedy of the commons phenomenon.
13	Employment	+	New generation methods provide employment opportunities throughout the project life cycle, from development to decommissioning.
14	Socio-Economic Development	+	Greater dependability on energy resource and increased employment opportunities corresponds with increases in socio-economic development.
15	Skills Enhancement	+	Through a new industry, a new skill set is required and this will drive skills training and development.
16	Industry Development	+	A new industry requires the value chain to be established, depending on the local capacity. Generally, opportunities exist to grow primary industry involved with manufacturing and deployment of RE technology. However, support services are also required and hence also benefit.
17	Non-RE Sector	-	Increasing diversification can lead to traditional generators losing market share.
18	Cost of Capital	0	
19	Cost Competitiveness	-	Initially, RE technology is not cost competitive with traditional generation methods.
20	Reliable Profits	0	
21	Risk	-	A new industry / sector brings uncertainty and therefore greater risk.
22	Technology Innovation	+	New generation methods need to mature and there is scope to improve and refine them. Hence new technological developments are spurred by diversification.
23	Existing Infrastructure	+	Connecting new RE generation facilities to the grid will require existing and new infrastructure to be built/adapted.
24	Deployment Time	0	

4.6 Revised FCM

Table 37 below is a tabular representation of the casual links extracted from the 24 tables in Appendix C:

Table 37: Revised FCM Model

"Receptors"

Transmitter	Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Diversification		1	1	1	1	1	1		-1	1	1	1	1	1	1	1	-1		-1		-1	1	1						
RE Target Capacity	1		-1	1	1	1	1		-1	1		1	1	1	1	1	1	-1	-1	1	-1		1						
Energy Cost	-1	-1		1	-1	-1	-1	1	-1		1			-1	-1	-1	1		-1										
FDI / Investment	1	1				1	1				1		1	1	1	1	-1	1			-1	1		1					
Common Good Elements	1	1							1	1	1	1	1	1	1	1	-1												
Energy Security			1				1		1	1	1	1	1	1	1	1	-1	1	-1		-1								
Market liberalisation	1	1	-1	1		1		-1	1	1	-1	1	1	1	1	1	-1	1			-1	1							
Resistance	-1	-1	1		-1	-1	-1		1		1		-1	-1	-1	-1													
Big Players	-1	-1				-1	-1	1									1					1							
Administration / Bureaucracy	-1	-1	1	-1		-1	-1						-1	-1	-1	-1		1			1			1					
Climate Politics	1	1	-1	1		1	1	1	1			1				1	-1												
Climate Change Initiatives				1							1							1			-1								
Employment									-1		1			1	1		-1			1	-1								
Socio-Economic Development				1			1				1	1	1		1	1		1			-1								
Skills Enhancement											1	1	1	1		1	1	1			-1	1							
Industry Developemnt				1		1	1	1	-1	1	1		1	1	1	1	-1	1	1		-1	1		1					
Non-RE Sector		1	-1		-1	-1	-1	1	1		1	1	1	1	1			1					1	1					
Cost of Capital	1			1		1	1						-1	1	1	1	-1		-1	1	1	1							
Cost Competitiveness	1	1	1		1	1	1	-1	-1		1		1	1	1	1	-1	1		1	-1	-1							
Reliable Profits	1	1	1	1	1	1	1	1	-1	1	1		1	1	1	1	-1	1	1		-1	1							
Risk	-1	-1	-1	-1	-1	-1	-1				1		-1	-1	-1	-1	1	-1		-1									
Technology Innovation	1		1	1	1	1	1						1	1	1	1		1	1	1	-1			1					
Infrastructure	1					1	1						1	1	1	1			1	1	-1	1							
Deployment Time	1	1			1	1	1		-1		1	1						1		1	-1	1	1						
REFIT	-1	1	1												1														
TGC	-1		1											-1	1									1					
Bid/Tender		-1	1									1																	
RPS		-1	-1																										
Fiscal	-1	-1					1								1	1								1					

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
	2																									0	0	0	0	0
	3																									0	0	0	0	0
	4																									0	0	0	0	0
	5																									0	0	0	0	0
	6																									0	0	0	0	0
	7																									0	0	0	0	0
	8																									0	0	0	0	0
	9																									0	0	0	0	0
Cycle	10																									0	0	0	0	0
	11																									0	0	0	0	0
	12																									0	0	0	0	0
	13																									0	0	0	0	0
	14																									0	0	0	0	0
	15																									0	0	0	0	0
	16																									0	0	0	0	0
	17																									0	0	0	0	0
	18																									0	0	0	0	0
	19																									0	0	0	0	0
	20																									0	0	0	0	0
	etc.																													

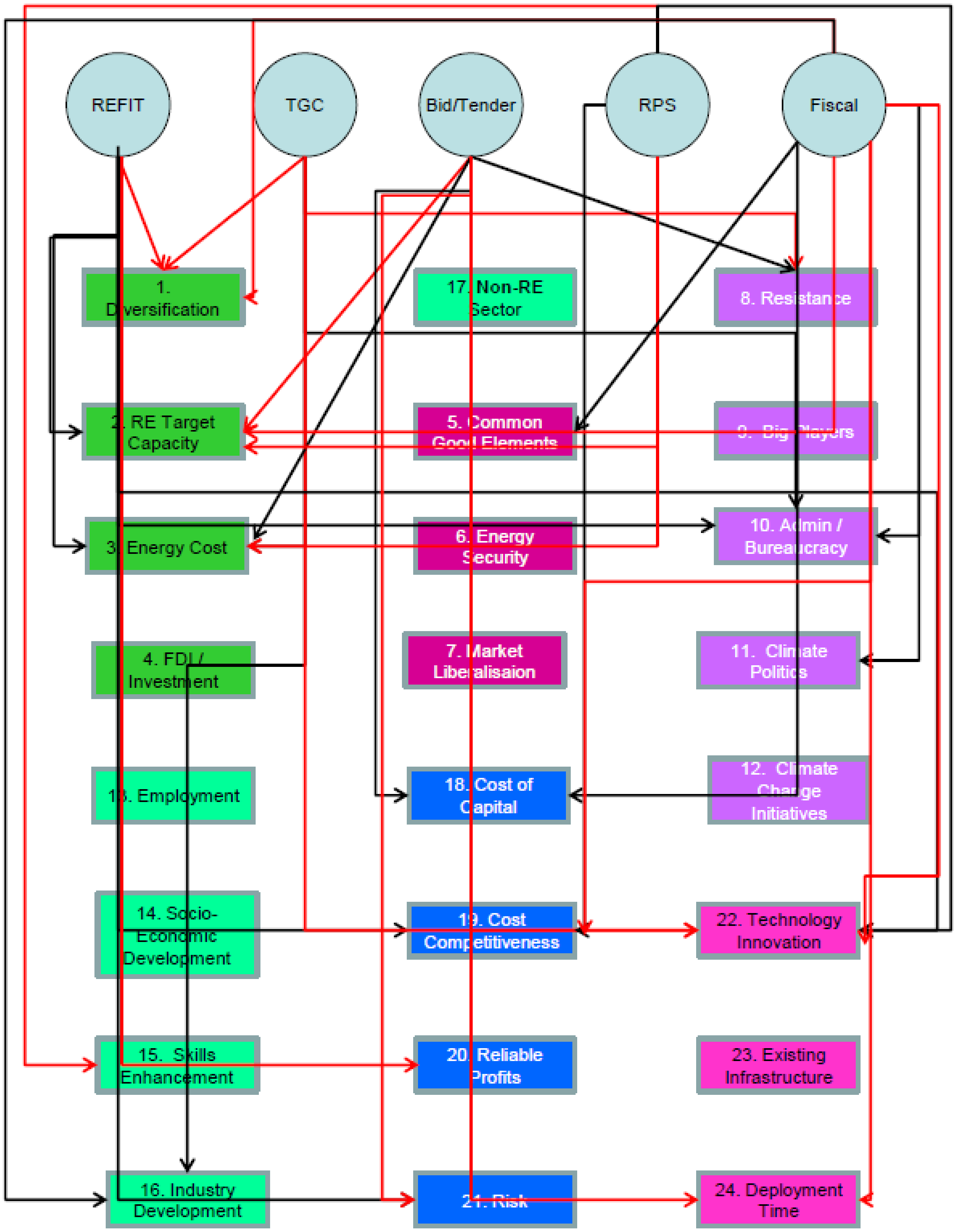


Figure 17: Revised FCM showing Policy node links only (for clarity)

In the above Figure 17, black lines represent positive casual links, while red lines represent negative causal links. Only the policy node causal links are shown for clarity sake, as the full FCM below is too complex to depict graphically in a clear manner.

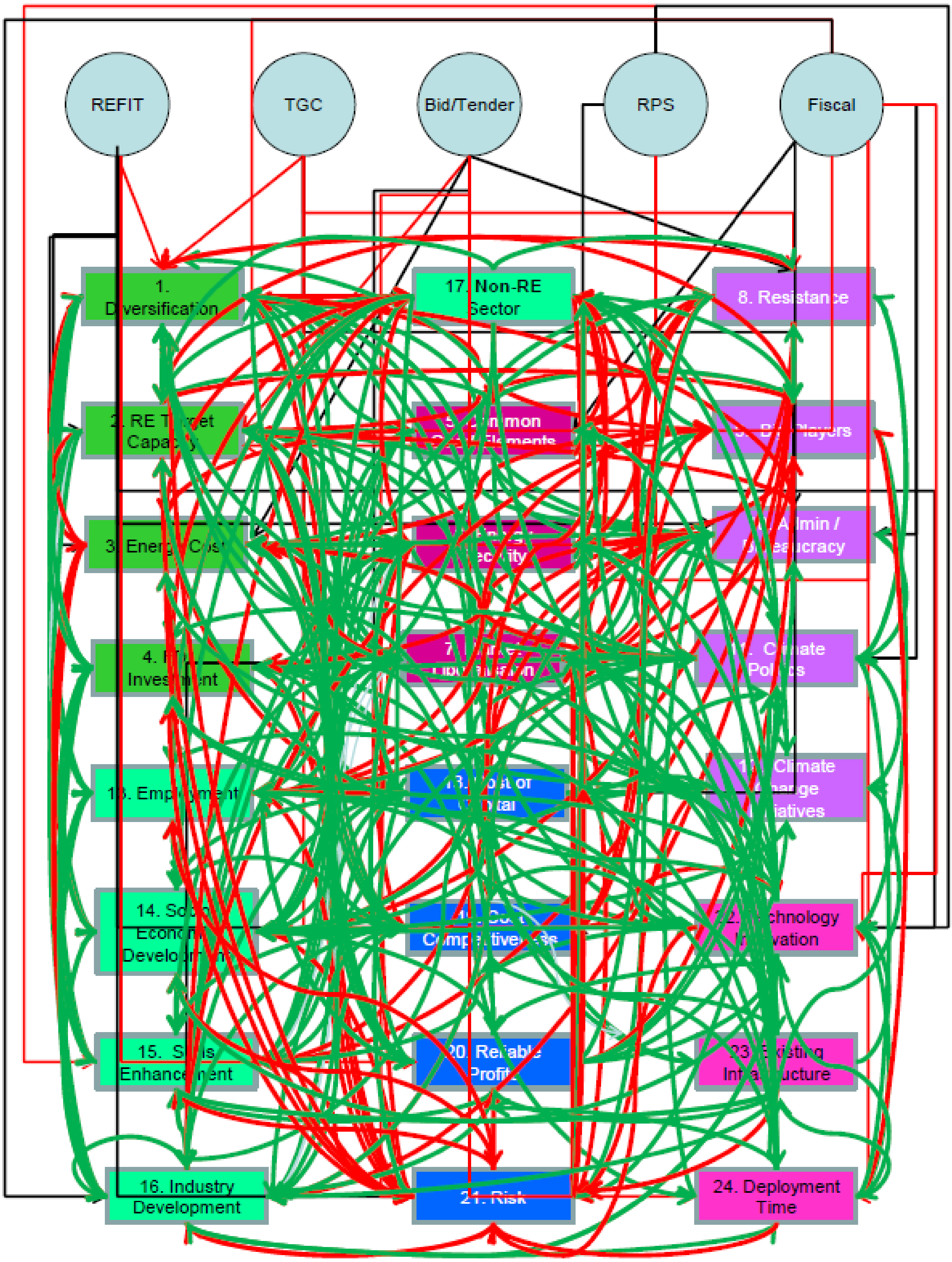


Figure 18: Revised FCM showing all casual links

In Figure 18 above, the same colour coding occurs from the policy nodes and these are the straight lines. The nodal casual links are represented by green for positive casual links and red for negative causal links and are the wavy lines.

The above also shows the power of using an FCM numerical based model opposed to a diagrammatic path analysis, as mentioned in section 2.2 above. The above is too involved and complex to be able to conduct a sensical analysis of the situation being researched.

4.7 Defining nodal activation/deactivation

At this point the model has been developed and casual links defined between the various drivers. The model is ready for validation. Before we start to run a few validation scenarios, the possible outcomes of the model need to be defined in order to be able interrupt them. Table 37 below outlines 4 possible outcomes for each driver and its generic interpretation. The four possibilities for each driver are:

1. Driver active in the start-up position and still active after simulation,
2. Driver not active in the start-up position and still not active after simulation,
3. Driver active in the start-up position and not active after the simulation, and
4. Driver not active in the start-up position, but active after the simulation.

For example, take driver 3, Energy Cost:

1. Energy cost is a driver and remains a driver within an RE sector.
2. Energy cost is not a driver within an RE sector at all.
3. Energy cost is initially a driver within an RE sector but falls away as the sector matures, and
4. Energy cost is not a driver initially, but becomes one as the industry matures.

The rest of the drivers are defined below in Table 38. These are generic categories however more specific deductions will be drawn as the specific scenarios are modelled.

Table 38: Defining simulation outputs

		Activation at start -up; Active After Simulation		**Un-Activated at Start-up; Inactive After Simulation**		**Active Before - Not Active After Simulation**		**Not Active Before - Active After Simulation**	
		Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
		1	**1**	**0**	**0**	**1**	**0**	**0**	**1**
1	Diversification	A need to diversify the energy mix remains a driver.		No need to diversify the energy mix remains a driver.		Initially diversification of the energy mix is a driver, but falls away.		Initially diversification of the energy mix is not a requirement, but becomes a driver subsequently.	
2	RE Target Capacity	A requirement to reach RE targets remains a driver		RE target capacities is never a driver.		A requirement to reach set targets falls away.		Initially RE target capacities are not a driver, but becomes a driver subsequently.	
3	Energy Cost	A need to consider the cost of RE energy remains a driver.		The cost of RE energy is never a driver.		Initially the cost of RE energy is a driver, but falls away.		While energy cost was not a driver initially, it becomes a driver subsequently.	
4	FDI / Investment	The attractiveness for investment remains a driver.		The attractiveness for investment is never a driver.		Initially investment attractiveness is a driver, but falls away.		Investment attractiveness is not a diver initially, but becomes a driver subsequently.	
5	Common Good Elements	Consideration for the environment, health and weather remains a driver.		The environment, health and weather are never drivers.		Initially, the environment, health and weather are drivers, but fall away.		Initially, the environment, health and weather are not drivers, but become so subsequently.	
6	Energy Security	The need to reduce reliance on imported energy remains a driver.		The need to reduce reliance on imported energy is never a driver.		The initial need to reduce reliance on imported energy falls away.		Initially, there is no need to reduce reliance on imported energy, but subsequently this becomes a driver.	
7	Market Liberalisation	A constant need to liberalise an energy market remains as a driver.		There is no need to diversify an energy market and hence this is never a driver.		The need to liberalise a market exists initially, but falls away.		Initially, market liberalisation is not a driver, but subsequently this becomes a driver.	
8	Resistance	Resistance to new energy production methods remains a driver.		Resistance to new energy production methods never becomes a driver.		Initially resistance to new energy production methods is a driver, but falls away.		Initially there is no resistance to new energy production methods, but subsequently becomes one.	
9	Big Players	Big players remain a driver in the energy sector.		Big players never become a driver in the energy sector.		Big players initially are a driver, but have fallen away as a driver in the energy sector.		Big players are not initially a driver, but subsequently become one.	

10	Administration / Bureaucracy	Administration and bureaucracy remain a driver within the energy sector.	Administration and bureaucracy is never a driver in an energy sector.	Initial administration and bureaucracy in an energy sector fall away as a driver	Administration and bureaucracy subsequently become a driver.
11	Climate Politics	Climate politics remain a driver.	Climate politics never become a driver.	Initial climate politics fall away as a driver.	Initially climate politics are not a driver but subsequently become one.
12	Climate Change Initiatives	Climate change initiatives remain a driver.	Climate change initiatives are never a driver.	Climate change initiatives fall away as a driver.	Climate change initiatives subsequently become a driver.
13	Employment	Employment opportunities remain a driver.	Employment opportunities never are a driver.	Employment opportunities as a driver fall away.	Initially employment opportunities are not a driver, but subsequently become one.
14	Socio-Economic Development	Socio-economic development remain a driver.	Socio-economic development is never a driver.	Initial socio-economic development drivers fall away.	Initially socio-economic development is not a driver and subsequently become one.
15	Skills Enhancement	The driver for skills enhancement remains a driver.	Skills enhancement is never a driver.	Initial skills enhancement as a driver falls away.	Skills enhancement subsequently become a driver.
16	Industry Development	Developing an industry remains a driver.	Developing an industry to support a RE sector is never a driver.	Initially developing an RE industry is a driver, that falls away.	Initially developing an RE support industry is not a driver but becomes one.
17	Non-RE Sector	The non-RE sector remains a driver.	The non-RE sector is never a driver.	The non-RE sector is driver initially, but falls away.	The non-RE sector is not initially a driver, but subsequently becomes one.
18	Cost of Capital	The cost of capital as a driver remains a driver.	The cost of capital is never a driver.	The cost of capital is a driver initially, but falls away.	Initially the cost of capital is not a driver, but subsequently becomes one.
19	Cost Competitiveness	Being a cost-competitive energy generation method remains a driver.	Being a cost-competitive energy generation method is never a driver.	Being a cost-competitive energy generation method is a driver initially, but then falls away.	Being a cost-competitive energy generation method is not initially a driver, but subsequently becomes one.
20	Reliable Profits	Producing reliable profits remains a driver.	Producing reliable profits is never a driver.	Producing reliable profits is an initial driver, but falls away.	Producing reliable profits is not an initial driver, but subsequently becomes one.
21	Risk	High risk is initially a driver and remains a driver.	Low risk initially that remains unchanged.	Initially a high level of risk exists but is reduced to low risk.	Initially a low risk is present, but increases to high risk.
22	Technology Innovation	The need for technology innovation remains a driver.	Technology innovation is never a driver.	Technology innovation is a driver initially, but falls away.	Technology innovation is not initially a driver, but subsequently becomes one.
23	Existing Infrastructure	The existing infrastructure of a region remains a driver.	Existing infrastructure is never a driver.	Existing infrastructure is initially a driver, but falls away.	Existing Infrastructure is not a driver initially, but subsequently becomes one.
24	Deployment Time	Deployment time of RE remains a driver.	Deployment time of RE is never a driver.	Deployment time of RE is initially a driver, but falls away.	Deployment time of RE is not a driver initially, but subsequently becomes one

4.8 Validation

In section 3.3.3, the validation of this method of research was discussed. There are two ways to validate it. The first is to test scenarios from countries with established RE sectors and to see if the model can predict how the specific RE sector did react in reality. The second is to approach experts in this field and present the model to them for review and comment. This research project will employ both methods to validate this model.

Each of these two methods is discussed.

4.8.1 *Method Country Specific Examples*

Countries with a well established RE sectors and where published literature is available have been selected to facilitate validation. A short review of their RE sector is presented and the start-up position concluded. This serves as a test scenario in order to verify the predictions of this model. The review also presents how the particular RE sector evolved which forms as a reference point to be able to conclude if the model did indeed predict how the RE sector established itself. If it can be deduced that in reality the evolution did follow the prediction of the model, it can be concluded that the model displays validity. Two countries are looked at for this validation. Various stages of their development are modelled. Countries have also been chosen with differing policy instruments to give better coverage of the different policy types used.

At the end of the time period validation, the simulation is ranked according to the following scale in Table 39 and an overall model validity is concluded. This ranking is only applied to the country validation section.

Table 39: Model Validity Scale

Category	**Scale**	**Definition**
1.	0 – 24% (Low)	The model did not predict the reality that existed after the time period. This means that less than 25% of the drivers being simulated can be related to the literature and the model cannot be considered validated.
2.	25 – 49% (Below Average)	The model did not draw on the full reality and needs to be amended. This means that less than 50% of the drivers being simulated can be related to the literature.
3.	50 – 74% (Above Average)	The model provides a good prediction of what occurred in reality. More than 50% of the drivers being simulated can be related to the literature.
4.	75 -100% (High)	The model provides a very good prediction of what actually occurred in reality and more than 75% of the drivers being simulated can be related to the literature.

Denmark and The UK have been chosen, as they have differing RE policies, differing sector maturities and different success rates. Sufficient published information exists from these two countries to start the process of validation. A brief summary of the situation prior to the policy choices is given to provide a context for the reader.

a. *Denmark*

The evolution of the Danish RE sector has occurred over 40 years (1970 to late 2000s) and was triggered by the 1970's oil crisis (Lindboe et al., 2008). The transition of an economy that relied on 99% of its energy source from foreign resources to an economy that is now a net exporter of electricity can be attributed to a number of drivers (Lindboe et al., 2008; Eurostat, 2009).

In 1974, fiscal support was introduced in the form of an energy tax and this was a direct reaction to the oil crisis (Lindboe et al., 2008). These taxes made electricity prices especially high in Demark and were not removed when the oil prices stabilised. In 2007, Demark had the highest electricity prices in the EU (Eurostat, 2009). This allowed a steady flow of financial support for R&D and manufacturing, allowing the power industry to rely on support for the establishment of a local RE sector (Lindboe et al., 2008). In 1979, the Danish Government introduced an Investment Subsidy to reimburse capital costs for installing RE generation facilities (Lindboe et al., 2008). These fiscal support mechanisms were revised accordingly as the sector matured. The aim of this support was to establish local energy security to reduce the risk of a further fossil fuel crisis affecting the Danish economy. The Danish authorities sought diversification of the local energy mix through RE generation as a means of achieving this aim.

In 1981, Denmark introduced a FIT system (Lindboe et al., 2008). Initially the FIT obligated utilities to purchase power from RE facilities at a rate of 70 -85% of retail electricity price to the consumer (Lindboe et al., 2008). Later in the same decade (1985), Government and utilities agreed on capacities to be installed and a timeframe at which these facilities needed to be operational. The initial target was 100MW with an operational target of 5 years (Lindboe et al., 2008). As the sector grew, wind took the lead and was the first technology to have the support subsidy reduced (1989) (Lauber and Toke, 2007). Other technologies still required support and hence subsidies for cogeneration plants in decentralised locations remained (Lindboe et al., 2008; Eurostat, 2009). The 1980s saw the implementation and incremental evolution of the FIT policy, with continued support for the fiscal measures where needed.

In the 1990s the FIT system was continued, however policy moves were used to shape the local RE market (Lindboe et al., 2008). In 1990, *Environmentally Friendly Zoning* promoted investment in such RE facilities outside of urbanised areas, such as biomass and cogeneration facilities (Lindboe et al., 2008). In addition, the Government established the *Wind Turbine Guarantee* that supported large wind farm projects through long term financing and specified the use of locally manufactured turbines (Lindboe et al., 2008). Other policy moves that were employed were grid access guarantees; grid connections cost sharing and clear boundaries between transmission system operators and IPPs (Lindboe et al., 2008). In 1992 a further tax in the form of a *carbon tax* was introduced that added 1.3 Euro cents/kWh to RE generators (Lindboe et al., 2008). The capacities that were agreed in the 80s was upped by 100MW and a clear divide between onshore and off shore wind facilities was forming (Lindboe et al., 2008). So while the FIT system was deployed with fiscal support, various other drivers were brought into play that helped support and guide the RE sector in Denmark.

In the 2000s, the Danish Authorities continued to shape and evolve the support mechanisms. One major development was that permitting and approvals were pooled under the Danish Energy Authority (Lindboe et al., 2008). All related activities (environmental assessments, construction approvals, licensing etc) sat with them, allowing a more streamlined approach to getting these facilities online quicker (Lindboe et al., 2008). One last aspect of the Danish RE sector is the cultural mindset that the country has demonstrated. From political to individual level, RE has received strong support, to the point when new target capacities were announced, the levels were thought too low and needed to be increased (Lindboe et al., 2008).

Over the past four decades the Danish RE sector has taken significant shape, primarily through a FIT mechanism, supported heavily by fiscal measures and political support. In 1991, 92% of the electricity was produced from coal; however, by 2006 this figure has been reduced to 54% (Eurostat, 2009). The Danish have been able to achieve this through energy efficiency measures, energy import/share agreements with other Nordic countries and through the establishment of RE generation facilities (Eurostat, 2009). The RE industry has developed incrementally and has successfully decentralised generation facilities and induced a level of energy market liberalisation. Demark is also a good example on how an economy can de-couple their energy needs from GDP growth i.e. Demark has had consistent economic growth with a minimal increase in energy needs (Eurostat, 2009). A further fact to note is that Denmark has one of the highest energy and environmental taxes in the EU showing their dedication to sustainability (Eurostat, 2009). One major success has been the establishment of local manufacturing facilities and the world’s largest wind turbine manufacturer: Vestas (Lindboe et al., 2008; Vestas, 2011).

Vestas manufactures, installs and operates wind facilities and has grown globally. Vestas listed in 1998 with 22.1% of the global wind market and has continued to grow, setting up manufacturing facilities globally (Vestas, 2011). In 2008, Vestas employed over 20 000 people (Vestas, 2011). The Danish RE sector is a good example of how the spill over affects can create a sustainable industry if supported properly.

Drivers are extracted and tabulated below in the same format used to create the model and delineated into the decades over which it developed i.e. 1970s, 80s, and 90s.

Danish energy situation in the 1970’s:

Table 40: Danish energy situation 1970's

		Situation	Start-Up
	REFIT	N/A	0
	TGCs	N/A	0
	Bidding/Tender	N/A	0
	RPS	N/A	0
	Fiscal	Energy taxes introduced to support the energy sector. Funds used to spur R&D, local manufacturing and instill price stability. Taxes not removed after '70's oil crisis. In the late 70's an investment subsidy was introduced to support the expensive cost of RE technology.	1
1	Diversification	Initially, still reliant on oil and coal.	0
2	RE Target Capacity	No initial target capacities set.	0
3	Energy Cost	Higher in relation to other EU countries due to energy taxes.	1
4	FDI / Investment	N/A. All internally driven.	0
5	Common Good Elements	N/A. 70's driven more by oil crisis than environment, health and weather concerns.	0
6	Energy Security	The 70's oil crisis coupled with the huge reliance on imported energy influenced the need for energy security.	1
7	Market Liberalisation	Not initially a driver.	0
8	Resistance	The social attitude of all Danish stakeholders can be described a progressive and accepting. Therefore resistance was not a driving factor.	0
9	Big Players	Did not play a significant role in the 70s.	0
10	Administration / Bureaucracy	Initially not a driver in the 1970s. It can be said the Danish government established new policies with all stakeholders in mind and with transparency, hence reducing the affect of this driver.	0
11	Climate Politics	The Danish government showed strong political will and leadership and the continuation of the taxes and investment subsidies is testament to this.	1
12	Climate Change Initiatives	N/A. Not a driver in the 70s.	0
13	Employment	N/A. Not a driver in the 70s.	0
14	Socio-Economic Development	N/A. Not a driver in the 70s.	0
15	Skills Enhancement	N/A. Not a driver in the 70s.	0
16	Industry Development	The use of the taxes to accumulate funds for the Danish energy market to spur R&D, manufacturing and RE related industries.	1
17	Non-RE Sector	Largely unaffected as baseload capacity was still needed.	0
18	Cost of Capital	N/A. Not a driver as the energy taxes were used to fund the RE sector.	0
19	Cost Competitiveness	N/A. Not a driver in the 70s.	0
20	Reliable Profits	N/A. Not a driver in the 70s.	0
21	Risk	N/A. Not a driver in the 70s.	0
22	Technology Innovation	The energy taxes were channeled to R&D for the RE sector.	1
23	Existing Infrastructure	N/A. Not a driver in the 70s.	0
24	Deployment Time	N/A. Not a driver in the 70s.	0

The resulting model outcomes are shown in Table 41 below.

Table 41: FCM for Denmark 1970s

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
Cycle	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1
	3																									0	0	0	0	1
	4																									0	0	0	0	1
	5																									0	0	0	0	1
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	16																									0	0	0	0	1
	17																									0	0	0	0	1
	18																									0	0	0	0	1
	19																									0	0	0	0	1
	20																									0	0	0	0	1
	etc.																													

The simulation shows interesting results. Firstly, the model reached equilibrium, which may not always occur. The move by Denmark to establish Energy Security triggered by the 1970s oil crisis evolved quickly. The simulation suggests that Energy Cost and Energy Security while initially a driver fall away as the industry developed. This suggests that the initial focus on these drivers was superseded by other drivers, which we will see in follow up simulations. The Danish energy market developed to become a net exporter of energy and the additional revenue to a predominately service orientated economy may have off-set any additional cost of RE (Lindboe et al., 2008). Another interesting outcome is that Big Players and the Non-RE sector while not initially a driver become so. This confirms what happened in Denmark as authorities regulated utilities to generate electricity using RE sources and carbon taxing initiatives in subsequent years (Lindboe et al., 2008). These are shown in the follow up simulations.

Overall, the first simulation can be categorised as a “3” as most drivers can be explained and are predicted.

Danish energy situation in the 1980's:

Table 42: Danish energy situation 1980's

		Situation	Start-Up
	REFIT	In 1981, the REFIT system was introduced. Utilities mandated to purchase electricity produced from RE sources at a rate equal to 70-85% of the consumer retail price.	1
	TGCs	N/A	0
	Bidding/Tender	N/A	0
	RPS	N/A	0
	Fiscal	Energy taxes continued. The investment subsidy for wind turbines removed (1989) as technology was maturing, but still available for less mature technology and for cogeneration facilities.	1
1	Diversification	Increasing, but not a key driver.	0
2	RE Target Capacity	In 1985, an agreement with utilities to install 100MW over a 5 year period.	1
3	Energy Cost	Higher in relation to other EU countries due to energy taxes.	1
4	FDI / Investment	N/A. All internally driven.	0
5	Common Good Elements	N/A. Still not a driver in the 80s.	0
6	Energy Security	Still a driver in the 80s.	1
7	Market Liberalisation	Not initially a driver.	0
8	Resistance	Still no resistance in the 80s.	0
9	Big Players	Big players like the Danish utilities are being mandated to buy RE electricity and to reach set target capacities.	1
10	Administration / Bureaucracy	Transparency and engagement with all political and other stakeholders continued.	0
11	Climate Politics	Political commitment continued.	1
12	Climate Change Initiatives	N/A. Not a driver in the 80s.	0
13	Employment	N/A. Not a driver in the 80s.	0
14	Socio-Economic Development	N/A. Not a driver in the 80s.	0
15	Skills Enhancement	N/A. Not a driver in the 80s.	0
16	Industry Development	The use of the taxes to accumulate funds for the Danish energy market to spur R&D, manufacturing and RE related industries. This is continued in the 80s and the results are evident through companies like Vestas, a wind turbine manufacturer and a leading manufacturer and exporter today.	1
17	Non-RE Sector	Authorities start mandating the purchase of RE generated electricity and setting targets for RE generation capacity.	1
18	Cost of Capital	N/A. Not a driver as the energy taxes were used to fund the RE sector.	0
19	Cost Competitiveness	Starting to become a driver. With wind technology not qualifying for investment subsidies, you can see technology maturing and thus becoming cost competitive.	1
20	Reliable Profits	Becoming a driver, especially with the set rates for purchase of RE electricity by utilities (70-85% of retail consumer price).	1
21	Risk	N/A. Not a driver in the 80s.	0
22	Technology Innovation	The energy taxes were channeled to R&D for the RE sector. This continued in the 80s.	1
23	Existing Infrastructure	N/A. Not a driver in the 80s.	0
24	Deployment Time	N/A. Not a driver in the 80s.	0

The resulting model outcomes are shown in Table 43 below.

Table 43: FCM for Denmark 1980s

	Output	Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
	Startup	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	1	1	0	1	1	0	1	0	0	1	0	0	0	1
	1	0	1	0	1	1	0	1	1	0	1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	1	0	0	0	1
	2	0	1	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	0	0	0	1	1	1	0	0	0	1
	3	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1	0	0	0	1
	4	0	1	0	0	0	0	0	0	1	1	0	1	1	1	1	1	0	0	0	0	1	0	1	0	1	0	0	0	1
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	1
	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	1
	7																									1	0	0	0	1
	8																									1	0	0	0	1
	9																									1	0	0	0	1
Cycle	10																									1	0	0	0	1
	11																									1	0	0	0	1
	12																									1	0	0	0	1
	13																									1	0	0	0	1
	14																									1	0	0	0	1
	15																									1	0	0	0	1
	16																									1	0	0	0	1
	17																									1	0	0	0	1
	18																									1	0	0	0	1
	19																									1	0	0	0	1
	20																									1	0	0	0	1
	etc.																													

This simulation once again reaches equilibrium, even though it takes a few more cycles to do so. Again, Energy Cost and Security do not remain key drivers in the Danish energy sector, suggesting that they are merely secondary drivers. In addition, Climate Politics, Industry Development and Technology Innovation also fall away as drivers in the 1980s. The simulation also confirms that Resistance and Administration remain dormant drivers, highlighting the cultural and social attitude of the Danish to the RE sector (Lindboe et al., 2008). Further observations from the above are that Big Players and the Non-RE sector continue to feature as drivers within the Danish energy sector. Indeed, as we will see in the following simulations, further regulation and evolution by the authorities see further hurdles for these players to adhere to, that shapes the Danish energy market. One final observation is that Risk while not initially a driver, becomes one. This could be attributed to a global industry and externalities that are starting to form and the exposure of the Danish RE sector to the export market and competitors.

Overall, the second simulation can also be categorised as a “3” as most drivers can be explained and are predicted.

Danish energy situation in the 1990’s:

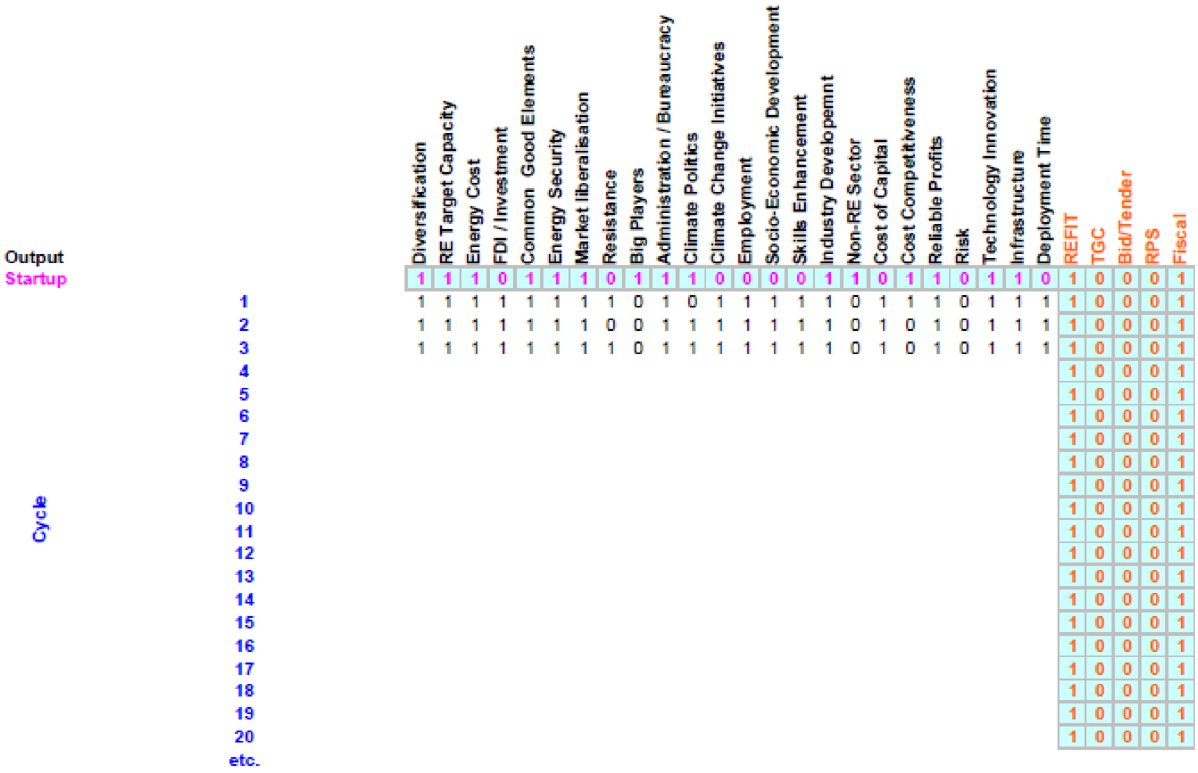
Table 44: Danish energy situation 1990's

		Situation	**Start-Up**
	REFIT	REFIT remained unchanged in the 90s.	1
	TGCs	N/A	0
	Bidding/Tender	N/A	0
	RPS	N/A	0
	Fiscal	Energy taxes continued. The ***Danish Wind Turbine Guarantee*** policy was established that provided long term investment finance for large wind projects that used Danish turbines. In 1992, a carbon tax of 1.3 Eurocents/kWh was added to the funds available to the sector.	1
1	Diversification	Cogeneration encouraged and the use of biomass in the combined heat and energy markets.	1
2	RE Target Capacity	The previous decade’s 100MW capacity drive was concluded and another 100MW was established in 1996.	1
3	Energy Cost	Energy cost increased due to the carbon tax in 1992.	1
4	FDI / Investment	N/A. All internally driven.	0
5	Common Good Elements	In 90s ***Environmental Friendly*** zoning was introduced. This mandated cogeneration, reduction in coal and oil use in favour of natural gas and the decentralised generation of electricity in villages etc.	1
6	Energy Security	Still a driver in the 90s.	1
7	Market Liberalisation	A *defacto* driver with the decentralised locality of the generation plants, thus providing opportunities for IPPs to enter the market and liberalise it.	1
8	Resistance	Still no resistance in the 90s.	0
9	Big Players	Further mandates to reduce fossil fuel generation sources and introduce RE generation methods.	1
10	Administration / Bureaucracy	Transparency and engagement with all political and other stakeholders continued.	1
11	Climate Politics	Political commitment continued.	1
12	Climate Change Initiatives	N/A. Not a driver in the 90s.	0
13	Employment	N/A. Not a driver in the 90s.	0
14	Socio-Economic Development	N/A. Not a driver in the 90s.	0
15	Skills Enhancement	N/A. Not a driver in the 90s, but *defacto* part of the R&D and manufacturing sector growth.	0
16	Industry Development	The ***Danish Wind Turbine Guarantee*** policy help establish the Danish wind turbine market and companies like Vestas. This created a home-market that incubated such companies before the foreign market grew in size.	1
17	Non-RE Sector	Authorities continued to work with existing energy companies. More stringent mandates were introduced. In addition, the Transmission operators were mandated to work with IPPs to ensure seamless connectivity to grid infrastructure.	1
18	Cost of Capital	N/A. Not a driver as the taxes were used to fund the RE sector.	0
19	Cost Competitiveness	As technology matured and manufacturers were established, cost competition was gaining momentum.	1
20	Reliable Profits	The policies designed to protect the generation and manufacturing segments helped make returns dependable as the sector matured.	1
21	Risk	N/A. Not a driver in the 90s.	0

22	Technology Innovation	The energy taxes were channeled to R&D for the RE sector. This continued in the 90s.	1
23	Existing Infrastructure	The Danish Energy Authority had to provide open and guaranteed access to grid. Cost had to be shared. This facilitated mutual working that helped bring new RE generation methods into operation quickly.	1
24	Deployment Time	As a *defacto* function of the agreement for transmission operators to work with IPPs, deployment time is reduced.	0

The resulting model outcomes are shown in table 45 below.

Table 45: FCM for Denmark 1990s



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	1	1	0	1	1	0	1	1	0	1	0	0	0	1
	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	0	1
	2	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	1
	3	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	1
	4																									1	0	0	0	1
	5																									1	0	0	0	1
	6																									1	0	0	0	1
	7																									1	0	0	0	1
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	9																									1	0	0	0	1
Cycle	10																									1	0	0	0	1
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	18																									1	0	0	0	1
	19																									1	0	0	0	1
	20																									1	0	0	0	1
	etc.																													

Once again the simulation reached equilibrium and in fewer cycles then before. Fifteen of the twenty four drivers are activated, of which eleven continue to be present from the start-up position. This suggests that continued drivers to grow the industry using a combination of the REFIT system and fiscal methods cited above. Points to note are that Big Players no longer remain a driver suggesting that with all the policies established by the Danish authorities, the new opportunities had been accepted by the players and hence they no longer posed a potential threat. FDI and Investment, while not a driver previously, suddenly is a driver suggesting that sector was attracting international attention. One example that confirms this is that Vestas in 2006 had nacelle and blade manufacturing operations in foreign countries (Lindboe et al., 2008). Here the FDI / Investment were however, off-shore, thus suggesting the export investment. Resistance, while not initially a part of the start-up, becomes a driver suggesting that the sector is becoming saturated and / or energy prices are increasing. This however is not conclusively confirmed in any data that is available, but Denmark has been cited as having the highest electricity prices in the EU (Eurostat, 2009). Another interesting observation is that activation of the Climate Change Initiatives driver. By the late 90s international environmental consciousness was gaining momentum and initiatives like the Kyoto Treaty (adopted in 1997) (UN, 1998) were being talked about, by more and more people. Employment, Skills and Socio-Economic Development are also active suggesting the trickle down affects of the opportunities around the RE sector. These were not primary drivers and the model quite correctly predicted that these would become effective as the industry matured. Finally, as transmission operators had to work with IPPs to connect the projects to the grid (Lindboe et al., 2008), Deployment Times, as a *defacto* driver were reduced, which the model has quite correctly predicted. One final observation is that the Risk driver remains dormant, which is in contrast to the 70s and 80s. This would suggest that with the development of the Danish policy and RE sector, risk has been reduced to manageable levels as actors became comfortable and learning curves experienced. It cannot however be said that all risk had been removed.

Overall, the third simulation can also be categorised as a “3” as most drivers can be explained and are predicted.

The above three simulations look at the Danish RE energy sector over three decades. The developed FCM quiet accurately predicts the development of the local RE industry, driven by various policy decisions made by the Danish leadership.

Following on from this, The UK RE sector is modelled to see if the FCM can be validated in an RE sector that had a different policy development path.

b. *The United Kingdom*

The UK support programme for its RE sector started in 1990 (Kelly, 2007) and followed a different path and opted to use fiscal and quota based mechanisms to start its RE sector (Kelly, 2007). In the 1990s, a tax, called the *Fossil Fuel Levy*

(FFL), was applied to non-fossil fuel based generators to generate revenue for the nuclear programme (Kelly, 2007). In addition these generators were obligated to purchase certain quotas from non-fossil fuel based power (Kelly, 2007). This programme was called the *Non-Fossil Fuel Obligation* (NFFO) and RE generators tendered for certain set quantities for RE generation from specified sources at set prices (Kelly, 2007). Targets for these quantities to be sourced from RE sources, were increased over a period of 8 years, but the actual attainment of these targets fell short (Kelly, 2007).

In 1997, the Blair Government set a target of 10% of the UKs electricity to be sourced from RE sources by 2010. By 2002, a new programme was introduced, the Renewables Obligation (RO), which again set quotas, but the price was in turn negotiated (Eurostat, 2009). Under this mechanism, price competition was maximised; Renewable Obligation Certificates (ROCs) were issued to accredited generators; ROCs could be bought out to meet set obligations; generators were exempt from a *Climate Change Levy* (CCL) and finally generators could still sell the generated electricity (Lauber and Toke, 2007). The revenue from the ROCs and various levies were channelled back into the industry as capital grants to develop technologies and spur localisation (Lauber and Toke, 2007). The overall philosophy behind this system was to expose the sector to market forces with a view to reduce the overall cost to the UK.

The UK approach differs markedly from the Danish experience. The UK has gone the opposite way, in terms of being a net importer of energy when it was previously a net exporter due its large reserves of oil, gas and coal (Eurostat, 2009). In addition, the UK energy market was opened up (liberalised) from the late 1980s, allowing more generation companies to compete for customers and at a time when RE policy was being introduced (Eurostat, 2009). The UK system uses a complicated hybrid of the bidding/tendering, fiscal and TGCs and its success has been mixed. In 2006, only 2% of the gross energy needs of The UK come from Renewable Energy Sources (Eurostat, 2009). The policy environment in The UK has evolved over the past 20 years and distinct milestones can be extracted to model and predict if the FCM has validity. The milestones (time periods) to be used for validation are the years 1990s and early 2000s. These are extracted separately below.

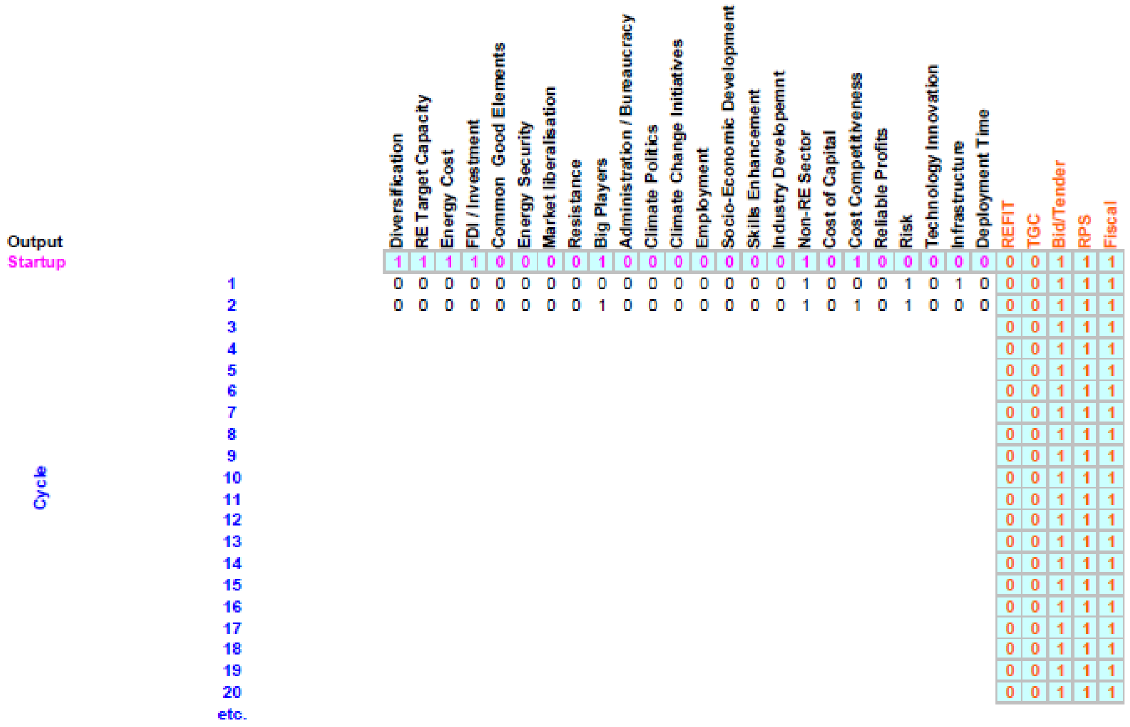
The UK energy situation in the 1990's:

Table 46: The UK energy situation 1990's

		Situation	**Start-Up**
	REFIT	N/A	0
	TGCs	N/A	0
	Bidding/Tender	Under the NFFO, generators tendered for set capacities at set prices.	1
	RPS	In essence this UK policy was RPS.	1
	Fiscal	Taxes were imposed on fossil fuel based generation to fund the more expensive RE generation.	1
1	Diversification	A driver initially to reduce energy mix away from fossil fuel based generation methods.	1
2	RE Target Capacity	RE generation capacities were set and increased over a period of 8 years.	1
3	Energy Cost	Formulation of the market based system suggests that the more expensive RE electricity was a driving a factor.	1
4	FDI / Investment	Attractiveness for investment was a driver through the various taxes and obligations.	1
5	Common Good Elements	Not initially a driver.	0
6	Energy Security	Not initially a driver. The UK in the early 1990s had large coal reserves and was a large producer of petroleum and natural gas.	0
7	Market Liberalisation	Not initially a driver for the RE sector development. However, the UK had started a large privatisation drive of state owned utilities in the late 1980s. This is seen as an independent programme to the RE sector.	0
8	Resistance	No evidence of initial resistance.	0
9	Big Players	Seen as driver, as the obligations on non-fossil fuel based generating organisations were to fill the start of moving to cleaner generation methods and also fund it through taxes and penalties for not meeting targets.	1
10	Administration / Bureaucracy	Initially not explicitly a driver.	0
11	Climate Politics	Initially not a driver. The NFFO was initially set up to fund nuclear expansion.	0
12	Climate Change Initiatives	Initially not a driver.	0
13	Employment	Initially not a driver.	0
14	Socio-Economic Development	Initially not a driver.	0
15	Skills Enhancement	Initially not a driver.	0
16	Industry Development	Initially not a driver.	0
17	Non-RE Sector	Seen as a driver as the obligations and taxes were directed at the non-fossil fuel based industry.	1
18	Cost of Capital	Initially not a driver.	0
19	Cost Competitiveness	Initially a driver due to the set tariffs for RE generation and exposure to the market forces to reduce cost to the economy.	1
20	Reliable Profits	Initially not a driver.	0
21	Risk	The risk of not achieving targets due to exposure of market forces was not a driver.	0
22	Technology Innovation	Initially not a driver.	0
23	Existing Infrastructure	Initially not a driver.	0
24	Deployment Time	Initially not a driver.	0

The resulting model outcomes are shown in Table 47 below.

Table 47: FCM for The UK 1990s



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	1
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	1	1
	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	1	1
	3																									0	0	1	1	1
	4																									0	0	1	1	1
	5																									0	0	1	1	1
	6																									0	0	1	1	1
	7																									0	0	1	1	1
	8																									0	0	1	1	1
	9																									0	0	1	1	1
Cycle	10																									0	0	1	1	1
	11																									0	0	1	1	1
	12																									0	0	1	1	1
	13																									0	0	1	1	1
	14																									0	0	1	1	1
	15																									0	0	1	1	1
	16																									0	0	1	1	1
	17																									0	0	1	1	1
	18																									0	0	1	1	1
	19																									0	0	1	1	1
	20																									0	0	1	1	1
	etc.																													

The simulation reached equilibrium in three cycles. The above however, produces a mix set of results to the actual situation experienced in The UK RE sector. Firstly, the positive results that confirm what actually happened. Big players and the Non-RE sector remain drivers, which is what actually happened. These drivers remain a factor, as they were the institutions that had the backing and established footing to continue with potentially meeting the targets set by the UK government. It is important to note however, that with the parallel privatisation of the electricity sector, the additional conditions to meet obligations may be clouded and no conclusive results can be extracted. In addition, Risk, which was not initially a driver, becomes one, suggesting that uncertainty in reaching the government targets was being experienced, which is confirmed by the fact that generators and industry players were did not reach the capacities set by government (Kelly, 2007). Secondly, the results that are in abeyance. Diversification, Target Capacities, Energy Cost and FDI

/ Investment, while initially a driver are no longer according to the outcomes of the model. But the industry was not meeting targets and little diversification was being met (Lauber and Toke, 2007); Energy Cost should have remained a driver, as market forces were driving up the overall cost of RE (Lauber and Toke, 2007) and finally due to perceived investment risk, additional investment was not being made (Lauber and Toke, 2007). These should have remained drivers, but are turned off in the final state of the model. Perhaps, this is the indication picked up by the Blair government that called for the reforms to the current systems that were implemented in the early 2000s. The balance of the drivers that were inactive in the start-up positions, remain so, with the exception of the already noted Risk driver. This suggests that current policy environment did not induce other drivers associated with The UK RE sector, as has been seen with the price certainty mechanism of the REFIT system in Denmark.

The overall conclusion from the above is that the initial UK RE policy did not achieve the set objectives and confirms a stagnant sector that required revision. The use of the combination of bidding/tendering, RPS and fiscal instruments, in The UK specific design, are therefore seen as lacking to jump start a sustainable RE sector. This revision is indeed what happened under the Blair administration.

Overall, the first simulation can be categorised as a “2” as the model did not predict enough of what occurred in reality.

We now continue to model these evolutions in the 2000s.

The UK energy situation in the 2000's:

Table 48: The UK energy situation 2000's

		Situation	Start-Up
	REFIT	N/A	0
	TGCs	ROCs introduced.	1
	Bidding/Tender	As in the 1990s, RE generators had to bid/tender for set capacities, but could now compete on price too.	1
	RPS	RPS continued.	1
	Fiscal	Continued taxation, through CCL and revenue generated from TGCs.	1
1	Diversification	ROCs do not differentiate between technologies and hence capital grants for less mature technologies were continued to counter this. Therefore diversification remains a driver.	1
2	RE Target Capacity	RE capacity remains a driver, with a target of 10% of all electricity generation by 2010 from RE sources.	1
3	Energy Cost	The additionality of the ROCs, further exposed the UK RE sector to market forces suggesting the energy cost was still a driver in the process.	1
4	FDI / Investment	FDI / Investment seen as a continued driver through the ROCs, taxes and exposure to market forces.	1
5	Common Good Elements	Still not a driver.	0
6	Energy Security	Still not a driver.	0
7	Market Liberalisation	General electricity market liberalisation still a driver, but not specifically for the RE sector.	0
8	Resistance	Not a driver.	0
9	Big Players	Remains a driver. Big players had the propensity to absorb risk and be able to allow market forces to dictate pricing and revenue. Smaller players were not protected from these forces.	1
10	Administration / Bureaucracy	Initially not explicitly a driver.	0
11	Climate Politics	Still not a driver.	0
12	Climate Change Initiatives	Still not a driver.	0
13	Employment	Still not a driver.	0
14	Socio-Economic Development	Still not a driver.	0
15	Skills Enhancement	Still not a driver.	0
16	Industry Development	Capital grants to spur R&D were made available, lead to suggest that The UK wished to establish an RE sector.	1
17	Non-RE Sector	Still a driver as existing utilities had the established market forge a way into the RE sector and meet the targets set by government.	1
18	Cost of Capital	Becomes a driver. With the ROCs, taxes, penalties and competitive bidding, the cost of capital dictates the viability of new generation facilities.	1
19	Cost Competitiveness	Remains a driver and with the additionality of ROCs and competitive bidding, the aim is to continue to drive cost down and become competitive with traditional generation methods.	1
20	Reliable Profits	Becomes a driver in order to attract investment. It can be inferred that ROCs and capital grants are used to protect and attract new investment.	1
21	Risk	Risk becomes a *defacto* driver as the market forces acting on ROCs in short timeframes increase risk, especially to small RE generators.	1
22	Technology Innovation	Becomes a driver through the capital grants to mature technologies that are perceived to have long term potential.	1
23	Existing Infrastructure	Initially not a driver.	0
24	Deployment Time	Initially not a driver.	0

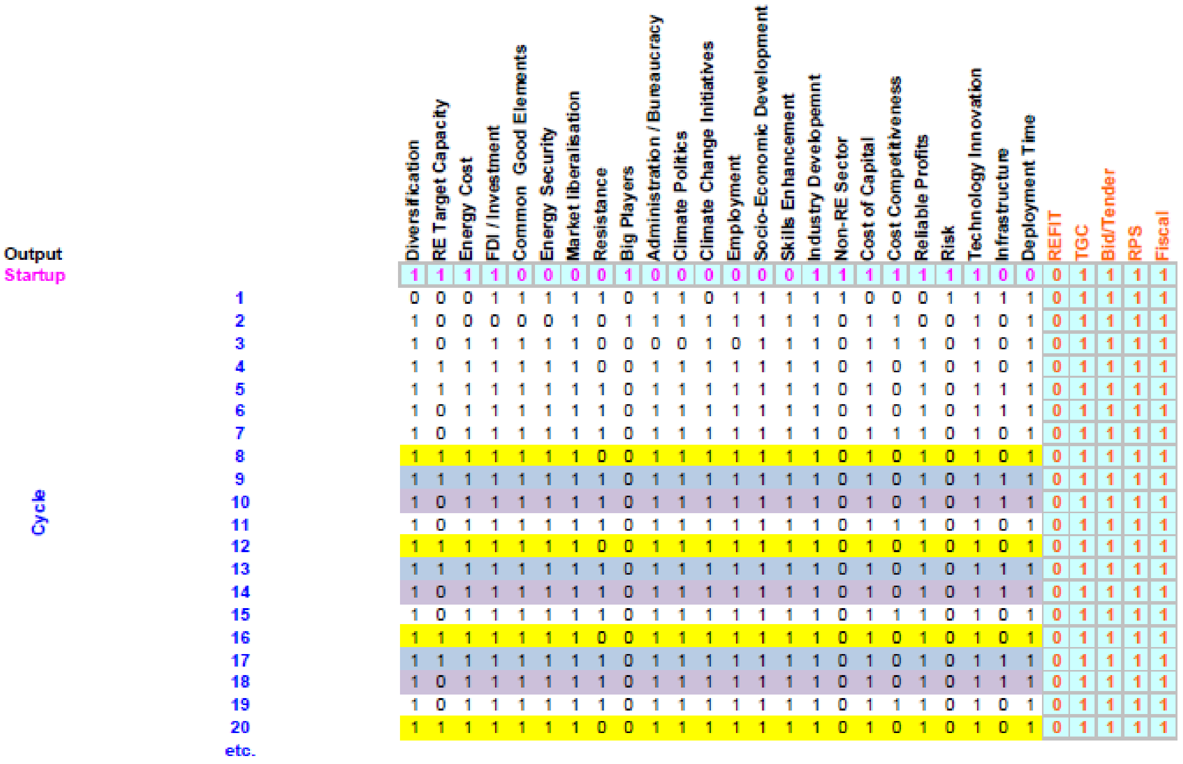
The resulting model outcomes are shown in Table 49 below.

Table 49: FCM for The UK 2000s

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1
Cycle	1	0	0	0	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	0	1	1	1	1
	2	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	1	0	1	1	1	1
	3	1	0	1	1	1	1	1	0	0	0	0	1	0	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	4	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	5	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	6	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	7	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	8	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	9	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	10	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	11	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	12	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	13	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	14	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	15	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	16	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	17	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	18	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	19	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	20	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	etc.																													

For the first time, the FCM does not reach equilibrium, but is in a limit state cycle. This is illustrated below in Table 50, by highlighting the cycles:

Table 50: FCM for The UK 2000s (showing cycles)



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1
Cycle	1	0	0	0	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	1	1	1	1	0	1	1	1	1
	2	1	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	1	0	1	1	1	1
	3	1	0	1	1	1	1	1	0	0	0	0	1	0	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	4	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	5	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	6	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	7	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	8	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	9	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	10	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	11	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	12	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	13	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	14	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	15	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	16	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	17	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	18	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1
	19	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1
	20	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	0	1	1	1	1
	etc.																													

From the above, the FCM switches between four possible cycles. The drivers that change are RE Target Capacities, Resistance, Cost Competitiveness and Deployment Time. Of these four, only RE Target Capacities and Cost Competitiveness are part of the start-up position. This suggests that these drivers were initially desired, but due to other drivers and policy, remain unstable elements in the sector. This is indeed the case in reality, as Target Capacities are not achieved and Cost Competitiveness is not achieved due to fact that market forces influence ROCs and the competitive tariffs being bid, reducing investment security (Kelly, 2007). With the cycles of Resistance and Deployment Time (not drivers in the start-up position), being cyclical, it can be deduced that due to the complexity of The UK hybrid policy environment and exposure to market forces, the industry generated Resistance and hence Deployment Time became a factor. This is indeed confirmed, as Big Players exposed to the open market stood a better chance of weathering uncertainties than did new IPPs (Lauber and Toke, 2007). The IPPs were simply not protected enough to gain good traction in the sector. In addition, the rush to secure good sites for RE generation, lead to difficulties in securing planning and permitting approvals as generators were met with resistance by local stakeholders (Kelly, 2007). For this reason, Deployment Time became an issue, as approved projects became financially unviable and projects were shelved.

Further conclusions and observations can be extracted from the above FCM and compared to the reality that actually unfolded. Suffice to say that the above has accurately modelled that complexity of The UK RE policy environment, by way of the model not reaching equilibrium and hence no further conclusions are deemed necessary.

Overall, the second simulation can be categorised as a “3” as the model did predict enough of what occurred in reality.

The above two simulations look at The UK RE energy sector over two decades. The developed FCM quiet accurately predicts the development of the local RE industry, driven by various policy decisions made by the British leadership. By contrast to the Danish RE sector, The UK has not delivered the set targets over the two decades. The policy approaches have been very different, where the Danish have mainly opted for price certain policy (REFIT) coupled with a “slowly-slowly” approach, while the British have employed market based policy (ROCs, bidding) that, through its complexity, exposure and ambitious targets has not established a new RE sector to the same degree of success as the Danes.

4.8.2 *Concluding remarks*

The Danish and British choices of RE sector policy have been modelled using the established FCM. These two countries’ approach to RE sector establishment have followed contrasting paths, yet the model has been able to predict the drivers that were influenced or established with a high degree of accuracy. Each of the timeframes and situations that were modelled has induced a response from the model (equilibrium state or limit state cycle) that could be related to what actually happened in reality. Where the outcomes of the model could not be accurately assigned to what happened in reality, further discussion was included to explain how this could have occurred.

Using the scale established above, 4 of the 5 simulations are categorised as a “3”, indicating that the model and the driver’s presence predict with a high degree of accuracy the reality that occurred. The 5th simulation was categorised as a “2”. Overall, the model has shown good validity through country specific validation.

To enhance the level of validity and reduce the influence of researcher’s bias, the FCM has been presented to external experts for review and comment. This expert validation process is outlined in the following section.

4.9 Expert Input

In order to reduce the risk of researcher’s bias, and in addition to the country specific validation above, the FCM has been presented to external experts for further validation. Experts from a range of backgrounds have been approached for further validation. These backgrounds include both foreign and local from mainly industry. Experience and functions range from 5 to 20 years and finance to lobbying.

Appendix D contains the extract and correspondence sent along with the full research report in its current state (Nov 2011) to the respondents. The following table highlights the respondents that have been approached to provide commentary on this research report model:

Table 51: Experts to be used for FCM Validation

No.	Name	Institution	Ref:
1	Ms. Mary Waller	Macquarie Bank, Cape Town	Project Finance for RE Sector. MSc in Energy Sector.
2	Mr. Davin Chown	Eco-Genesis	Managing Director
3	Mr. Nick Fedorkiw	Mainstream Renewable Power	Regulatory Affairs Manager

All the above respondents were contacted and invited to participate in the review. Each respondent was briefed verbally on the formulation of the model and all questions were answered. Finally, the required outcome of the review was reinforced.

Four respondents were initially approached, with three ultimately providing feedback. Comments were incorporated into the research and sent back to respondents to highlight the changes made. Finally, a formal response from each respondent to the posed questions has been received and can be found in Appendix E. The overall requisite of this external validation is to gauge if the FCM is indeed inherently representative of an RE sector and can hence be used to model the propositions set forth by this research.

4.9.1 *Comments Received from Experts*

The comments received from the respondents can broadly be categorised as positive, with no major flaws with the FCM. All three respondents could not find any major areas of improvement with the model. The comments that were received, were based more on the complexities of an RE sector and pointing out areas where the research could be more clear or provide more detail to the reader. This includes:

- The SA RE sector has evolved dramatically in 2011 and areas need to be revised, i.e. the evolution of REFIT to REBID. This has been done and Section 2.5 has been updated.

- The country validation section required a scale to rate the validity of each simulation. This has been added and used to draw an overall validity to the country case study validation section 4.8

- The background information to the Danish RE sector needed to be beefed up and to provide a better context for the reader. This has been revised.

- The respondents differed on the combination and terminology used for the various policy mechanisms. For example, the term REBID in SA and the similarity to FIT system were hugely contested, citing the new policy as more of a bidding system with almost no similarity to a FIT system. No change has been made to the policy mechanisms as all have been extracted under the literature review from academic resources and these responses were opinion and not mass thinking.

- Respondents also made a common comment that RE sectors and local drives are so diverse that standardising them into a model is not a clear cut exercise. The gap between an academic model and the reality is indeed a huge one and all have cautioned against not reviewing actual situations and relying heavily on this model.

- Respondents also confirmed both in the meeting and in their responses that the key drivers of an RE sector are Energy Cost, Risk, Common Goods Elements and Cost of Capital.

- Respondents also cited the developing economy status of SA and that the RE sector infancy needs to be monitored. Further investigation based on other developing economies like Brazil, India and China was suggested.

The responses received have been positive and have proved valuable for validation.

Specific comments are found with Appendix E.

4.9.2 *Final FCM Model*

As no inherent flaws were identified during the external expert validation process, no major changes have been made to the model. Changes have been to the activation of drivers in the various propositions modelled.

The model has been validated through both country specific examples and expert validation. Therefore the model can now be used to model the propositions and answer the problem statements of this research report.

5 MODELLING

The FCM has received a thorough validation, both through case studies and expert input. At this stage the model can be used to model the propositions set forth in section 2.7. These propositions are modelled and analysed here.

5.1 Proposition 1: Deploying different RE policies

FIT policy has demonstrated the largest growth of a renewable energy sector.

Under this proposition, various scenarios are investigated. No drivers are activated as this proposition seeks to see if policy choice in isolation can be effective in establishing a RE sector. The various chosen scenarios are repeated here again and include:

Scenario 1: To investigate the affect on a renewable energy sector if no high level policy is chosen for a country or region.

Scenario 2: To investigate the affect on a renewable energy sector if only a FIT instrument is deployed.

Scenario 3: To investigate the affect on a renewable energy sector if only a TGC system is deployed.

Scenario 4: To investigate the affect on a renewable energy sector if only a bidding/tendering instrument is deployed.

Scenario 5: To investigate the affect on a renewable energy sector if only a RPS instrument is deployed.

Scenario 6: To investigate the affect on a renewable energy sector if only fiscal instruments are deployed.

Scenario 7: To investigate the affect on a renewable energy sector if a combination of policies are deployed. Combinations as follows:

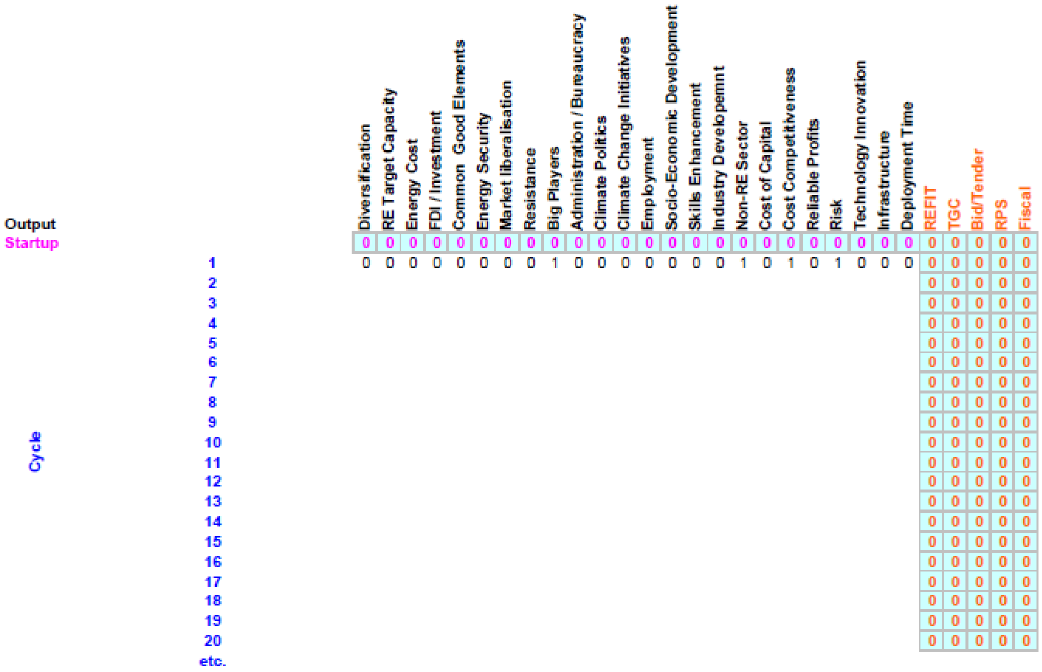
- FIT with TGC,

- FIT with TGC and Bidding Tendering,
- FIT with TGC, Bidding/Tendering and RPS,
- All polices at the same time.

5.1.1 *Results (Scenario 1 to 6)*

Modelling scenarios 1 through 6 invoke the same result from the FCM. The following FCM Table 52 represents scenarios 1 through 6:

Table 52: FCM (Scenario 1 to 6)



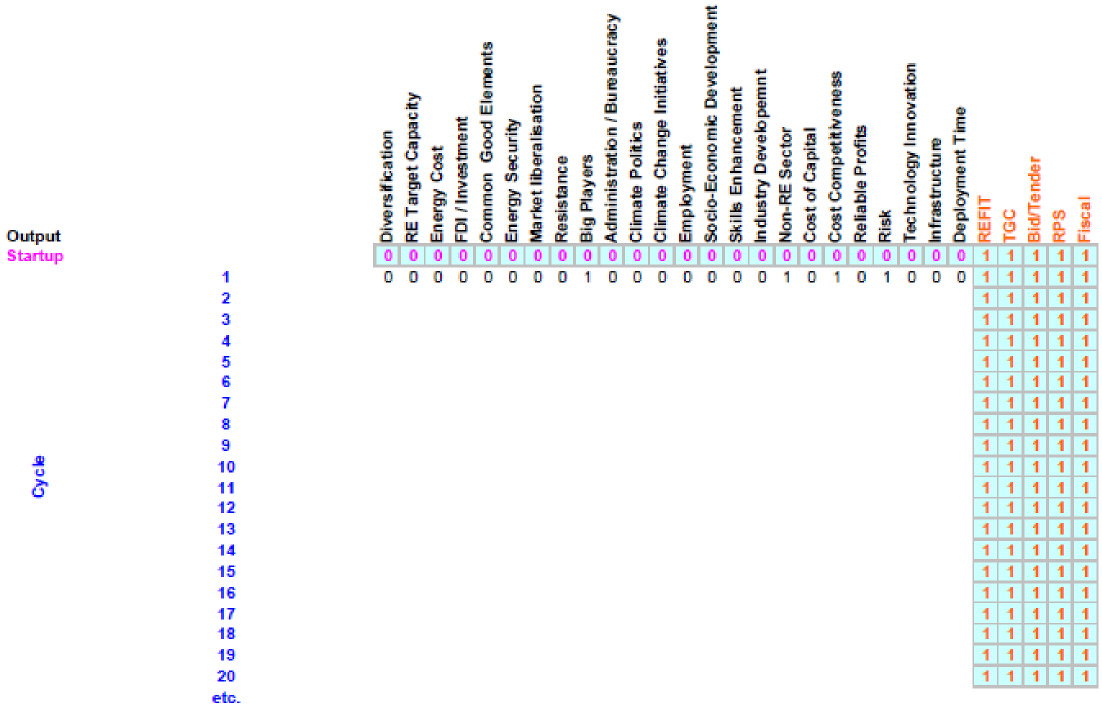
Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cycle	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
	2																									0	0	0	0	0
	3																									0	0	0	0	0
	4																									0	0	0	0	0
	5																									0	0	0	0	0
	6																									0	0	0	0	0
	7																									0	0	0	0	0
	8																									0	0	0	0	0
	9																									0	0	0	0	0
	10																									0	0	0	0	0
	11																									0	0	0	0	0
	12																									0	0	0	0	0
	13																									0	0	0	0	0
	14																									0	0	0	0	0
	15																									0	0	0	0	0
	16																									0	0	0	0	0
	17																									0	0	0	0	0
	18																									0	0	0	0	0
	19																									0	0	0	0	0
	20																									0	0	0	0	0
	etc.																													

The simulation above shows an interesting result. The interpretation is that regardless of a no policy choice or deployment of a single policy type to ignite a RE sector, (in light of no other drivers), the same four drivers are present in the equilibrium state. These include Big Players, Non-RE sector, Cost Competitiveness and Risk. All four drivers were inactive in the start-up position, yet are activated under all 6 scenarios. This can be interrupted by saying that all existing generators, big players will be the first to react to any intention to deploy an RE sector. In addition, risk levels increase and cost-competition will be driving factors as the industry takes shape. RE generation is also more costly than traditional fossil fuel based generation.

5.1.2 *Results (Scenario 7)*

The various combinations above have been simulated and the results are no different to the non-combined options in 5.1.1 above. The various results are not shown as they are all the same. However, to instil confidence in the reader, the final combination (all 5) is shown for completeness sake in Table 53 below:

Table 53: FCM (Scenario 7)



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	1	1	1
	2																									1	1	1	1	1
	3																									1	1	1	1	1
	4																									1	1	1	1	1
	5																									1	1	1	1	1
	6																									1	1	1	1	1
	7																									1	1	1	1	1
	8																									1	1	1	1	1
	9																									1	1	1	1	1
Cycle	10																									1	1	1	1	1
	11																									1	1	1	1	1
	12																									1	1	1	1	1
	13																									1	1	1	1	1
	14																									1	1	1	1	1
	15																									1	1	1	1	1
	16																									1	1	1	1	1
	17																									1	1	1	1	1
	18																									1	1	1	1	1
	19																									1	1	1	1	1
	20																									1	1	1	1	1
	etc.																													

The same four drivers are activated, regardless of which combination is used. The conclusion can be that by simply using a combination of policy types, where a FIT is part of the mix, will not invoke different results to a no-policy option.

5.1.3 *Conclusion*

The literature review has been concluded as saying that FIT systems lead to the largest growth in a RE sector. When FITs are simulated in relation to the other high level policies, (with no other active drivers and also in various combinations), the FIT is no better than a no-policy stance. Therefore it can be concluded that a FIT and/or any other policy used in isolation of the other drivers identified in the model, will not lead to an effective RE sector being developed. Hence there is no merit in choosing a policy type without considering the other drivers. In reality, this theoretical scenario will not occur, as the other drivers play a very important role in shaping the success of an RE sector. For example, Common Good Elements and Energy Security will always appear on the agenda in any region or country.

Under proposition two the most important drivers are identified.

5.2 Proposition 2: Drivers of RE Sector

Policy choice relies on various country specific conditions to drive their effectiveness and feature the categories of Local Energy Constraints; Encouraging an RE Industry; Local Conditions; Economics; Financial and Technical, each individually defined in the concluding sections of the literature review in Chapter two..

The effectiveness and influence of the various drivers identified in the literature review are simulated here. The five categories are activated in isolation to identify which set is most effective in driving a RE sector. As not all scenarios can be modelled, the drivers will be used under the high level policy deployment of a FIT system. For example, the set of Local Energy Constraints are all activated with the FIT system and the results interrupted, and so forth.

The following scenarios have been formulated:

Scenario 1: To investigate the affect on a renewable energy sector if only the ‘Local Energy Constraints’ drivers are activated with a FIT policy.

Scenario 2: To investigate the affect on a renewable energy sector if only the ‘Encouraging a RE Industry’ drivers are activated with a FIT policy.

Scenario 3: To investigate the affect on a renewable energy sector if only the ‘Local Conditions’ drivers are activated with a FIT policy.

Scenario 4: To investigate the affect on a renewable energy sector if only the ‘Economic’ drivers are activated with a FIT policy.

Scenario 5: To investigate the affect on a renewable energy sector if only the ‘Financial’ drivers are activated with a FIT policy.

Scenario 6: To investigate the affect on a renewable energy sector if only the ‘Technical’ drivers are activated with a FIT policy.

The results for each scenario are separated out below. However, one overall conclusion is drawn at the end.

5.2.1 *Results (Scenario 1) – Local energy Constraints*

Table 54: FCM Result, (Scenario 1) - Local Energy Constraints

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cycle	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.2 *Results (Scenario 2) – Encouraging an RE Industry*

Table 55: FCM Result, (Scenario 2) - Encouraging an RE Sector

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
Cycle	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.3 *Results (Scenario 3) – Local Conditions*

Table 56: FCM Result, (Scenario 3) - Local Conditions

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Cycle	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	2																									1	0	0	0	0
	3																									1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.4 *Results (Scenario 4) - Economics*

Table 57: FCM Result, (Scenario 4) - Economics

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0
	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
Cycle	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.5 *Results (Scenario 5) - Financial*

Table 58: FCM Result, (Scenario 5) - Financial

Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	0
Cycle	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.6 *Results (Scenario 6) - Technical*

Table 59: FCM Result, (Scenario 6) - Technical

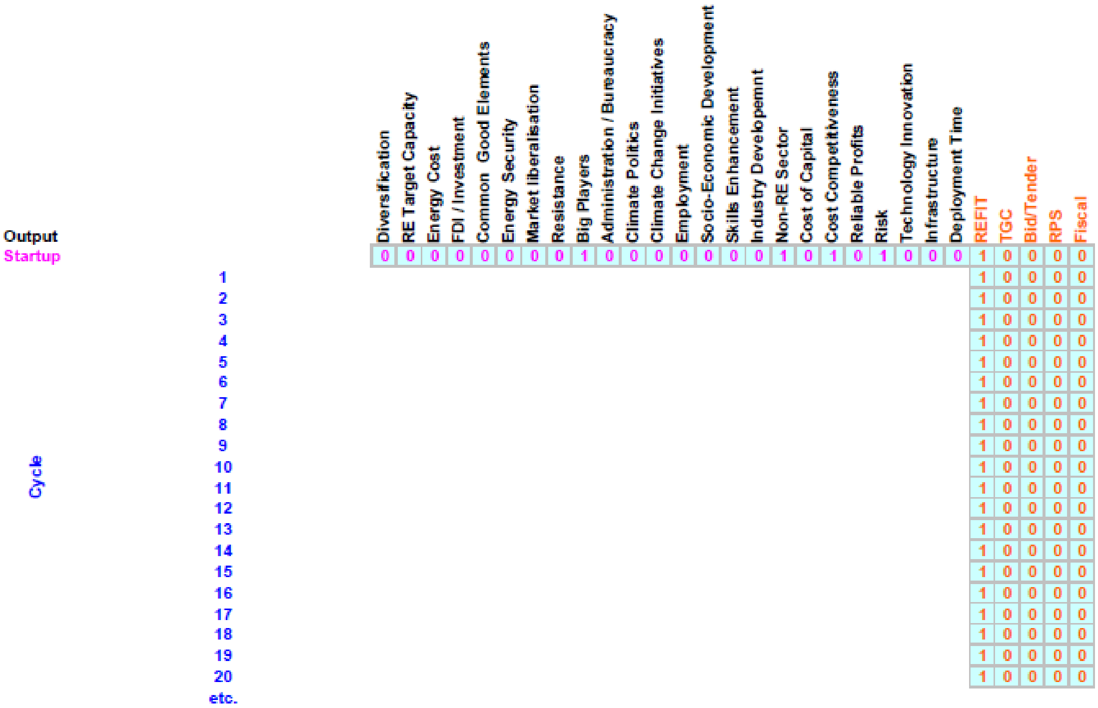
Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0
	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
Cycle	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

5.2.7 *Conclusion for Scenario 1 to 6:*

All the above simulations reach equilibrium. An initial observation is that under all scenarios, the active drivers in the start-up position are no longer drivers in the equilibrium state. This is the case for all scenarios, except for the drivers that were identified under proposition one as being ever present. Indeed, Big Players, the Non-RE Sector, Cost-Competitiveness and Risk all remain present throughout each scenario simulation.

The conclusion that can be drawn from this is that these four drivers appear to be the key factors involved within an RE sector. It is perhaps worth working with just these four identified drivers to model, under a FIT system:

Table 60: FCM - Results of 4 Drivers



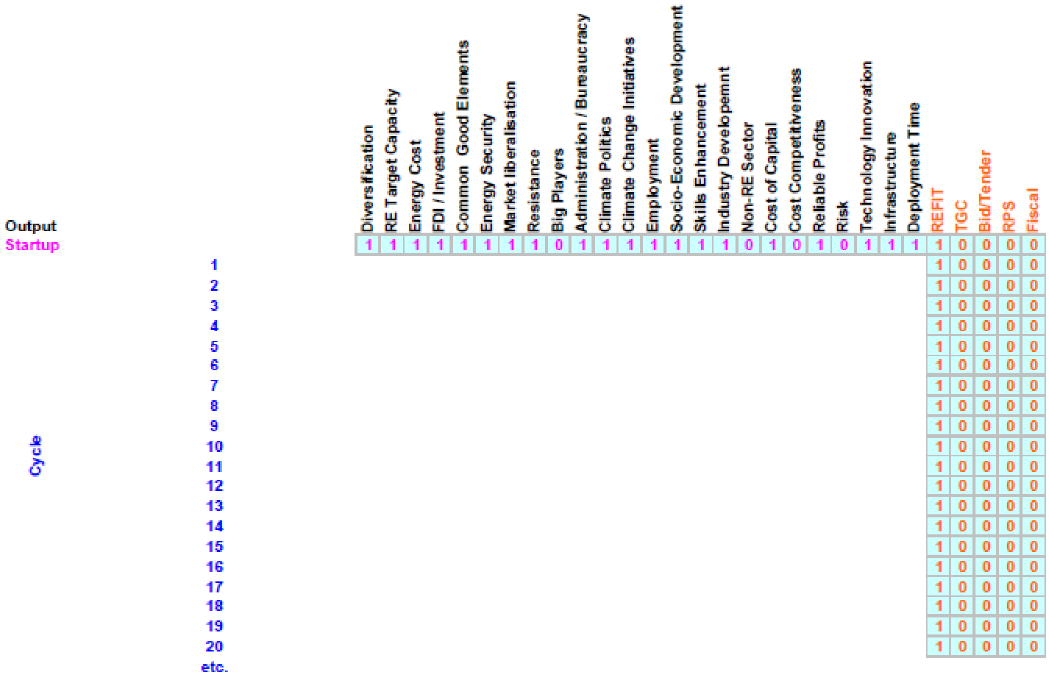
Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
Cycle	1																									1	0	0	0	0
	2																									1	0	0	0	0
	3																									1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

This indeed does produce an interesting result. For the first time, the FCM takes zero cycles to get to equilibrium. These four drivers in conjunction with a FIT policy, indicate the most influential drivers, as they are still present in the equilibrium state. Big Players (category: Local Conditions), Non-RE Sector (category: Economics), Cost Competitiveness (category: Financial) and Risk (category: Financial) play the most influential part of a RE sector when a FIT policy mechanism is deployed.

These are in line with the literature review. Big Players have the large balance sheets to enter into the RE generation field and can act as barriers to entry for IPPs. Hence their presence in the start-up and equilibrium state is warranted. The Non-RE Sector is forced to react as any significant capacity awarded to IPPs will reduce their market share and hence this driver's presence is in line with FIT policy literature. It is also noted that the price certainty offered by FITs are usually at a significant higher rate than traditional generation sources, and indicates that the issue of cost is ever present. While tariffs do decline in various procurement rounds, the previous tariffs need to be absorbed by the consumer which can lead to resistance. So reducing cost, to maintain profit margins for producers and keep electricity affordable for the final users is high on the agenda. So this leads to technology development as a means to reduce costs with the aim of achieving cost parity. Therefore the ever present driver for Cost Competitiveness is correct. Finally, the Risk driver is again ever present. Again this is in line with FIT literature. Various risks are associated with FITs, most notable being the potential for authorities to remove or digress tariffs faster than agreed in PPAs. PPAs on average run for 20 years and if removed prematurely can lead to a halt in new capacity deployment and IPPs having to absorb the losses. Spain has as recently as 2008 experienced such a move, which has originated from the economic recession. So the presence of risk under the FIT policy is a warranted driver.

Before we progress to the final proposition, let’s have a look at the corollary to the above. Let’s remove the four key drivers, activate the balance in conjunction with a FIT policy only.

Table 61: FCM - Results excluding the 4 Main Drivers



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	0
Cycle	1																									1	0	0	0	0
	2																									1	0	0	0	0
	3																									1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

Once again the simulation reaches equilibrium. In this scenario, if the drivers of Big Players (category: Local Conditions), Non-RE Sector (category: Economics), Cost Competitiveness (category: Financial) and Risk (category: Financial) are deliberately excluded from the start-up state and the balance of the drivers activated in conjunction with FIT policy, than the balance of the drivers remain drivers in the equilibrium state.

The conclusion that can be drawn from this is that if the four identified drivers can be managed to not be present, than the balance of the drivers are present. By way of example, if Market Liberalisation is initially a driver, than it will continue to be one as the sector takes shape under a FIT policy mechanism. Another example is that if Industry Development is a driver initially, it will remain one in the equilibrium state.

Specifically:

- Big Players should be excluded from the FIT system. They have the power and strong balance sheets to deploy RE facilities without the need for support. These can include big industry like mining, manufacturing and large infrastructure companies. By excluding Big Players, IPPs are given a chance to take root.

- Non-RE Sector should be excluded from a FIT system. Again, they possess the experience, balance sheets and infrastructure to deploy their own RE facilities. The FIT design should exclude them, yet still facilitate their evolution to cleaner generation methods. In SA Eskom is excluded from qualifying for the RE IPP programme, yet are still mandated to source their electricity from RE sources. By doing so their market share is maintained and their evolution is facilitated.

- Cost-Competitiveness is more difficult to exclude and manage, as it will remain a *defacto* driver. However, authorities can manage this driver by increasing traditional electricity prices and also by reducing FIT tariffs over time to achieve price parity. Another management tool is to contract IPPs through the PPA to reduce technology prices through R&D clauses. By managing this driver through the above suggestions, RE electricity will reach price parity with traditional generation methods and thus this protection mechanism can eventually be removed. By way of example, big hydro projects (the most mature RE generation source) generally do not qualify for support of any form as the cost has reached price parity.

- Risk as driver is difficult to exclude, but as per Cost-Competitiveness can be managed. The most useful tool is through the PPA with the IPP and by committing to the long term support needed to establish an RE sector. Authorities need to ensure they instil the correct support to allow investment to occur and to achieve the long term goals of an RE programme. There are cases from various developed countries where new leadership or economic woes have lead to drastic revisions or cancellations of PPAs and FITs that have stunted growth and confidence within regions. The USA and Spain are recently cited examples of this.

5.2.8 *Conclusion of a the Most Effective Drivers*

Proposition 2 has sought to identify the most effective drivers with an RE sector under a FIT policy mechanism. It is perhaps better to rephrase this as the 'most influential drivers', as this refers to the drivers that are key and not necessarily assigned a positive connotation. The most influential drivers have been identified to be Big Players (category: Local Conditions), Non-RE Sector (category: Economics), Cost Competitiveness (category: Financial) and Risk (category: Financial). Under a FIT policy mechanism these 4 drivers have consistently emerged from the various simulations as ever present and contextualised accordingly. Therefore these drivers are the most influential and need to be managed to ensure a stable and sustainable RE sector can potentially be formed. If these are managed, the other drivers become influential.

5.3 Proposition 3: Policy Choice for SA

Proposition 3: A FIT system can be applied to reap the growth needed to diversify and secure energy for future generations rather than the alternatives of fiscal, bidding, RPS and Tradable Green Certificate systems.

The model has been validated using country specific examples and expert input. The model is now used to investigate if SA's choice of support mechanism will lead to a sustainable RE sector. The initial choice to deploy a FIT will be compared with the current choice of a hybrid system of a capped FIT with a competitive bidding system.

In Part 4 of the literature review, the SA energy and renewable energy situation was investigated. The concluding remarks were that SA has a non-liberalised electricity market, with over 90% of the electricity being generated through coal resource and that RE support policies are extremely new, with no track record. The SA authorities had initially used the fiscal measure of the REFSO, which was superseded by a FIT policy (never actually used) and recently been replaced with a hybrid support mechanism of a capped FIT and competitive bidding system, locally termed, “REBID”. Developments lately have also seen the formulation of funds and initiatives to support the new RE sector through blended financial tools, multilateral agreements and high level Government strategy to protect and mature the local RE sector.

Proposition 3 seeks to use the established FCM to investigate if SA has chosen the correct mechanism and whether it can achieve the set goals. This investigation will look at four systems within the context of the local drivers that have been derived from the Part 4 of the literature review. The four systems are as follows:

1) REFSO System – model using just a fiscal policy driver, within the context of local drivers,

2) REFIT System -model using the FIT system policy driver, within the context of the local drivers,

3) REBID System – Model using the capped FIT in conjunction with the competitive bidding system, within the context of the local drivers, and

4) REBID (as above), but coupled with the funding mechanisms of SARi and thus a fiscal policy mechanism, within the context of the local drivers

In each of the above, the presence of 24 country specific drivers are extracted from the literature review above and tabulated below, to show the start-up position. The model is than run and the results are interrupted.

5.3.1 *SA REFSO*

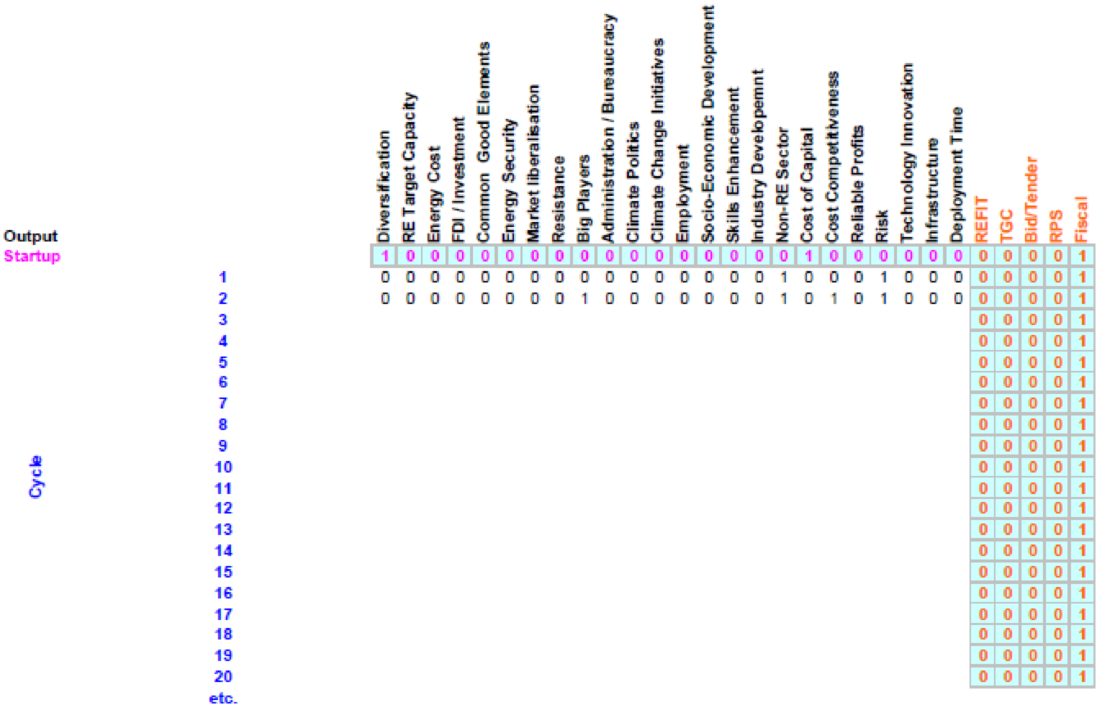
Table 62 below shows the existing drivers during the deployment of the REFSO policy:

Table 62: SA REFSO Start-Up Position

		Situation	**Start-Up**
	REFIT	N/A	0
	TGCs	N/A	0
	Bidding/Tender	N/A	0
	RPS	N/A	0
	Fiscal	Government established the REFSO to provide financial support for RE projects and IPPs.	1
1	Diversification	Seen as a move to diversify the SA energy mix.	1
2	RE Target Capacity	No targets set.	0
3	Energy Cost	Not a driver as SA had one of the world's lowest energy costs.	0
4	FDI / Investment	Initially not looking to attract FDI/Investment.	0
5	Common Good Elements	Not a primary driver.	0
6	Energy Security	While SA was experiencing an energy crisis, RE was not seen as the answer, as Eskom had started to build Mudupi, a coal fired power station.	0
7	Market Liberalisation	Eskom is the *defacto* monopolistic electricity producer and no evidence exists to confirm that liberalisation is a primary driver.	0
8	Resistance	No major resistance is evident at the establishment of the REFSO, other than the small size of it.	0
9	Big Players	Not a major driver.	0
10	Administration / Bureaucracy	Not a major driver.	0
11	Climate Politics	Not a major driver.	0
12	Climate Change Initiatives	Not a major driver.	0
13	Employment	Not a major driver.	0
14	Socio-Economic Development	Not a major driver.	0
15	Skills Enhancement	Not a major driver.	0
16	Industry Development	Not implicit, but will be taken as an explicit driver.	0
17	Non-RE Sector	Not a major driver.	0
18	Cost of Capital	Seen as a drive as RE projects are expensive to establish and the reason for this fund was to entice IPPs to establish local generation facilities.	1
19	Cost Competitiveness	Not seen as a driver, as connection to grid was not established and hence cost would not be burdened to the consumer.	0
20	Reliable Profits	Not a major driver.	0
21	Risk	Not a major driver. All risk was in effect lumped on the IPP.	0
22	Technology Innovation	Not a major driver.	0
23	Existing Infrastructure	Not a major driver.	0
24	Deployment Time	Not a major driver.	0

The above start-up positions have been inserted in the FCM and the resulting FCM is shown in Table 63 below:

Table 63: SA REFSO FCM



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1
	3																									0	0	0	0	1
	4																									0	0	0	0	1
	5																									0	0	0	0	1
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	7																									0	0	0	0	1
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Cycle	10																									0	0	0	0	1
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	18																									0	0	0	0	1
	19																									0	0	0	0	1
	20																									0	0	0	0	1
	etc.																													

The above simulation comes to equilibrium. The initial drivers of Diversification and Cost of Capital are no longer present in the equilibrium state. This suggests that either they were achieved and are no longer a driver or that the desired goal was not reached. The latter can be confirmed as the case, as only one project qualified for funding under the REFSO. One project is insufficient to achieve diversification. Another known fact is that the REFSO process was extremely onerous. This may well have pushed costs up and left little to reduce the cost of capital.

Further observations are that Big Players, The Non-RE Sector and Risk, are active drivers in the equilibrium state. Big Players once again have the strong balance sheets to finance these RE projects and can become large barriers to entry to IPPs. The Non-RE sector is awoken to the RE sector, as happened with Eskom, who started developing small demonstration RE facilities. Finally, Risk is present and can be interrupted in many forms. Risk to the IPP who did not get the necessary financial support to see a project generating electricity and bearing all the development costs or Risk that Government goals of establishing an RE sector were not going to be met with REFSO. Other forms of risk exist, but suffice to say, the REFSO did not reduce risk.

To conclude, the REFSO system as a form of fiscal policy did not have the desired results and this is evident through the fact that only a single project qualified.

5.3.2 *SA REFIT*

Table 64 below shows the existing drivers during the deployment of the REFIT policy:

Table 64: SA REFIT Start-Up Position

		Situation	Start-Up
	REFIT	REFIT programme announced.	1
	TGCs	N/A	0
	Bidding/Tender	N/A	0
	RPS	N/A	0
	Fiscal	No evidence of a continuation of fiscal support.	0
1	Diversification	Seen as a move to diversify the SA energy mix.	1
2	RE Target Capacity	Clear targets, medium and long term set through the IRP.	1
3	Energy Cost	NERSA increasing electricity prices until 2013, but cost of RE electricity not factored in yet.	0
4	FDI / Investment	Seen as a driver through the attractive FITs.	1
5	Common Good Elements	Not a primary driver.	0
6	Energy Security	Not seen as a driver, as a further coal fired power station (Kusile) is under development.	0
7	Market Liberalisation	The IRP document is framed to attract IPPs, indicating a willingness to liberalise.	1
8	Resistance	No major resistance is evident at the establishment of the FIT, except from supporters of fossil fuel based generation methods.	0
9	Big Players	Big Players not allowed to apply for REFIT, so in theory, not a driver. However, as Eskom owns and operates the national grid infrastructure, potential conflict is envisaged.	1
10	Administration / Bureaucracy	Clear intentions and targets set by Government so this is not seen as a driver. In addition, no existing RE capacity has been deployed, so this is hard to gauge at this point.	0
11	Climate Politics	Not a major driver.	0
12	Climate Change Initiatives	SA does not need to ratify the Kyoto Protocol, but has aligned strategies to international goals, through the SA Renewable Energy Policy in 2004.	1
13	Employment	Seen as a national driver and the RE industry seen as a way of creating employment.	1
14	Socio-Economic Development	Socio-economic development and upliftment of the previously disadvantaged has been a key national driver since 1994. The RE sector is again a way of achieving these goals.	1
15	Skills Enhancement	Again a driver and follows on from the above two.	1
16	Industry Development	The attractive FITs seen as a way of developing a local industry and hence a driver.	1
17	Non-RE Sector	Not a major driver.	0
18	Cost of Capital	The FIT seen as a way to overcome capital costs, so a driver.	1
19	Cost Competitiveness	Not seen as a driver, however cost of electricity to both domestic and industrial consumers is of high importance and hence will be included as a driver.	1
20	Reliable Profits	Seen as a diver through the FIT.	1
21	Risk	Not a major driver. All risk was in effect lumped on the IPP.	0
22	Technology Innovation	Through the FIT, technology innovation expected, but not explicit.	1
23	Existing Infrastructure	Seen as a major driver and hence national grid access guaranteed.	1
24	Deployment Time	Initial targets set for the end of 2013, but implementation times not factored in at high level.	0

The above start-up positions have been inserted in the FCM and the resulting FCM is shown in Table 65 below:

Table 65: SA REFIT FCM

	Output	Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
	Startup	1	1	0	1	0	0	1	0	1	0	0	1	1	1	1	1	0	1	1	1	0	1	1	0	1	0	0	0	0
	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	1	1	0	1	0	0	1	0	0	0	0
	2	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	1	0	0	0	0
	3	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	0	0
	4																									1	0	0	0	0
	5																									1	0	0	0	0
	6																									1	0	0	0	0
	7																									1	0	0	0	0
	8																									1	0	0	0	0
	9																									1	0	0	0	0
Cycle	10																									1	0	0	0	0
	11																									1	0	0	0	0
	12																									1	0	0	0	0
	13																									1	0	0	0	0
	14																									1	0	0	0	0
	15																									1	0	0	0	0
	16																									1	0	0	0	0
	17																									1	0	0	0	0
	18																									1	0	0	0	0
	19																									1	0	0	0	0
	20																									1	0	0	0	0
	etc.																													

Once again the FCM reaches equilibrium. In the above if a driver was active in the start-up position and remains so, and vice versa, than it can be assumed that the need for that driver has remained. For example, Diversification remains a driver, suggesting that insufficient Diversification has occurred and hence needs to continue. Incidentally, at the time of writing, SA has had no mass deployed RE facilities; therefore this FCM state is consistent with the actual situation.

Of interest from the above FCM are the drivers of Energy Cost, Energy Security and Cost Competiveness. All three have changed activation status in the final equilibrium position. This suggests that a FIT system in a developing country may be in conflict with national goals and that the cost may be prohibitively high. Indeed this has been confirmed when the SA Treasury and the DoE reneged on the FIT policy chosen by NERSA on the basis that the cost would be in conflict of national goals and would be too expensive to the consumer. This occurred when the REFIT was replaced by the REBID system.

Two further observations worth noting are the presence of Common Good Elements and Climate Politics in the equilibrium state. This suggests that the environment, health and weather issues are coming to public consciousness in SA. Indeed SA has been experiencing Green Marketing campaigns and with Durban hosting COP17, the average South African has never before been exposed to such volumes of climate change topics. In addition, climate change is creeping into politics and will be the case as the RE sector takes shape.

To conclude, the FIT system has sparked significant more development, than the REFSO did. To date, no mass RE facilities have been deployed and with the REFIT being replaced by REBID, it is difficult to model the effectiveness of the FIT. Suffice to conclude, that within the local context of the other 24 drivers, the REFIT did spark a greater reaction than did REFSO, the most note worthy being the Cost and Energy security drivers. When analysed in context on SA, a developing economy, the conflict between national equality goals and expensive RE, is evident.

5.3.3 *SA REBID*

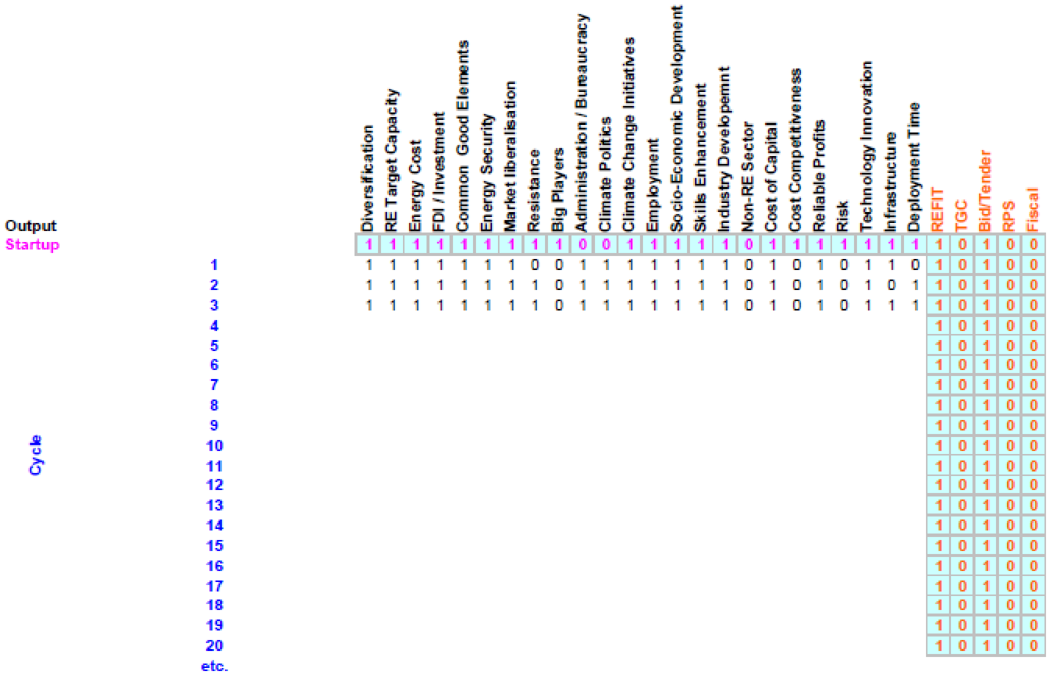
Table 66 below shows the existing drivers during the deployment of the REBID policy:

Table 66: SA REBID Start-Up Position

		Situation	Start-Up
	REFIT	Capped FIT.	1
	TGCs	N/A	0
	Bidding/Tender	Competitive bidding	1
	RPS	N/A	0
	Fiscal	N/A	0
1	Diversification	Seen as a move to diversify the SA energy mix.	1
2	RE Target Capacity	Clear targets, medium and long term set through the IRP.	1
3	Energy Cost	Energy cost seen as a major driver and hence the move away from a standalone FIT system.	1
4	FDI / Investment	The RFP outlined conditions for foreign investment.	1
5	Common Good Elements	Part of the COP17 agenda and now a major driver locally.	1
6	Energy Security	Becoming a major driver and part of the future energy mix for SA.	1
7	Market Liberalisation	The DoE RFP geared towards IPPs and hence market liberalisation.	1
8	Resistance	Resistance from developers for changing the FIT to REBID.	1
9	Big Players	Continue to be a driver, but grid access and PPA conditions seen as way of managing these players.	1
10	Administration / Bureaucracy	Clear guidelines set out in the RFP, but too early to gauge level. However, RFP set out to make the process as clear and transparent as possible in the hope of streamlining. Therefore not a driver.	0
11	Climate Politics	Not a major driver.	0
12	Climate Change Initiatives	SA does not need to ratify the Kyoto Protocol, but has aligned strategies to international goals, through the SA Renewable Energy Policy in 2004.	1
13	Employment	RFP has set clear targets and criteria for job creation that aligns with other national strategies and plans (NPC, Green Economy Accord etc).	1
14	Socio-Economic Development	Clear targets for Socio-Economic Development and Enterprise development in the RFP.	1
15	Skills Enhancement	Again a driver and follows on from the above two. The DoE wants to develop local skills so SA does not become reliant on imported skills and thus creates local value.	1
16	Industry Development	The DoE RFP geared towards local content and manufacturing facilities being established.	1
17	Non-RE Sector	Not a major driver.	0
18	Cost of Capital	Seen as a driver. The thoroughness and transparency of the RFP seen as a way of reducing risk and hence the potential higher costs of capital.	1
19	Cost Competitiveness	Energy cost seen as a major driver and hence the move to the REBID system.	1
20	Reliable Profits	FIT profits seen to be too high for IPPs and hence another reason for going to the REBID system.	1
21	Risk	Major driver. RFP and clear guidelines seen as a way of driving risk out of the process. Yet, risk remains high.	1
22	Technology Innovation	RFP still calls for reduction in costs and technology remains a major area to focus on.	1
23	Existing Infrastructure	Seen as a major driver and hence national grid access guaranteed.	1
24	Deployment Time	Deployment times specified in RFP and seen as a major driver.	1

The above start-up positions have been inserted in the FCM and the resulting FCM is shown in Table 67 below:

Table 67: SA REBID FCM



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0
	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	0	1	0	1	0	0
	2	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	0	1	1	0	1	0	0
	3	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	0
	4																									1	0	1	0	0
	5																									1	0	1	0	0
	6																									1	0	1	0	0
	7																									1	0	1	0	0
	8																									1	0	1	0	0
	9																									1	0	1	0	0
Cycle	10																									1	0	1	0	0
	11																									1	0	1	0	0
	12																									1	0	1	0	0
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	etc.																													

This FCM also reaches equilibrium. The first observation is that the REBID drivers are almost identical to the REFIT drivers. But on closer inspection it can be noted that the equilibrium state of the FIT has activated drivers in the REBID scenario and most of these drivers remain active in the REBID equilibrium state. For example the following drivers remain active: Common Good Elements, Resistance, and Deployment Time. It is understandable that these three drivers remain common and would be so for any policy system. Environmental sustainability and quick deployment are essential in any Renewable Energy market. And with Resistance, any change to an accepted environment of operation will be met with resistance from various parties. So the presence of Resistance is also of no surprise.

Of interest in this FCM is that ever present driver of Energy Cost. The evolution of the FIT to REBID was based on the fact that the FITs would become too costly to the consumer and were not aligned to national policies of equality and development. With the Energy Cost driver still being active in the equilibrium state suggests that REBID may not be able to reduce the final energy cost and this will remain an issue as the SA RE industry takes form. On the other hand the Cost Competiveness driver is no longer active in the final equilibrium state. This is interesting as this suggests that under the REBID system, RE will become competitive with fossil fuel based electricity. This is a fundamental goal of any RE sector and policy environment and especially under REBID. However, in the SA context, could this mean that the steep hikes in fossil fuel generated electricity over a period of years will bring electricity prices up to RE generation rates or vice versa?

One final observation from the above FCM is the Cost of Capital driver. It is present in both the start-up and equilibrium states, suggesting that financing these RE facilities will remain an issue. Indeed with a developing economy like SA and the associated risks, one can well accept that the cost of financing these projects will indeed be higher to cater for local risks.

To conclude, the REBID system bares much resemblance to the REFIT system. No major step changes have been introduced through this hybrid system. Major differences fall into the cost and finance drivers sections, which are of interest as REBID has replaced REFIT on cost grounds, yet they remain ever present. Again, with no deployed RE generation capacity or local industry maturity, these above observations are just that. This model will need to be re-analysed as the SA RE sector takes shape.

5.3.4 *SA REBID and Fiscal*

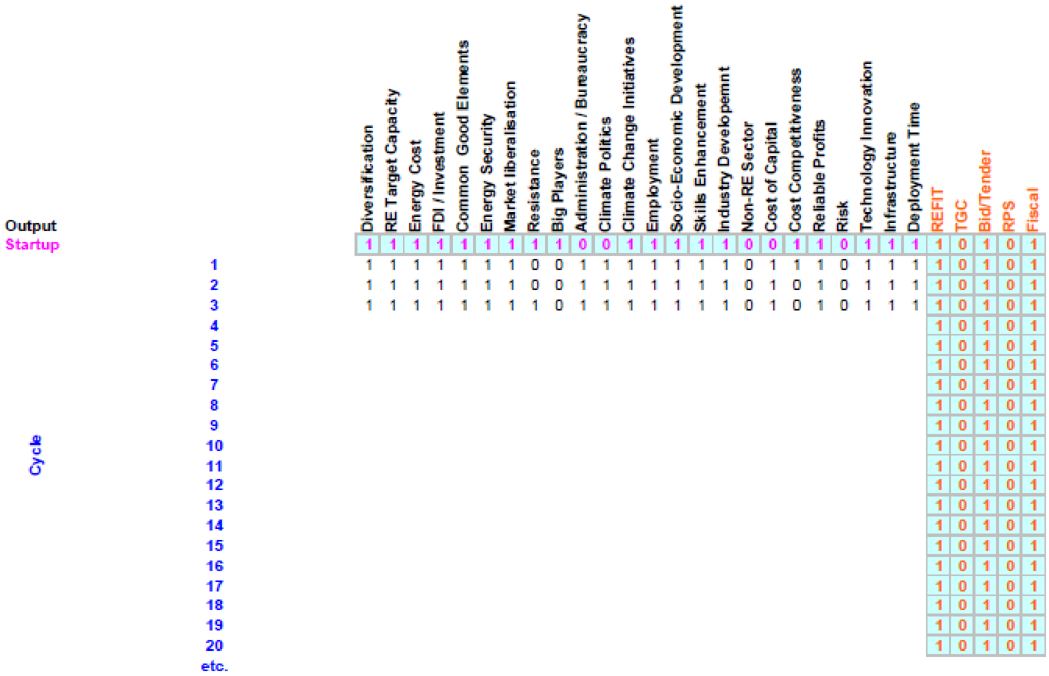
Table 68 below shows the existing drivers during the deployment of the REBID in conjunction with the fiscal policy through SARi:

Table 68: SA REBID and Fiscal Start-Up Position

		Situation	Start-Up
	REFIT	Capped FIT.	1
	TGCs	N/A	0
	Bidding/Tender	Competitive bidding	1
	RPS	N/A	0
	Fiscal	SARi blend of financial instruments established.	1
1	Diversification	Seen as a move to diversify the SA energy mix.	1
2	RE Target Capacity	Clear targets, medium and long term set through the IRP.	1
3	Energy Cost	Energy cost seen as a major driver and hence the move away from a standalone FIT system.	1
4	FDI / Investment	The RFP outlined conditions for foreign investment.	1
5	Common Good Elements	Part of the COP17 agenda and now a major driver locally.	1
6	Energy Security	Becoming a major driver and part of the future energy mix for SA.	1
7	Market Liberalisation	The DoE RFP geared towards IPPs and hence market liberalisation.	1
8	Resistance	Resistance from developers for changing the FIT to REBID.	1
9	Big Players	Continue to be a driver, but grid access and PPA conditions seen as way of managing these players.	1
10	Administration / Bureaucracy	Clear guidelines set out in the RFP, but too early to gauge level. However, RFP set out to make the process as clear and transparent as possible in the hope of streamlining. Therefore not a driver.	0
11	Climate Politics	Not a major driver.	0
12	Climate Change Initiatives	SA does not need to ratify the Kyoto Protocol, but has aligned strategies to international goals, through the SA Renewable Energy Policy in 2004.	1
13	Employment	RFP has set clear targets and criteria for job creation that aligns with other national strategies and plans (NPC, Green Economy Accord etc).	1
14	Socio-Economic Development	Clear targets for Socio-Economic Development and Enterprise development in the RFP.	1
15	Skills Enhancement	Again a driver and follows on from the above two. The DoE wants to develop local skills so SA does not become reliant on imported skills and thus creates local value.	1
16	Industry Development	The DoE RFP geared towards local content and manufacturing facilities being established.	1
17	Non-RE Sector	Not a major driver.	0
18	Cost of Capital	Seen as a driver, but being managed through the establishment of SARi. Therefore this driver falls away.	0
19	Cost Competitiveness	Energy cost seen as a major driver and hence the move to the REBID system.	1
20	Reliable Profits	FIT profits seen to be too high for IPPs and hence another reason for going to the REBID system.	1
21	Risk	A developing country seen as a high risk area and both capital and technology costs increase. The SARi fund seen as a way of reducing this risk and will no longer be a driver.	0
22	Technology Innovation	RFP still calls for reduction in costs and technology remains a major area to focus on.	1
23	Existing Infrastructure	Seen as a major driver and hence National grid access guaranteed.	1
24	Deployment Time	Deployment times specified in RFP and seen as a major driver.	1

The above start-up positions have been inserted in the FCM and the resulting FCM is shown in Table 69 below:

Table 69: SA REBID and Fiscal FCM



Output		Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup		1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	0	1
	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	1	0	1
	2	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	1
	3	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	0	1
	4																									1	0	1	0	1
	5																									1	0	1	0	1
	6																									1	0	1	0	1
	7																									1	0	1	0	1
	8																									1	0	1	0	1
	9																									1	0	1	0	1
Cycle	10																									1	0	1	0	1
	11																									1	0	1	0	1
	12																									1	0	1	0	1
	13																									1	0	1	0	1
	14																									1	0	1	0	1
	15																									1	0	1	0	1
	16																									1	0	1	0	1
	17																									1	0	1	0	1
	18																									1	0	1	0	1
	19																									1	0	1	0	1
	20																									1	0	1	0	1
	etc.																													

The final FCM of this research report also reaches equilibrium. The only difference between this FCM and the previous one is that Cost of Capital and Risk were not present in the start-up position as these were the main drivers to establish SARi. While Risk remains dormant, Cost-of Capital does activate in the final equilibrium state. Coupled with this, as with the REBID only FCM, Administration / Bureaucracy and Climate Politics drivers become present in the final equilibrium state too. This suggests that this fiscal measure will introduce administrative hurdles and political attention that may render the function of this fund less than impactful leading to capital costs remaining a major driver in the SA RE sector.

To conclude the addition of the SARi fund has limited influence on the SA RE sector. Again, it is hard to verify the outputs of the FCM, especially in this case, as the SARi has recently been formed and no application have been made to date. The biggest observation is that this fund may be embroiled in politics and administrative hurdles that will reduce its effectiveness and still have capital costs a major barrier in the SA RE sector.

5.3.5 *Conclusion of SA Policy Choice*

It is too early to conclude whether SA has chosen the correct policy support mechanism or not. Indeed as this research project has been carried out, a major policy change has occurred (Oct 2010 – Feb 2012). And as no large scale grid connected facilities have been deployed, the theoretical model cannot be sense checked with the actual reality.

Conclusions that can be drawn are as follows. The model has the biggest effective change from the REFSO to REFIT policy stances. REFSO has been the least effective policy mechanism to start the SA RE sector, while REFIT is seen as a good move towards alternative policy that is not purely fund support based. The evolution from the FIT to REBID, by capping tariffs and calling on competitive bidding does not evoke a major step change. Energy and Capital costs remain an ever present driver and this can be attributed to the risk associated with SA as a new and developing RE market, within a developing economy. The final FCM added the fiscal policy to FIT and Bidding, through the formation of SARi, and this model suggests that capital costs will remain high as administrative and political hurdles start to appear in the sector.

As no grid connected RE generating capacity has been installed and the first set of projects is currently being developed, a lot of the above issues will need to be revisited and monitored to see if the predications are indeed correct. So SA seems to be working towards the ultimate goal of diversifying the fossil fuel only energy mix by introducing RE generation capacity. The initial outcomes of the REFIT and REBID models suggest that the choice is aligned to reach this goal, while meeting the other local drivers. The key here is to ensure that SA authorities support the chosen policies and ensure that all parties remain committed to the ultimate goal. Any abrupt change could stunt the confidence from international developers and hence stunt the SA RE sector.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This section seeks to highlight the salient findings of this research report and in doing so provide guidance to investors, high level policy makers and the business community on how the future of a RE sector can be shaped through various policy types and drivers. This section relates the theoretical findings of the literature review, with the outcomes of the modelling in the context of the propositions and main research problem.

6.2 Conclusions of the study

This research topic has established the context within which the policies and drivers of a renewable energy sector linked. The aim was to create an understanding of what policy types have been used globally and what drivers (factors) are used to shape the sector. The fundamental objective was to create an understanding of the influence (impact) that high level policy decisions makes on the business of RE generation. This understanding came through a comprehensive literature review that formulated a model that can be applied universally. By modelling scenarios borne out of the propositions, the key influencing factors have been identified.

The literature review concluded that broadly speaking there are ten high level policy types that are used to create the protection needed to start a renewable energy sector. Of these ten, FITs, TGCs, bidding/tendering, RPS and fiscal are the most prominently deployed. Hence these were used for modelling purposes. Of these five, FITs have been cited repeatedly as producing the most success. Hence FITs formed the focus from a policy perspective. Through the review of policy types, thirty five common factors (drivers) were identified as the most influential within a RE sector, however consolidated to twenty four. These were categorised into the following groups: Local Energy Constraints; Encouraging Renewable Energy; Local Conditions; Economics; Financial and Technology. Of these, the technological field received the largest review, however, ultimately had the least influence through modelling. Finally, the SA RE sector was reviewed citing its first procurement round in 2011 and hence its infancy. The development of the SA RE policy framework has been reviewed and also the local drivers that feed into the local sector. The ultimate goal to investigate the plausible future scenarios of the SA RE sector.

This research then used the qualitative research tool of Fuzzy Cognitive Maps to form a model. This model related the five RE policy types (policy nodes) to the twenty four factors (drivers(nodes)) through casual links extracted from the literature review. This model was validated through country specific case studies and verified by external experts. The country specific case studies (The Danish and UK RE sectors) provided good reviews citing empirical data related to timelines and historical outcomes so that the theoretical outputs of the model could compared to what actually occurred. Indeed the model predicated what actually occurred. To add further validity to the model, external experts were asked to review the FCM and to provide comment whether the model is a good reflection of a RE sector. All respondents agreed that the model was a good reflection of the theoretical situation, however cautioned that the reality is far more complex due to the magnitude, sensitivity and local conditions of a specific RE sector. Hence, the universal applicability of this model needs to be adjusted to the local conditions and related to the outcomes.

With the model formulated and validated the propositions emerging from the literature review were modelled. The literature review concluded that the FIT system has been the most successful in growing a RE sector. However, under proposition one, it was found that a FIT system, when deployed in isolation of the other drivers, is no better than the other four policy mechanisms. Even when a FIT was deployed in combination, (as is usually the case in reality), the model still did not present an output that confirmed this proposition. The key conclusion coming from this is that when a RE support policy is chosen, the twenty four drivers need to be considered too. Choosing only a policy type without considering which other drivers are needed, is as good as not choosing a policy type at all.

In all modelled cases under proposition one, the same four drivers were activated in the output. These were Big Players, Non-RE Sector, Cost-Competitiveness and Risk. This serves to confirm that in reality, these drivers remain most influential. Big Players (big industry, mining, manufacturing etc) will be involved whether a RE sector is formed or not. The Non-RE Sector (traditional electricity generators), will also be present under a policy type and form a barrier to entry to IPPs as IPPs are seen as a potential threat. Cost-Competitiveness is a key component not only to the RE sector but to the energy sector in general, as energy keeps an economy working and controlling this cost centre is always fiercely watched. Finally, Risk is an ever present driver in many forms that has a direct influence on cost. If an RE sector were not present, Risk would still remain a driver in other forms like energy security and low market liberalisation etc. So to conclude, a standalone FIT system is no better than the other policy systems to establishing a RE sector. It needs to be considered with the twenty four drivers.

Proposition two emerged from the final twenty four drivers that were consolidated from the literature review. The proposal here was that a policy choice relies heavily on the specific local drivers and was aimed at identifying which are the most effective. As the FIT has been cited as the most successful policy mechanism, all model scenarios were run by activating them under the FIT policy system. The various categories Local Energy Constraints; Encouraging Renewable Energy; Local Conditions; Economics; Financial and Technology were modelled in isolation, as modelling all twenty four drivers was not deemed sensible. While variations did exist, a trend emerged. Of the six different modelling scenarios, four drivers were always present. These drivers are Big Players (big industry, mining, manufacturing etc), The Non-RE Sector (traditional electricity generators), Cost-Competitiveness and Risk. It was also noted that these drivers carry a negative connotation and hence “most effective” was replaced with “most influential”. Risk and Cost-Competitiveness are categorised into the Financial set of drivers, while Big Players and the Non-RE sector are categorised into the Local Conditions and Economics set of drivers respectively.

In needs to be noted that the financial set of drivers remain at the heart of an effective RE sector. Throughout the research conducted for this report existing research that focused on cost related topics have continually been uncovered. Long term financial attributes of a RE policy; FIT levels and digression levels; economic spin-offs; country risk; TGC pricing; market forces and how they shape RE prices have all been researched to date, confirming the importance of financial drivers. As a

RE sector competes with traditional energy generation sector, cost comparison, both direct and indirect has formed the basis of many climate and clean energy research work. Energy is needed to power industry, especially in industry and manufacturing based economies and hence energy cost is the conclusion of these financial drivers. In addition, the risk associated with policy mechanisms failing or not being designed and supported properly has been heavily researched and related to cost. Once again this illustrates the fact that the financial set of drivers remains the most influential.

The other two influential drivers, Big Players and The Non-RE Sector play a major role in RE policy. Policy needs to ring fence these active drivers in an economy so as to protect IPPs. These players have the strong balance sheets and established markets to form large barriers to IPPs. Policy needs to think carefully about how to include these players (e.g. mandate them to connect IPPs to grid; legislate the purchase of green electricity; exclude them from participating in the RE generation procurement process etc). As has been shown under proposition one, these players will be ever present regardless of what policy is deployed and hence they need to be managed through the RE policy procurement design. By way of example, Eskom is not allowed to participate in the DoE IRP process and by doing so allows IPPs the opportunity to develop and build their own facilities. In addition, Eskom has been committed through NERSA to connect new generation facilities to the national transmission system. These two are examples of how an existing player can be managed through effective policy design.

These four drivers emerge as the key components that need to be managed when designing a RE policy mechanism. Managing these four key drivers is key to establishing a RE sector that has the potential to be sustainable. This has been confirmed through the literature reviews; country specific validation and expert input.

Finally, under proposition three this research sought to confirm if SA’s RE policy choice will indeed form the foundation of a sustainable local RE sector. This proposition was difficult to investigate for two main reasons. Firstly, the local RE sector has only as recently as 2011 invited IPPs to present RE projects for consideration for PPAs, thus highlighting the infancy of the local industry. Secondly, within the past year the DoE and NERSA have changed their policy choice from a FIT to a competitive bidding system (REBID). This is the third policy choice change since 2008. This highlights a crucial aspect of a RE sector that has been cited throughout the current body of literature: consistency of support. IPPs rely heavily on authorities supporting the policy mechanisms. If changes are made abruptly, developers/players carry the costs. This in turn detracts from creating a pool of IPPs and can stunt the deployment of RE capacity. This has been the case in recent times in both The USA and Spain with reasons cited in political leadership change and the recent economic recession. Nonetheless, the various policy approaches in SA have been modelled.

The model looked at four policy stances: REFSO; REFIT; REBID and REBID in conjunction with SARi. The REFSO has been cited as the least successful mechanism and this is evident through the fact that only one project qualified for funding. The biggest response invoked from the model was the jump from REFSO to REFIT. The effectiveness of REFIT will unlikely be confirmed as no projects were ever procured under this mechanism. Finally, REBID has only been in play since August 2011, however, projects have already been awarded preferred bidder status, indicating that REBID is already more effective than REFIT. The evolution to the last two policy simulations added incrementally to the outcomes.

As SA is classified as a developing country and with 30% energy poverty, one national goal is to provide access for all to electricity. However, this national goal, along with other national goals for equality and poverty alleviation, make RE electricity an expensive option. Hence the evolution from REFIT to REBID. REFIT with its price certainty has been replaced with REBID that mandates competitive bidding and employs market forces to drive cost down. Finally, SARi was formed to be used in conjunction with REBID to facilitate access to cheaper capital to fund these expensive RE projects.

No finite conclusions can be drawn that SA has deployed the right policy choice. SA is just starting to establish the sector and policy is in its infancy with the first large grid connected projects being developed and due to be generating electricity by early 2014. Hence it is too early to say outright that SA is on the correct path. A conclusion that can however, be drawn is that if authorities do indeed support the commitments made through the REBID programme, than the system design could possibly reach the goals set by Government with a greater degree of success than

REFSO ever did. Key outputs from the modelling under the REFIT system, suggest that Energy and Capital Costs remain drivers and this is accurate as REFIT was replaced by REBID due to projected potential societal cost implications. However, in further modelling under the REBID mechanism, Energy and Capital Cost <u>remain</u> drivers, suggesting that under REBID cost and financial drivers may not disappear. To this the SARi mechanism has been created to facilitate access to cheap capital and reduce high capital costs associated with the high risk profile associated with a developing country. The additional fiscal support of the SARi also awakens Climate Politics and Administrative drivers suggesting that as the SA RE sector takes shape, RE and its cost will become more of a public point of debate, as is currently the case with NERSA's electricity price revisions. So in conclusion, REBID seems set to provide the correct platform for a successful local RE sector, however, the Energy and Capital Cost drivers will ultimately be present unless managed properly. This is consistent with the outcomes of proposition two, where managing financial drivers remain key to establishing a local RE sector.

This research report has successfully looked into the various policy types currently available to kick start a RE sector and the associated drivers. Based on these components a universally applicable model was formed and used to look at specific propositions. FIT policy in isolation is not necessarily any better than a 'no-policy' stance and the financial set of drivers remain the most influential when deploying a policy mechanism. In SA, the REBID in conjunction with SARi is set to establish a local RE sector, however, it is too early to say this without caution or uncertainty. The key components to watch are financial drivers, especially the energy cost and cost of capital ones.

6.3 Recommendations

It is recommended that this model be adapted to suite local conditions. The results should also be carefully analysed before taking the results as conclusive. The model is a hybrid of both hard and soft issues, some only emerging as the sector experiences spill over affects, e.g. skills development and industry development. This is to be used for high level indications of a specific application, but to unpack local conditions to ensure accuracy. For example, when looking at an island nation, where sun and wind resource may be excellent, the fact that capacity needs and demand may be minor drivers, may lead to a fiscal support system being far more applicable than a FIT system.

This research recommends that the business sector and policy makers monitor the financial set of drivers. Understanding how the local context can influence the business and financial drivers can be insightful to analysing the viability of an RE sector and the possible returns. Energy Cost, Risk and the Cost of Capital will need to ultimately dictate the design of the RE policy and if managed properly can increase the attractiveness of the market to investors and business. For example, by ring fencing existing, established players or technologies, IPPs and technology diversification will have the potential to take root. If these are clearly defined and supported, this can attract investors and developers to develop local projects and hence provide the private funding needed. Softer issues will also need to be monitored, as certain societal attributes that contribute to the risk profile and hence the financial drivers. For example in SA the legacy of Apartheid has created Broad Based Black Economic Empowerment (BBBEE) criteria to facilitate business opportunity equality that may be at odds to international business fraternities. Policy needs to clearly define the targets and definitions under such balancing initiatives so that international investors understand the implications and can base investment decisions upon these. The soft local issues feed straight into the harder business metrics and should never be excluded from the business case. In addition, the existing players that may see market share dwindle or big players that can aggressively enter a RE sector needs to be managed to be able to deploy a sustainable RE sector. These players can act as significant barriers to entry and could ultimately slow the growth of IPPs e.g. utilities slowing down grid connectivity.

In the South African context, it is recommended that good market intelligence is gained and that investment trends are monitored. Most developers and funding are from abroad and local policy formulation and support is paramount for keeping this foreign investment on these shores. This research has continually found that Energy Cost, Cost-Competitiveness, Cost of Capital and Risk have been the most influential. In light of the current economic recession and the devloping nation status of SA, it is important that local business have a clear understanding of how these financial drivers and how they can be used to attract FDI and to keep it here for the support of the RE sector. Good market intelligence, is recommended to achieve this.

6.4 Suggestions for further research

The following suggestions are made for future research at WBS:

- The four key drivers Big Players, The Non-RE Sector, Cost-Competitiveness and Risk should be expanded upon. Each driver should be unpacked and specific issues looked at. For example, what Risk elements are present that drive financial costs up in the RE context? Or, what factors lead to Cost-Competitiveness?

- Risk under the financial set of drivers should be research in the context of RE in a developing country. For example: what specific local risks are present in SA that is different to developed economies and what are the implications for business?

- The FCM has not assigned weightings to the casual links i.e. either the casual link is either active or not. By weighting the casual links, partial activation may provide better insight to which influential drivers are the most influential. Further research could expand on the financial drivers and add weightings to the links to see which drivers, when weighted induce more of an influence than the others.

- The majority of the published work has been done prior to the current economic recession. Funding during the good times made such initiatives and REFIT policies easier to deploy. Future research should focus on understanding how this recession has affected the growth in the international RE sector. As the economic recession has seen cutbacks in spending on RE generation in developed economies, (as is the case in Spain), has this seen a focus on developing economies for funding and development?

- Five broad categories of policy have been explored in this modelling. Future research could look to extract each individual policy and expand on specific design methods for specific economies. E.g. Is there a specific design method of a FIT type policy that can be tailored for a developing economy like SA?

- The research suggests that not one specific, stand alone policy will establish a sustainable RE sector. Indeed in many of the cited cases, a mixture of fiscal and other bespoke policy have yielded the desired results. Further research should explore which combination of policies within a specific economic context will yield the best results. E.g. a FIT and Fiscal policy in a developed economy, versus a Bidding and Fiscal policy in a developing economy.
- Most literature has been based on established RE sectors in OECD countries. In developing countries, other more pressing social issues have been prioritised. As in the case of SA, developing countries are establishing policies to start RE generation capacity. Drivers are different, looking at for example employment opportunities and upliftment initiatives over and above the Energy Security and Climate Change initiatives drivers as reason to pursue RE. Studies should be initiated now to monitor and track how these are being implemented in order to develop a credible database for development, investment and success monitoring.
- Future research could investigate timeframes in deploying RE capacity in developing economies to measure the rates of growth against set targets and objectives. This should include planning and permitting timeframes that have been found to be a hindrance to timely deployment. Furthermore technology maturation rates could possibly unlock further myths as to which policy is best placed to establish a sustainable RE sector.
- Investigate the possible quantum leap that Africa, (with a local capacity to generate any form of electricity), could make by using policy support to deploy RE generation capacity and use it to reduce to close the poverty gasp through the spill over affect.
- This research has not dealt with RE policy and regulation for transportation energy. One major sector is Biofuels and its generation of fuel through

agriculture. Future research can focus on biofuel support policy and the implications on competing with food production while creating employment.

- This research dealt with RE policy specifically for large grid-connected facilities. Off-grid facilities and indeed smaller feed-in systems, while smaller in capacity, can have a major affect when economies of scale are considered. Future research should look at policy around the demand-side management and efficiency elements of initiatives like net-metering and Solar Water Heaters in the context of a developing country.

- The cost of RE has been cited regularly as being extremely high. Expert input to the FCM have commonly cited this as a misnomer, with full cost accounting being a missing element. Future research should investigate the true cost of large grid connected RE facilities and compare this with traditional generation methods.

- Is climate change a major driver for RE policy as cited from the literature review? Timelines for RE policy formation and sector development follow decade timeframes. Climate change and global warming follow timeframes far greater than this. Future research should expand on what drivers have timeframes too long to include into first tier RE policy formation.

- Risk has been identified as one of the most influential drivers. Expert input has highlighted the work of Shimon Awerbuch. His theory focuses on how a diversified portfolio helps reduce risk and in turn increases GDP. Future research should investigate what the implications of such work can have for SA.

- SA is a mineral resource rich country and mineral rights and associated works take precedence over other activities. Coupled with this are the BBBEE laws. When these both meet, money is present. RE is not yet understood from the money value perspective. Future research should investigate the implications of attracting BBBEE attention away from minerals and into RE.

- SA is a developing economy. The validation of the FCM model was done using developed country case studies as the history and maturity of these RE sectors provide a volume of information. Future research should look to the developing world economies of Brazil, India and China to further validate the merging RE sector in South Africa.

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Appendix A – abbreviations

AT	Austria
Bankable Project	Land secured (usually via options), EIA done, all necessary Permits obtained e.g. IPP, PPA and grid connection
BE	Belgium
BBBEE	Broad Based Black Economic Empowerment
CHP	Combined Heat and Power
COP	Conference of Parties
CSP	Concentrated Solar Power – in the South African context, this means solar thermal with storage
DE	Germany
DBSA	Development Bank of South Africa
DEAT	Department of Environmental Affairs and Tourism
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry.
DK	Denmark
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement, Construction
ES	Spain
EU	European Union
FCM	Fuzzy Cognitive Mapping
FI	Finland
FIT	Fit In Tariff
FR	France
GO	Guarantee of Origin
GR	Greece
GW	Gigawatt
GWh	Gigawatt hour
HDR	Hot Dry Rock
IDC	Industrial Development Corporation
IE	Ireland
IPP	Independent Power Producer

IRP	Integrated Resource Plan
IRR	Internal rate of return
ISMO	Independent System and Market Operator
IT	Italy
KW	Kilowatt
KWh	Kilowatt hours
LU	Luxembourg
MW	Megawatt
MWh	Megawatt hours
NDP	National Development Plan
NERSA	National Energy Regulator of South Africa
NL	Netherlands
OPEX	Operating expenses (excluding personnel)
O&M	Operations and Management
PPA	Power Purchase Agreement
PT	Portugal
PTC	Production Tax Credits
PV	Photovoltaic
RE	Renewable Energy
REFIT	Renewable Energy Feed in Tariff
REFSO	Renewable Energy Fund and Subsidy Office
SAPVIA	South African Photovoltaic Industry Association
SASTELA	South African Solar Thermal Electricity Association
SAWEA	South African Wind Energy Association
SE	Sweden
TGC	Tradable Green Certificates
UNFCC	United Nations Framework Convention on Climate Change
UK	United Kingdom
WBS	Wits Business School

Appendix B – Non-Policy Drivers Casual Links for Draft Model

A. Local Energy Constraints

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 35 other drivers?

1. Diversification			
Driver No:	**Driver**	**Effect**	**Comment**
2	RE Target Capacity	+	A move away from fossil fuels.
3	Energy Cost	+	Greater use of expensive RE is initially at a higher cost.
4	FDI / Investment	+	Attracts investment in new projects.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Reduced GHG emissions leads to less negative impact on the environment.
8	Health	+	Reduced GHG emissions leads improved health.
9	Weather	+	Reduced GHG emissions leads to less adverse weather conditions and patterns.
10	Energy Security	+	Less reliance on imported energy.
11	Market Liberalisation	+	RE induced Independent Power Producers and can dilute previously monopolistic markets.
12	Resistance	0	
13	Big Players	-	New generation methods reduce market share of existing power producers.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	Increased power generation pool requires greater administration and hence bureaucracy.
16	Climate Politics	+	Increased lobbying for and against RE generation will be experienced.
17	International Opinion / Reputation	+	Reducing reliance on fossil fuels is seen in a positive light as it reduces the tragedy of the commons phenomenon.
18	International Policy Agreements	+	Reducing emissions through greater RE generation, is moving towards compliance with international agreements like Kyoto etc.
19	Employment	+	New generation methods provide employment opportunities throughout the project life cycle, from development to operation.
20	Economic Development	+	Greater dependability on energy resource and increased employment opportunities corresponds with increases in economic activity.
21	Social Development	+	Through a new industry, new opportunities present themselves to unite and uplift forgotten pockets of society. Geographically and generally, RE facilities are located in rural areas, where social development may be a priority.
22	Skills Development	+	Through a new industry, a new skill set is required and this will drive skills training and development.
23	Primary Industry	+	A new industry requires the value chain to be established, depending on the local capacity. Generally, opportunities exist to grow primary industry involved with manufacturing and deployment of RE technology.
24	Services	+	Support services needed to carry out development, research, funding and management etc are required throughout the life cycle of RE projects and by the industry itself.
25	Non-RE Sector	-	Increasing diversification can lead to traditional generators losing market share.
26	Engineering Skills	+	RE is reliant on technology for development and deployment. Technical aspects require traditional and new engineering skills.
27	Cost of Capital	0	
28	Cost Competitiveness	-	Initially, RE technology is not cost competitive with traditional generation methods.
29	Reliable Profits	0	
30	Risk	-	A new industry / sector brings uncertainty and therefore greater risk.
31	Technology Innovation	+	New generation methods need to mature and there is scope to improve and refine them. Hence new technological developments are spurred by diversification.
32	Infrastructure	+	Connecting new RE generation facilities to the grid will require existing and new infrastructure to be built/adapted.
33	Maintenance	+	New generation capacity using RE technology will require new maintenance regimes and skills.
34	Deployment Time	0	
35	Solar	+	A maturing technology that is chosen when diversifying energy mixes.
36	Wind	+	A maturing technology that is chosen when diversifying energy mixes.

By setting capacity targets for RE generation, what casual links are evident to the other 35 drivers?

2. RE Target Capacity

Driver No:	Driver	Effect	Comment
1	Diversification	+	Targets for RE capacity lead to potential diversification.
3	Energy Cost	-	Expensive RE in large capacities is initially costly to society.
4	FDI / Investment	+	Attractive capacities helps attract investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Large capacity potentially reduces negative affect on environment.
8	Health	+	Large capacity potentially reduces negative affects on health.
9	Weather	+	Large capacity reduces negative affects on the environment and may reduce the adverse weather conditions.
10	Energy Security	+	Greater RE capacity, potentially means less reliance on imported energy.
11	Market Liberalisation	+	The greater the targeted capacity, the greater the space for IPP's to enter the market and liberlise it.
12	Resistance	0	
13	Big Players	-	Myopic traditional utilities will have their market share reduced as target capacities increase.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased lobbying for and against RE target capacities will be experienced.
17	International Opinion / Reputation	+	Setting realisable RE targets will see improved country reputation.
18	International Policy Agreements	+	Setting realisable RE targets that fall in line with ratified climate change agreements.
19	Employment	+	Larger capacities bring greater opportunities for employment.
20	Economic Development	+	Larger capacities correspond with increases in economic activity, both through employment opportunities and energy dependability.
21	Social Development	+	Capacity drives market size. The bigger the market the greater the potential for social development.
22	Skills Development	+	Capacity drives market size. The bigger the market the greater the need for skills development.
23	Primary Industry	+	Capacity drives market size. The bigger the market the greater the need for localisaton.
24	Services	+	Capacity drives market size. The bigger the market the greater the need for services related to the industry.
25	Non-RE Sector	-	Greater RE capacity will see market share lost by traditional energy generators.
26	Engineering Skills	+	Capacity drives market size. The bigger the market the greater the need for engineering skills.
27	Cost of Capital	-	Greater RE capacity, means a larger potential market and hence competitive funding rates.
28	Cost Competitiveness	+	Greater RE capacity, means a larger potential market and hence competition to bring costs down as producers compete for customers.
29	Reliable Profits	+	The greater the capacity the greater the market and IPPs can forecast industry growth and profits.
30	Risk	0	
31	Technology Innovation	+	Greater RE capacity, means a larger potential market and hence competition to bring costs down as producers and hence investment in R&D to find cheaper and newer technology.
32	Infrastructure	-	The greater the targeted capacity, the greater the need for grid capacity, which may not be available.
33	Maintenance	+	Greater capacity, the greater the potential for RE plants and hence maintenance requirements.
34	Deployment Time	0	
35	Solar	+	A maturing technology that is chosen when target capacities need to be achieved.
36	Wind	+	A maturing technology that is chosen when target capacities need to be achieved.

By increasing energy cost through the deployment of RE generating capacity, what casual links are evident on the other 35 drivers?

3. Energy Cost

Driver No:	Driver	Effect	Comment
1	Diversification	-	Increased energy cost could be met with resistance and hence hinder further diversification.
2	RE Target Capacity	-	Increased energy cost may see larger RE capacities seen as unaffordable and hence set low RE target capacities.
4	FDI / Investment	+	The greater the cost of electricity coupled with attractive RE target capacities can attract FDI/investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	-	The higher the cost, the less socially acceptable and hence reduced deployment. Trend to use traditional methods and similar environmental impacts exist.
8	Health	-	The higher the cost, the less socially acceptable and hence reduced deployment. Trend to use traditional methods and same health implications exist.
9	Weather	-	The higher the cost, the less socially acceptable and hence reduced deployment. Trend to use traditional methods and same adverse affects on the weather exist.
10	Energy Security	-	The higher the cost, the less socially acceptable and hence reduced deployment. Therefore continued reliance on imported energy.
11	Market Liberalisation	-	Increased energy cost the less socially acceptable and less future target capacities will be set. This will stunt the entry of IPPs and hence reduce the potential to liberalise the market.
12	Resistance	+	High cost of energy increase resistance.
13	Big Players	-	Higher energy costs allow existing power producers to compete on price for customers.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased lobbying against RE target capacities will be experienced.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	0	
20	Economic Development	-	Increased energy cost increases cost of production/business in economy and profit margins are reduced. This leads to reduced economic development.
21	Social Development	-	Increased energy cost leads to reduced economic development and in turn less social development.
22	Skills Development	-	Increased energy cost leads to reduced economic development and in turn less need for skills development.
23	Primary Industry	-	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This reduces amount of opportunities to primary industry.
24	Services	-	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This reduces amount of opportunities available to associated services industry.
25	Non-RE Sector	+	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This maintains traditional generation methods in favour.
26	Engineering Skills	-	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This reduces the need for engineering skills.
27	Cost of Capital	0	
28	Cost Competitiveness	-	Increased energy cost does not allow for RE deployment and hence a road to cost competitiveness is not achieved.
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

By attracting FDI / Investment as a result of increased RE generation capacity needs, what casual links are evident on the other 35 drivers?

4. FDI / Investment

Driver No:	Driver	Effect	Comment
1	Diversification	+	Investment will spur further RE deployment.
2	RE Target Capacity	+	Investment will increase capacity from RE.
3	Energy Cost	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	Investment will increase local RE generation capacity and hence improve energy security.
11	Market Liberalisation	+	Investment will increase the number of IPPs and hence increase market players.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased lobbying for RE target deployment will be experienced quoting investor appetite a as good reason.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Increased funding for RE projects leads to employment opportunities.
20	Economic Development	+	Investment into a new industry has positive spin offs for local economic development.
21	Social Development	+	Investment into a new industry has positive spin offs for the local social development.
22	Skills Development	+	Investment into a new industry has positive spin offs for local skills development.
23	Primary Industry	+	Investment into a new industry has positive spin offs for the developing a primary RE industry.
24	Services	+	Investment into a new industry has positive spin offs for the support services for the local economy.
25	Non-RE Sector	-	Less investment for traditional generation methods and hence less growth.
26	Engineering Skills	+	Investment into a new industry has positive spin offs for the developing local engineering skills needed to support the RE sector.
27	Cost of Capital	+	Increased investor appetite creates competition and hence competitive access to capital results.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Increased investment indicates lower perceived risk.
31	Technology Innovation	+	Increased investment, where profits can be reinvested to improve of technological development.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	+	Easier access to capital/investment allows for quicker deployment.
35	Solar	0	
36	Wind	0	

When existing energy generation facilities reach their end of their design and operating life, and RE generation deployment is an option, what casual links are evident on the other 35 drivers?

5. Age of Existing Infrastructure

Driver No:	Driver	Effect	Comment
1	Diversification	+	A re-think to how newer plant is deployed, when exiting plants are reaching their design life. This can lead into investment into cleaner technologies.
2	RE Target Capacity	0	
3	Energy Cost	-	Initially, newer plant and generation methods can drive the cost of energy up, in the short term.
4	FDI / Investment	+	The size of investment needed for newer plant can attract investment.
6	Internalisation of Emissions	0	
7	Environment	+	New RE generation plant will reduce GHG emissions and have a positive effect on the environment.
8	Health	+	New RE generation plant will reduce GHG emissions and have a positive effect on health.
9	Weather	+	New RE generation plant will reduce GHG emissions and will reduce adverse weather conditions and patterns.
10	Energy Security	+	Investing in newer generation infrastructure that is renewable leads to energy security.
11	Market Liberalisation	+	Investing in newer generation infrastructure as plant is reached its design life can lead to IPPs entering the market and liberalising the energy market.\
12	Resistance	-	Resistance form traditional generators to reinvest in older more mature technologies.
13	Big Players	-	Resistance form traditional generators to reinvest in older more mature technologies.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased lobbying for and against replacing old technology with new RE technology.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Replacing old plants with new ones creates employment opportunities.
20	Economic Development	+	Replacing old plants with new ones creates employment opportunities and hence economic development.
21	Social Development	+	Replacing old plants with new ones creates employment opportunities and hence social development.
22	Skills Development	+	Replacing old plants with new ones creates employment opportunities and a need for new skills.
23	Primary Industry	+	Replacing old plants with new ones creates new industry opportunities.
24	Services	+	Replacing old plants with new ones creates opportunities for support services.
25	Non-RE Sector	-	Replacing old plants reduces market share.
26	Engineering Skills	+	Replacing old technology with new technology creates new engineering skills requirements.
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	Replacing old technology with newer immature technology will require innovation to improve and make it cost competitive.
32	Infrastructure	0	
33	Maintenance	-	Older infrastructure requires more maintenance and by replacing them, maintenance opportunities disappear.
34	Deployment Time	0	
35	Solar	+	Older infrastructure could lead to solar generation methods being considered.
36	Wind	+	Older infrastructure could lead to wind generation methods being considered.

When climate change agreements legislate the reduction of GHG emissions, through internalisation, and RE generation capacity becomes an attractive offset option, what casual links are evident on the other 35 drivers?

6. Internalisation of Emissions

Driver No:	Driver	Effect	Comment
1	Diversification	+	Deploying newer technology to offset emissions will see diversification away from traditional technologies.
2	RE Target Capacity	+	Will see potential to reach set RE targets.
3	Energy Cost	-	Deploying newer more expensive technology will see consumers energy costs go up. This may be less than the cost of internalisation being passed onto to consumers.
4	FDI / Investment	+	Newer generation techniques could be sought and hence attract investment.
5	Age of Existing Infrastructure	-	Older more polluting infrastructure could fall out of favour as costs are internalised.
7	Environment	+	Costs to internalise will spur the search for newer and greener ways of production and hence reduce GHG emissions having a positive affect on the environment.
8	Health	+	Costs to internalise will spur the search for newer and greener ways of production and hence reduce GHG emissions having a positive affect on health.
9	Weather	+	Costs to internalise will spur the search for newer and greener ways of production and hence reduce GHG emissions having a positive affect on changing weather patterns.
10	Energy Security	+	Costs to internalise will spur the search for newer and greener ways of production and hence deploy local generation facilities, hence reducing reliance on foreign energy imports, leading to energy security.
11	Market Liberalisation	+	Costs to internalise will spur the search for newer and greener ways of production and create a market for potential IPPs and hence start the liberalisation of the local energy market.
12	Resistance	-	Increased costs could see resistance from producers and consumers as costs are passed on.
13	Big Players	-	Increased costs to traditional players will see profit margins diminish and hence threaten their business. There will be resistance.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	-	Regulating this internalisation will require onerous management to make it effective. This will increase administration and bureaucracy.
16	Climate Politics	+	Increased lobbying for and against replacing old technology with new RE technology.
17	International Opinion / Reputation	+	This will be seen as a positive move to reduce GHG emissions.
18	International Policy Agreements	+	This will be seen as a positive move to reduce GHG emissions and compliance with treaties like Kyoto etc.
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	+	Greener technology/facility investment will open up opportunities to deliver these new initiatives.
24	Services	+	As primary industry opportunity increase, so does the support services for them.
25	Non-RE Sector	-	A move away fro traditional methods will reduce the need for older methods and threaten their existence.
26	Engineering Skills	+	New engineering skills will be required to deliver these lower emissions generation methods.
27	Cost of Capital	0	
28	Cost Competitiveness	+	Increased cost in traditional generation methods will allow newer greener technologies to reach cost parity.
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	Increased cost in traditional generation methods will spur investment into research and development of newer technologies to reduce GHG emissions.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	+	Increased cost in traditional generation methods will spur investment carbon neutral facilities like solar generation.
36	Wind	+	Increased cost in traditional generation methods will spur investment carbon neutral facilities like wind generation..

B. Encouraging a RE Industry

When increased RE generation capacity reduces GHG emissions and has positive effects on the environment, what casual links are evident on the other 35 drivers?

7. Environment			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	Increased diversification.
2	RE Target Capacity	+	Target capacities may be revised spurring further RE deployment.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalization of Emissions	0	
8	Health	+	Greater environmental protection leads to improved health.
9	Weather	+	Greater environmental protection leads to less adverse weather patterns.
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	+	Linking environmental damage can help change culture and mind set.
15	Administration / Bureaucracy	+	Increased regulation in environmental protection leads to more administration and bureaucracy through Environmental Management Practices etc.
16	Climate Politics	+	Improved environmental conditions can lead to further lobbying to deploy more RE generating capacity.
17	International Opinion / Reputation	+	Recognising the need to protect the environment will harbor a positive international response.
18	International Policy Agreements	+	Improved environmental conditions demonstrate adherence to international climate change iniatives.
19	Employment	+	New industry that aims to protect the environment will create work opportunities.
20	Economic Development	+	Increased employment opportunities lead to economic development.
21	Social Development	+	Increased employment opportunities lead to social development.
22	Skills Development	+	Increased employment opportunities in a new industry lead to skills development.
23	Primary Industry	+	New primary industry that aims to protect the environment.
24	Services	+	New service industry that supports primary industry.
25	Non-RE Sector	-	New industries having a positive impact on the environment will see old industries fall out of favour and hence loose market share.
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When increased RE generation capacity reduces GHG emissions and has positive effects on health, what casual links are evident on the other 35 drivers?

8. Health			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	Increased diversification.
2	RE Target Capacity	+	Target capacities may be revised spurring further RE deployment.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	+	The affects of GHG emissions on health will drive the need to internalise emissions.
7	Environment	+	By demonstrating improved health conditions as a result of environmental protection, further environmental protection can be expected.
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	+	Linking health issues to environmental damage can help change culture and mind set.
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Improved health conditions can lead to further lobbying to deploy more RE generating capacity.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	0	
20	Economic Development	+	Improved health conditions can lead to economic development by having a healthier labour pool.
21	Social Development	+	Improved health conditions can lead to social development by having a healthier labour pool.
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	-	New industries having a positive impact on health will see old industries fall out of favour and hence loose market share.
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When increased RE generation capacity reduces GHG emissions and reduces adverse weather conditions and patterns, what casual links are evident on the other 35 drivers?

9. Weather

Driver No:	Driver	Effect	Comment
1	Diversification	+	Increased diversification.
2	RE Target Capacity	+	Target capacities may be revised spurring further RE deployment.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	+	Increased adverse weather conditions linked to GHG emissions will drive the need to internalise.
7	Environment	+	Increased adverse weather leads to changes in the environment.
8	Health	+	Increased adverse weather conditions can lead to extreme events (floods, drought, hurricanes etc) that can spell disasters which affect health.
10	Energy Security	+	Adverse weather conditions can damage fuel supplies and reduce energy security.
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	+	Adverse weather conditions can be the evidence that GHG emissions are real and help change local culture and mindset.
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Linking weather conditions to environmental damage can help change culture and mind set.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	0	
20	Economic Development	+	Increased adverse weather conditions leads to less economic activity. For example crop yields can be diminished.
21	Social Development	+	Less adverse weather conditions stabilises the environment where people can engage I social development as disasters will not interrupt progress.
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	+	Adverse weather conditions within an area will increase the risk level and hence the cost of capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	+	Adverse weather conditions increase risk.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	+	Increased adverse weather conditions will see existing infrastructure needing to be maintained more as they are operated outside of design parameters.
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When increased localised RE generation is deployed and energy security is increased, what casual links are evident on the other 35 drivers?

10. Energy Security

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	+	Increased energy security leads to higher energy cost initially, but lower cost in the long run with less reliance on imported energy and exposure to international markets.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
11	Market Liberalisation	+	With greater local generation there is opportunity to use more IPPs and hence liberalise the local market.
12	Resistance	0	
13	Big Players	+	Less reliance on imported energy may be met with resistance from existing energy suppliers.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased pressure to achieve energy security can add pressure to the political circles to use RE generating sources.
17	International Opinion / Reputation	+	Positive affect if energy security is achieved through deployment of RE technologies.
18	International Policy Agreements	+	Energy security via RE deployment reduces GHG emissions and hence shows adherence to international treaties like Kyoto.
19	Employment	+	Greater energy security leads larger local industry which will create employment opportunities.
20	Economic Development	+	A bigger local energy sector leads to greater economic development.
21	Social Development	+	Greater energy security, greater economic development and hence greater social development.
22	Skills Development	+	Greater energy security using RE technology will require a different skill set and hence a need to develop skills.
23	Primary Industry	+	Greater energy security using RE technology will develop a new primary industry.
24	Services	+	Greater energy security using RE technology will develop a need for support services.
25	Non-RE Sector	-	Newer localised energy generating capacity will see traditional methods loose market share.
26	Engineering Skills	+	Greater energy security using RE technology will develop a need for engineering skills.
27	Cost of Capital	+	Less volatility in energy price can lead to lower capital costs.
28	Cost Competitiveness	-	Initially, newer localised RE generation methods will not be cost competitive.
29	Reliable Profits	0	
30	Risk	-	Increased energy security will reduce energy security risk of relying on imported fuel sources.
31	Technology Innovation	+	Newer localised energy generating capacity will see newer methods being sought out to harness local resource.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	+	Energy security may favour solar methods if local resource is good.
36	Wind	+	Energy security may favour wind methods if local resource is good.

When RE target capacities attract IPPs and energy monopolies experience competition, what casual links are evident on the other 35 drivers?

11. Market Liberalisation

Driver No:	Driver	Effect	Comment
1	Diversification	+	The more IPPs the greater use of different resources to generate electricity.
2	RE Target Capacity	+	The more IPPs the greater the chance of reaching set RE targets.
3	Energy Cost	-	Liberalised markets introduce a greater level of competition and hence drive down cost.
4	FDI / Investment	+	Liberalised markets with good policy mechanisms will attract investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	Liberalised markets that make use of RE generation methods lead to local energy security.
12	Resistance	-	The greater the liberalised market the less resistance by public to reduce energy costs etc.
13	Big Players	+	The greater the threat of IPPs joining into a liberalised market the greater the resistance from traditional method generating players.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	Increased IPPs leads to greater administrative processes needed.
16	Climate Politics	-	The more liberalised a market the less need to lobby politically to achieve greater competition.
17	International Opinion / Reputation	+	Greater the liberalisation and use of RE technology the better the opinion of the country in the international arena.
18	International Policy Agreements	+	The more the IPPs using alternative sources of energy, the evidence of adherence to international climate change agreements,
19	Employment	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment.
20	Economic Development	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment and hence economic development
21	Social Development	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment and hence social development.
22	Skills Development	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment and hence a need for skills development.
23	Primary Industry	+	Greater liberalisation leads to increased IPPs which will build primary industry related to energy generation.
24	Services	+	Greater liberalisation leads to increased IPPs which will build primary industry and there will be a need for support services.
25	Non-RE Sector	-	Greater liberalisation and an increase in RE generation methods will see traditional methods of generation diminish.
26	Engineering Skills	+	More IPPs and hence more diversified generation capacity will lead to a need for engineering skills.
27	Cost of Capital	+	A new industry with little track record will carry greater risk. Greater risk equates to increased cost for capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Liberalisation and increased alternative generating capacity reduces energy security risks and risk over all.
31	Technology Innovation	+	In liberalised markets competition drives price. Hence newer generation methods and efficiencies will drive technological innovation.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	+	Liberalised markets will see solar generation methods deployed if solar resource locally is good enough.
36	Wind	+	Liberalised markets will see wind generation methods deployed if wind resource locally is good enough.

C. Local Conditions

When the cost of RE generation to the consumer or loss of market share from existing power producers, increases, resistance, what casual links are evident on the other 35 drivers?

12. Resistance

Driver No:	Driver	Effect	Comment
1	Diversification	-	Stunted diversification.
2	RE Target Capacity	-	RE target capacities may be lowered.
3	Energy Cost	+	Traditional generation methods may be retained with a lower cost of energy.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	-	Greater the resistance to deploy clean technology the greater the continued negative affect on the environment.
8	Health	-	Greater the resistance to deploy clean technology the greater the continued negative affect on health.
9	Weather	-	Greater the resistance to deploy clean technology the greater the continued negative affect on weather patterns and adverse conditions.
10	Energy Security	-	Greater the resistance to deploy clean technology the greater the continued reliance on imported fuels and hence less energy security.
11	Market Liberalisation	-	Greater resistance leads to no RE targets being set and hence reduced IPPs enetering the market, and hence lower potential to liberalise the energy market.
13	Big Players	+	Resistance to market share loss.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased resistance to more expensive RE generation methods leads to political lobbying and pressure.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	-	Greater resistance to a RE sector being formed the lower the opportunities available for employment in a new industry.
20	Economic Development	-	Greater resistance to a RE sector being formed the reduced possibility for economic development.
21	Social Development	-	Greater resistance to a RE sector being formed the reduced possibility for social development.
22	Skills Development	-	Greater resistance to a RE sector being formed the reduced possibility for new skills development.
23	Primary Industry	-	Greater resistance to a RE sector being formed the reduced possibility for new primary industry to be developed.
24	Services	-	Greater resistance to a RE sector being formed the reduced possibility for the supporting service industry to be developed.
25	Non-RE Sector	0	
26	Engineering Skills	-	Greater resistance to a RE sector being formed the reduced possibility for the supporting service industry to be developed..
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When increases in RE generation leads to the loss of market share for big players, what casual links are evident on the other 35 drivers?

13. Big Players

Driver No:	Driver	Effect	Comment
1	Diversification	-	Pressure to maintain existing generation methods leads to low RE deployment and hence diversification.
2	RE Target Capacity	-	Less potential to reach set RE target capacities.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	-	Great resistance from big players leads to lower internalisation of GHGs.
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	-	Big players that rely on imported fuels will resist developing energy security.
11	Market Liberalisation	-	Many big players will provide big barriers to entry and hence reduce market liberalisation.
12	Resistance	+	Big players will resist changes to their business environment.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Big players will exercise their lobbying departments in political circles.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	+	Big players will promote their own industry and hence there will be greater resistance to RE deployment.
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	Big players will not invest in RE R&D as this will affect their core business.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE generation sets to change the energy mix and is met with a positive attitude and mindset, what casual links are evident on the other 35 drivers?

14. Culture / Mindset			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	Can lead to further diversification.
2	RE Target Capacity	+	Can see greater RE target capacities set.
3	Energy Cost	0	
4	FDI / Investment	+	Can attract further investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	A positive mindset to RE generation methods, the better for the environment.
8	Health	+	A positive mindset to RE generation methods, the better for health.
9	Weather	+	A positive mindset to RE generation methods, will reduce adverse weather patterns.
10	Energy Security	+	A positive mindset to RE generation methods, will see RE generation capacity deployed and hence energy security increased.
11	Market Liberalisation	+	A positive mindset to accept and increase RE generation methods will see IPPs entering the market and hence liberalising the market.
12	Resistance	-	A positive mindset can reduce resistance to new green generation methods.
13	Big Players	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	A positive mindset can be used to lobby political figures to adopt and implement RE generation methods.
17	International Opinion / Reputation	0	
18	International Policy Agreements	+	A positive mindset to climate change can help meet local targets to meet international agreements.
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	A positive mindset can reduce the risk of resistance stunting the growth an RE sector.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When increased RE generating capacity is deployed and policy mechanisms require increased administration and bureaucratic hurdles, what casual links are evident on the other 35 drivers?

15. Administration / Bureaucracy

Driver No:	Driver	Effect	Comment
1	Diversification	-	The greater the admin/bureaucracy the lower the possibility for diversification.
2	RE Target Capacity	-	The greater the admin/bureaucracy the lower the possibility of reaching target capacities.
3	Energy Cost	+	The greater the admin/bureaucracy the lower the possibility of diversifying the energy mix and hence energy cost will be kept lower with traditional generation methods.
4	FDI / Investment	-	The greater the admin/bureaucracy the less easily FDI / Investment will flow in.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	-	The greater the admin/bureaucracy the less likely RE will deployed in large enough capacity to see energy security achieved.
11	Market Liberalisation	-	The greater the admin/bureaucracy the less likely RE will deployed in large enough capacity to see market liberalisation.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	-	Too onerous the bureaucracy the slower employment opportunities will be made available.
20	Economic Development	-	Too onerous the bureaucracy the slower employment opportunities and RE generation capacity deployed and so too will economic development will be slow.
21	Social Development	-	Too onerous the bureaucracy the slower employment opportunities and RE generation capacity deployed and so too will social development be slow.
22	Skills Development	-	Too onerous the bureaucracy the slower employment opportunities and RE generation capacity deployed and so too will skills development.
23	Primary Industry	-	Too onerous the bureaucracy and the more stunted the deployment of primary industry will be.
24	Services	-	Too onerous the bureaucracy and the more stunted the growth potential of the support service industry will be.
25	Non-RE Sector	0	
26	Engineering Skills	-	Too onerous the bureaucracy and the more stunted the growth potential for new engineering skills will be.
27	Cost of Capital	+	The greater the admin/bureaucracy the greater the cost of capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	+	The greater the admin/bureaucracy the more risk that is introduced to the sector.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	+	The greater the admin/bureaucracy the longer it may take to deploy the RE generation facility.
35	Solar	0	
36	Wind	0	

When RE generation capacity is increased and proponents/opponents to RE generation increase pressure on political leaders, what casual links are evident on the other 35 drivers?

16. Climate Politics

Driver No:	Driver	Effect	Comment
1	Diversification	+	Positive climate politics lobbying will lead to diversification.
2	RE Target Capacity	+	Positive climate politics lobbying will lead greater capacity deployed.
3	Energy Cost	-	Positive climate politics lobbying will see energy cost increase initially as the sector takes root.
4	FDI / Investment	+	Positive climate politics lobbying will attract FDI / Investment
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	+	Positive climate politics lobbying will increase the drive to internalise emissions and hence the need for alternative generation methods.
7	Environment	+	Positive climate politics lobbying will improve environmental protection through RE deployment.
8	Health	+	Positive climate politics lobbying will improve health conditions through RE deployment.
9	Weather	+	Positive climate politics lobbying will potentially reduce adverse weather conditions through RE deployment.
10	Energy Security	+	Positive climate politics lobbying will increase energy security by localising generation facilities.
11	Market Liberalisation	+	Positive climate politics lobbying will increase the drive to introduce IPPs.
12	Resistance	+	Positive climate politics lobbying will increase resistance from individuals if costs increase.
13	Big Players	+	Positive climate politics lobbying will affect big players in the energy use/generation sector.
14	Culture / Mindset	+	Strong political climate leadership should help change culture/mindset to RE.
15	Administration / Bureaucracy	0	
17	International Opinion / Reputation	+	Positive climate politics lobbying will improve reputation if RE generation is lobbied for.
18	International Policy Agreements	+	Strong political climate vision will ratify international climate change agreements.
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	+	Positive climate politics lobbying will pave the way for a RE sector to be formed and hence the primary industry needed for it.
24	Services	+	Similarly positive climate politics will increase service involvement.
25	Non-RE Sector	-	Positive climate politics will force the reduction in traditional generation methods.
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When a country adopts and deploys RE generating capacity and international opinion improves, what casual links are evident on the other 35 drivers?

17. International Opinion / Reputation

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	Good reputation for encouraging RE generation will see an increase in FDI / Investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Improved international opinion should encourage further improvements in positive climate politics.
18	International Policy Agreements	0	
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	+	Good reputation will reduce the cost of capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Good reputation will reduce overall country risk.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When a country ratifies an international climate change agreement and results in increased RE generating capacity being deployed, what casual links are evident on the other 35 drivers?

18. International Policy Agreements

Driver No:	Driver	Effect	Comment
1	Diversification	+	Adherence to international agreements will see diversification as key to meeting these iniatives.
2	RE Target Capacity	+	Ratification of international agreements provides the vision to achieve targets.
3	Energy Cost	+	International agreements will see alternative generation sources required and hence energy cost will increase initially.
4	FDI / Investment	+	Ratification of international agreements provides investors with a clear message of commitment and hence inflows are facilitated.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Will increase environmental protection.
8	Health	+	Will improve health conditions.
9	Weather	+	Will reduce adverse weather patterns.
10	Energy Security	+	Will increase energy security through localised generation capacity.
11	Market Liberalisation	+	Will increase the potential for IPPs to enter the market and hence liberalise it.
12	Resistance	0	
13	Big Players	+	The more the pressure to alter traditional energy generation and use the more resistance from big players.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	A mechanism to lobby support in the political arena.
17	International Opinion / Reputation	+	Ratifying international climate change agreements improve international opinion etc.
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	+	By adhering to the conditions of the international treaties new generation methods are required and hence the primacy industry will grow.
24	Services	+	Similarly, if the primary industry is established, the need for service will also increase.
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	+	Rarifying international climate change agreements will allow access to cheaper capital, as it demonstrates commitment.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Commitment to international agreements will reduce overall country risk.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

D. Economics

With increased RE generating capacities set and deployed, and employment opportunities increasing, what casual links are evident on the other 35 drivers?

19. Employment

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	-	By establishing a new sector with new employment opportunities, jobs from the old generation methods will be reduced and this will be met with resistance from big players.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	A greater need for employment will see lobbying efforts to present the new renewable energy sector as an opportunity to create employment.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
20	Economic Development	+	Establishing a new renewable sector will lead to job creation and hence economic development.
21	Social Development	+	Establishing a new renewable sector will lead to job creation and hence social development.
22	Skills Development	+	Establishing a new renewable sector will lead to job creation and needs for new skills. These skills will need to be developed.
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	-	A increase in renewable energy sector employment, will lead to a reduction in traditional energy generation sector employment.
26	Engineering Skills	+	New employment opportunities will be created in the engineering field needed to service the technical needs of the RE industry.
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Better employment opportunities will reduce the risks associated with disgruntled citizens revolting as they cannot access the economy.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and economic development increasing, what casual links are evident on the other 35 drivers?

20. Economic Development

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	A productive economy that grows due to energy security will attract further investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	+	Economic development will allow better access to health care; reduced GHG due to increased RE generation will also improve health conditions.
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	+	Increased economic development will increase market capacity for IPPs and hence liberalise the local energy market.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	If renewable energy is seen as a positive addition to an economy in terms of creating economic growth, than this will lobby climate politics in a positive manner.
17	International Opinion / Reputation	+	Positive economic development due to RE deployment leading to sustainability will improve international opinion and reputation.
18	International Policy Agreements	0	
19	Employment	+	Economic development leads to increased employment opportunities. Cyclic/multiplier affect.
21	Social Development	+	Economic development leads to increased social development.
22	Skills Development	+	Economic development leads to increased skills development.
23	Primary Industry	+	Economic development will allow primary industry needed for the RE sector to be established.
24	Services	+	Economic development will allow the support services to access and support the RE sector.
25	Non-RE Sector	0	
26	Engineering Skills	+	Economic development will encourage engineering skills development.
27	Cost of Capital	+	Economic development will demonstrate that an economy has an appetite to attract investment. Such mechanisms will allow access to cheaper capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Economic development demonstrates a stable economy and reduces investment risk.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and social development increasing, what casual links are evident on the other 35 drivers?

21. Social Development

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	A socially devloping economy will attract further investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Increased social development will allow individuals to switch to cleaner methods for living and hence reduce the negative impact on the environment. E.g. social development leads to a switch from wood/coal burning to electricity use.
8	Health	+	Increased social development will allow individuals to switch to cleaner methods for living and hence reduce the negative impact on the environment and improved health conditions. E.g. less wood/coal burning leads to less GHG emissions and cleaner air and improved health.
9	Weather	+	Increased social development will allow individuals to switch to cleaner methods for living and hence reduce the negative impact on the environment and hence reduced climate change and more consistent weather patterns.
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	+	Increased social development provides improved human capital to the existing industry players.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	-	Increased social development will reduce the need to govern and administer social development programmes.
16	Climate Politics	+	If renewable energy is seen as a positive driving factor for social development, than this will lobby climate politics in a positive manner.
17	International Opinion / Reputation	+	Increased social development will demonstrate that local authorities are delivering on policy and hence improve international opinion etc.
18	International Policy Agreements	+	Climate change programmes/agreements incorporate the fundamentals of social development. Hence increased social development demonstrates adherence to such initiatives.
19	Employment	+	Increased social upliftment leads to further job opportunities.
20	Economic Development	+	Increased social development leads to economic development.
22	Skills Development	+	Increased social development leads to skills development.
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	+	Increased social development provides displaced workers from older energy industries with new ways of accessing the economy.
26	Engineering Skills	+	Increased social development allows individuals to pursue higher learning and perhaps engineering vocations.
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Increased social development leads to more a more stable country environment and hence reduces country risk.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and skills development increasing, what casual links are evident on the other 35 drivers?

22. Skills Development

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Increased skills development demonstrate that governmental goals are being met and if influenced by the new renewable energy sector, than a positive view of climate politics will be the result.
17	International Opinion / Reputation	+	Increased skills development demonstrate that governmental goals are being met and if influenced by the new renewable energy sector, than an increase in reputation will result.
18	International Policy Agreements	+	Climate change programmes/agreements incorporate criteria for skills development. Hence increased skills development will demonstrate adherence to such initiatives.
19	Employment	+	Improved pool of skills, the greater the job opportunities available to individuals.
20	Economic Development	+	Improved pool of skills, the greater the job opportunities and hence the greater the potential for economic development.
21	Social Development	+	Improved pool of skills, the greater the job opportunities and hence the greater the potential for social upliftment.
23	Primary Industry	+	Improved skills tailored to the RE industry will deploy local skills rather than importing them.
24	Services	0	
25	Non-RE Sector	+	Improved skills can be transferred across industry sectors and help redeploy displaced workers from industries that have lost market share.
26	Engineering Skills	+	The RE sector is heavily reliant on engineering skills and hence skills development will have a tendency to be engineering focused.
27	Cost of Capital	+	Increased local skills will reduce the reliance on imported skills and hence reduce the capital needs and cost.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	-	Increased local skills development will reduce the risk related to a low supply of the essential skills needed to realise renewable energy sector deployment and capacity.
31	Technology Innovation	+	Improved skills development will supply skills needed for technological development.
32	Infrastructure	0	
33	Maintenance	+	Increased skills development tailored to the RE sector will allow for local maintenance teams to carry out essential O&M rather than importing them.
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and primary RE related industry increasing, what casual links are evident on the other 35 drivers?

23. Primary Industry			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	If local RE generation capacity is significant enough, primary industry can access markets to raise the funds to establish permanent manufacturing facilities locally.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	Establishing a local primary industry to deliver RE capacity deployment will reduce deployment times and increase local energy security.
11	Market Liberalisation	+	Increased primary industry to deploy RE capacity will facilitate/accelerate market liberalisation as they will be able to supply the needs of IPPs and their projects.
12	Resistance	+	Established local industry will resist new primary industry from setting up shop.
13	Big Players	-	Increased RE primary industry will reduce market share from existing big players.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	Increased RE primary industry will require increased administration to ensure fairness and transparency.
16	Climate Politics	+	Primary industry establishing themselves in a new market will lobby authorities to protect deployment and use climate politics to achieve this.
17	International Opinion / Reputation	0	
18	International Policy Agreements	+	Increased local primary industry supporting RE deployment will demonstrate commitment to international policy and initiatives established for climate change.
19	Employment	+	Increased primary industry will create employment opportunities.
20	Economic Development	+	Increased primary industry leads to greater employment opportunities, greater supply to create RE generation methods and hence economic development.
21	Social Development	+	Increased primary industry leads to greater employment opportunities and hence social development.
22	Skills Development	+	Primary industry will require new skills and hence facilitate local skills development.
24	Services	+	Primary industry will require support services.
25	Non-RE Sector	-	Primary RE industry will reduce the market share for supplying the non-RE sector.
26	Engineering Skills	+	Primary RE industry will need significant engineering skills for deployment and R&D.
27	Cost of Capital	+	An established primary industry will allow local supply and hence the costs involved to import components and skills will reduce the cost of RE deployment.
28	Cost Competitiveness	+	As primary industry established itself and the market grows, competition is introduced and hence facilitates cost competitiveness.
29	Reliable Profits	0	
30	Risk	-	Local primary RE industry reduces risk associated with importing components and skills.
31	Technology Innovation	+	As primary industry establishes itself and the market floods, technological innovation will drive costs down.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	+	Local primary RE industry will reduce lead times on items needed for RE projects and facilities and hence improve delivery times.
35	Solar	+	Primary industry can target various technologies, but solar is maturing and popular.
36	Wind	+	Primary industry can target various technologies, but wind is the most mature.

With increased RE generating capacities set and deployed, and RE service related industry increasing, what casual links are evident on the other 35 drivers?

24. Services

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	0	
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	There are many facets of the RE sector that need to be serviced. The availability and engagement of these services will influence the level of administration of the RE sector. Good availability leads to lower admin levels and visa versa.
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	+	Increased support services will provide the necessary avenue to measure and report on progress made in adhering to international climate change initiatives.
19	Employment	+	The need for support services will increase employment opportunities.
20	Economic Development	+	Increased support services lead to more employment opportunities and hence economic development.
21	Social Development	+	Increased support services lead to more employment opportunities and hence social development. E.g. funds channeled to NGOs and trusts etc.
22	Skills Development	+	Increased support services lead to more employment opportunities and skills may need to be adapted for RE sector support and this will require skills development. E.g. training colleges to hoan skills to RE industry.
23	Primary Industry	+	Increased support services will provide the necessary support to help establish and support the primary industry. E.g. legal advice.
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	Support services will help technological innovation. E.g. the use of academic institutions for research or laboratory testing.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and the non-RE related industry decreasing, what casual links are evident on the other 35 drivers?

25. Non-RE Sector

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	+	Decreasing market share for traditional generators will help meet set RE target capacities.
3	Energy Cost	-	Reducing Non-RE sector will see energy costs increase initially.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	-	Increased traditional generation methods will increase environmental degradation.
8	Health	-	Increased traditional generation methods will increase GHG levels and hence not improve heath conditions.
9	Weather	-	Increased traditional generation methods will continue to add to GHG emissions and increase erratic weather conditions and patterns.
10	Energy Security	-	Increased traditional generation methods will not remove the reliance on international energy markets and hence not improve energy security.
11	Market Liberalisation	-	Increased traditional generation methods from existing players will not allow market liberalisation to occur.
12	Resistance	+	Traditional generators will resist new, greener technologies from entering the market.
13	Big Players	+	Traditional generators will lobby with big industry players to oppose deployment of RE technology and generation capacity. They try to avoid losing them as customers to IPP using greener generation methods.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Traditional generators will use lobbying in the political field to protect their market. They will advocate anti-climate change reasons and research.
17	International Opinion / Reputation	+	Traditional generators will influence international opinion based on their views to protect their market and business.
18	International Policy Agreements	+	Traditional generators will oppose initiatives to reduce climate change and hence challenge conditions of the agreements as these affect their business and market.
19	Employment	+	Traditional generation facilities do provide more employment than RE in the long term.
20	Economic Development	+	Traditional generation methods supply baselaod and this, if sufficient capacity exists in the system, will encourage economic development.
21	Social Development	+	Traditional generation methods will be mandated encourage social development and this will be spin-off of the work created because of the energy generated.
22	Skills Development	+	Traditional generation methods will need to maintain a pipeline of skills.
23	Primary Industry	0	
24	Services	0	
26	Engineering Skills	+	Traditional generation methods will still need to keep engineering skills investment.
27	Cost of Capital	+	Bigger, established utilities with long track records have access to larger markets and can fundraise preferential rates.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	0	
32	Infrastructure	+	Traditional generators will have a firm handle on transmission and distribution needs and plan for various scenarios. They will also influence gird availability to IPPs.
33	Maintenance	0	
34	Deployment Time	+	Access to grid connections and incorporation of feeds to the grid can be heavily influenced by traditional system operators that can affect RE deployment.
35	Solar	0	
36	Wind	0	

With increased RE generating capacities set and deployed, and RE engineering related skills increasing, what casual links are evident on the other 35 drivers?

26. Engineering Skills

Driver No:	Driver	Effect	Comment
1	Diversification	+	The availability of the engineering skills will help lead to diversification.
2	RE Target Capacity	0	
3	Energy Cost	+	Engineering skills lead to technological innovation and can drive RE generation costs down.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Availability of local engineering skills lead to the development and deployment of newer and cleaner generation methods that reduce GHG emissions and hence have a positive impact on the environment.
8	Health	+	Availability of local engineering skills lead to the development and deployment of newer and cleaner generation methods that reduce GHG emissions and hence have a positive impact on the health conditions..
9	Weather	+	Availability of local engineering skills lead to the development and deployment of newer and cleaner generation methods that reduce GHG emissions and hence reduce adverse affects on weather conditions and patterns.
10	Energy Security	+	Availability of local engineering skills lead to the development and deployment of newer and cleaner local generation methods that reduce the reliance on imported energy and hence increase energy security.
11	Market Liberalisation	+	Availability of local engineering skills lead to the development and availability of newer and cleaner local generation methods to IPPs and help liberalise the market.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Political Climate	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	The availability of the engineering skills will be met with employment opportunities.
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	+	Availability of engineering skills leads to the establishment and support of primary industry that needs engineering skills for technological development.
24	Services	0	
25	Non-RE Sector	-	The Non-RE sector could loose engineering skills to the new RE sector as workers migrate.
27	Cost of Capital	0	
28	Cost Competitiveness	+	Engineering skills influence technology improvements and drive associated costs down.
29	Reliable Profits	0	
30	Risk	-	Good local engineering skills reduces risks associated with importing the skills.
31	Technology Innovation	+	Engineering skills lead to technological innovation.
32	Infrastructure	+	Engineering skills help solve issues associated with grid connection and distribution of generated electricity.
33	Maintenance	+	Engineering skills influence the maintenance of RE facilities and help keep plant operational.
34	Deployment Time	+	Engineering skills can develop new technology that can reduce deployment time and facility establishment.
35	Solar	+	Engineering skills can improve solar technology, reduce associated costs, mature the technology and improve cost competitiveness.
36	Wind	+	Engineering skills can improve wind technology, reduce associated costs, mature the technology and improve cost competitiveness.

F. Financial

When RE generating capacity targets are being financed and the cost of the finance is high or low, what casual links are evident on the other 35 drivers?

27. Cost of Capital			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	High capital costs could hinder diversification and visa versa.
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	High capital costs could discourage FDI / Investment if investor appetite sees this as a deterrent.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	The greater the cost of capital the less likely RE generation capacity will be deployed and hence energy security will be lagging.
11	Market Liberalisation	+	The greater the cost of capital the less likely RE generation capacity will be deployed and hence market liberalisation will be stunted.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	-	If capital costs are high and investment is stunted, then employment opportunities will diminish.
20	Economic Development	+	Cheaper access to capital will allow for investment and hence economic development.
21	Social Development	+	Cheaper access to capital will allow for investment and increased social development.
22	Skills Development	+	Cheaper access to capital will allow for investment and increased skills development.
23	Primary Industry	+	Cheaper access to capital will allow for investment in primary industry.
24	Services	0	
25	Non-RE Sector	-	Cheaper access to capital will lead to RE sector deployment and once this barrier is removed, the market share of the traditional generators will be reduced.
26	Engineering Skills	0	
28	Cost Competitiveness	-	Lower capital costs will maintain profit margins and allow the sector to invest in R&D which will ultimately see deployment costs diminish and allow RE to become cost competitive.
29	Reliable Profits	+	Cheaper access to capital increase the potential for reliable profits.
30	Risk	+	Cheaper access to capital reduces the risk of a project being shelved due to the economics.
31	Technology Innovation	+	Cheaper access to capital allows for greater investment into technology innovation.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE projects/installations are deployed and become cost competitive with traditional generation methods, what casual links are evident on the other 35 drivers?

28. Cost Competitiveness

Driver No:	Driver	Effect	Comment
1	Diversification	+	As RE generation becomes more cost competitive further deployment is envisaged and leads to diversification.
2	RE Target Capacity	+	The more cost competitive the RE technology is the greater the potential to meet RE target capacities.
3	Energy Cost	+	The more cost competitive the RE technology is the lower the cost to deploy and hence energy costs will be lower.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	The more cost competitive the sooner the RE generating technology will become the standard and hence the reduced level of environmental degradation as GHG emissions are reduced.
8	Health	+	The more cost competitive the sooner the RE generating technology will become the standard and hence the reduced level of GHG and improved health conditions.
9	Weather	+	The more cost competitive the sooner the RE generating technology will become the standard and hence the reduced level of GHG emissions and hence the less adverse weather conditions and patterns.
10	Energy Security	+	The more cost competitive the RE technology is the lower the cost to deploy and hence mass local deployment will increase energy security.
11	Market Liberalisation	+	The more cost competitive the RE technology is the lower the cost to deploy and hence the more IPPs will be attracted and hence market liberalisation can be facilitated.
12	Resistance	-	The more cost competitiveness a technology is the less resistance there will for its deployment.
13	Big Players	-	The more cost competitiveness the greater the threat to big players, as it makes switching costs lower.
14	Culture / Mindset	+	The more cost competitiveness the technology is the more likely it is to affect culture/mindset positively.
15	Administration / Bureaucracy	0	
16	Climate Politics	+	The more competitiveness a technology than the less pressure needed to lobby in political circles.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	The more cost competitive a technology the greater the potential deployment and hence the greater employment opportunities.
20	Economic Development	+	The more cost competitive a technology the greater the potential deployment and employment, and hence the greater the potential economic development.
21	Social Development	+	The more cost competitive a technology the greater the potential deployment and hence the greater the potential for social development.
22	Skills Development	+	The more cost competitive a technology the greater the potential deployment and hence the greater the potential for skills development.
23	Primary Industry	+	The more cost competitive a technology is and earmarked for mass deployment, the more the economics to establish a primary industry are.
24	Services	0	
25	Non-RE Sector	-	The more cost competitive a technology is that greater potential for deployment and hence the reduced capacity for expansion in the traditional generation facilities.
26	Engineering Skills	-	The more cost competitive a technology is, the reduced need to invest in engineering skills to drive costs down.
27	Cost of Capital	+	The more cost competitive and mature a technology with a proven record, the lower the investment risks and hence the cost of capital will be lower.
29	Reliable Profits	+	The more mature the technology the more cost competitive it will be and hence profits generated will be more reliable.
30	Risk	-	The more cost completive a technology is the more mature it will be and hence new technology risk is reduced.
31	Technology Innovation	-	The more cost competitive a technology the less need to improve the technology.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE generation projects/installations are deployed and a reliable stream of income and profit is generated over the operational life span, what casual links are evident on the other 35 drivers?

29. Reliable Profits

Driver No:	Driver	Effect	Comment
1	Diversification	+	Reliable profits will see greater diversification as more IPPs will enter the market.
2	RE Target Capacity	+	Reliable profits with greater RE capacities will see greater capacity deployed.
3	Energy Cost	+	Reliable profits with greater RE target capacities will see greater deployment and hence drive energy costs down in the long run.
4	FDI / Investment	+	Reliable profits will see greater investment being attracted.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence reduced GHG emissions and reduce environmental impact.
8	Health	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence reduced GHG emissions and improve health conditions.
9	Weather	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence reduced GHG emissions and reduce adverse weather patterns etc.
10	Energy Security	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence increase local generation and reduced reliance on imported energy.
11	Market Liberalisation	+	Reliable profits will see greater deployment of RE capacity and hence provide more incentives for IPPs to enter the market and hence liberalise it.
12	Resistance	+	Reliable profits usually come at a high cost to society and can increase resistance.
13	Big Players	-	Reliable profits will dilute the market for big players and make them loose market share.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	+	Reliable profits usually come at a high cost to society and need to be managed to ensure fairness and transparency. More authority control is needed.
16	Climate Politics	+	Reliable profits may meet public resistance and influence politics.
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Reliable profits allow long term investments to be made and hence greater employment opportunities.
20	Economic Development	+	Reliable profits allow long term investments to be made and hence greater economic development is possible.
21	Social Development	+	Reliable profits allow long term investments to be made and hence greater social development is possible.
22	Skills Development	+	Reliable profits allow long term investments to be made and hence greater potential for skills development.
23	Primary Industry	+	Reliable profits allow long term investments to be made and hence greater potential to establish a primary RE industry.
24	Services	+	Reliable profits allow long term investments to be made and hence greater potential to use the support services industry.
25	Non-RE Sector	-	Reliable profits allow long term investments to be made and hence greater potential to reduce the market share of traditional generators.
26	Engineering Skills	+	Reliable profits allow long term investments to be made and hence greater potential to enhance engineering skills.
27	Cost of Capital	+	Reliable profits allow long term investments and stability which leads to lower capital costs for future RE projects.
28	Cost Competitiveness	+	Reliable profits lead to investment in technological development and a drive towards driving costs down and bringing RE technology to a cost competitive position.
30	Risk	-	Reliable profits lead to long term planning and hence reduce risks of the industry being stunted due to economic issues.
31	Technology Innovation	+	Reliable profits lead to investment in technological development and hence innovation.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE generating capacity is deployed and risks leading to this deployment have been minimised (country, political, financial, economic etc), what casual links are evident on the other 35 drivers?

30. Risk			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	-	Too much risk leads to less investment and hence less diversification.
2	RE Target Capacity	-	Too much risk leads to less investment and hence less likelihood of reaching RE capacity targets.
3	Energy Cost	-	Too much risk leads less deployment of RE generation methods and energy costs are exposed to international markets and can drive costs up.
4	FDI / Investment	-	Too much local risk can detract investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	-	Too much risk can lead to less deployment of RE generating capacity and hence not reduce GHG emissions, hence continuing environmental degradation.
8	Health	-	Too much risk can lead to less deployment of RE generating capacity and hence not reduce GHG emissions, hence continuing health implications.
9	Weather	-	Too much risk can lead to less deployment of RE generating capacity and hence not reduce GHG emissions, hence continuing of adverse weather patterns and conditions.
10	Energy Security	-	Too much risk can lead to less deployment of RE generating capacity and continued reliance on imported energy and hence reduced energy security.
11	Market Liberalisation	-	Too much risk can lead to less deployment of RE generating capacity and not enticing IPPs to enter the market and hence liberalise it.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Too much risk can lead to increased lobbying to make conditions more favorable for RE deployment.
17	International Opinion / Reputation	0	
18	International Policy Agreements	-	Too much risk to deploy RE generation capacity and hence be in contravention of international climate change agreements.
19	Employment	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available.
20	Economic Development	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available and therefore less economic development can occur.
21	Social Development	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available and therefore less social development can occur.
22	Skills Development	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available and there less skills development can occur.
23	Primary Industry	-	Too much risk reduces RE deployment potential and less of a drive to establish a primary RE sector.
24	Services	-	Too much risk reduces RE deployment potential and hence fewer opportunities for services that cab support the RE sector.
25	Non-RE Sector	+	Too much risk will help maintain the existing market for traditional generation methods.
26	Engineering Skills	-	Too much risk will not create a RE sector and hence the engineering skills needed to supply it.
27	Cost of Capital	-	Too much risk can lead to increased costs in capital.
28	Cost Competitiveness	0	
29	Reliable Profits	-	Too much risk can lead to reduced profits.
31	Technology Innovation	0	
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

F. Technology

When RE generating capacity is deployed and an industry is grown, with ever increasing competition and reducing tariffs, the increased technological innovation to maintain profit margins increases. What casual links are evident on the other 35 drivers?

31. Technology Innovation			
Driver No:	Driver	Effect	Comment
1	Diversification	+	The greater the technological innovation the greater potential to diversify the energy mix.
2	RE Target Capacity	0	
3	Energy Cost	+	The greater the technological innovation the greater the reduction in technology cost and hence the cost of energy.
4	FDI / Investment	+	The greater the technological innovation the greater the chance to deploy new technologies and start attaining a track record. The more mature the technology the greater attraction of investment.
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	The more technological innovation, the greater the possibility to create/improve ways to generate greener electricity and hence reduce GHG emissions.
8	Health	+	The more technological innovation, the greater the possibility to create/improve ways to generate greener electricity thereby reducing GHG emissions and hence reducing health issues.
9	Weather	+	The more technological innovation, the greater the possibility to create/improve ways to generate greener electricity thereby reducing GHG emissions and hence reducing the erratic and adverse weather conditions.
10	Energy Security	+	Technological innovation allows the harnessing of local renewable resources and can increase energy security.
11	Market Liberalisation	+	Technological innovation allows new technology costs to be reduced, bringing about cost competitiveness. This will allow a greater number of IPPs to enter a market and help liberalise it.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Employment opportunities are created as technological innovation needs people to drive the processes.
20	Economic Development	+	Employment opportunities are created as technological innovation needs people to drive the processes and this leads to economic development.
21	Social Development	+	Employment opportunities are created as technological innovation needs people to drive the processes and this leads to social development.
22	Skills Development	+	Employment opportunities are created as technological innovation needs people to drive the processes and this leads to skills development.
23	Primary Industry	+	Employment opportunities are created as technological innovation needs people to drive the processes. This will create a new primary industry for innovation.
24	Services	+	Employment opportunities are created as technological innovation needs people to drive the processes. This will create a new primary industry that will require support services.
25	Non-RE Sector	0	
26	Engineering Skills	+	Technological innovation is engineering focused and will influence the engineering skill sets.
27	Cost of Capital	+	Technological innovation will improve technology, thereby improving efficiencies and proving technology. This will bring the capital costs down.
28	Cost Competitiveness	+	As RE technology improves and in greater resource fields, the sector becomes more cost competitive with traditional generation methods.
29	Reliable Profits	+	Technological innovations leads to better technology which will be more efficient and will be able to produce better energy outputs leading to more reliable profits.
30	Risk	-	By improving technology, risk for untested technology is removed hence reducing technology risk.
32	Infrastructure	0	
33	Maintenance	0	
34	Deployment Time	+	Technology innovation will improve ways to deploy RE generating capacity.
35	Solar	+	Technological innovation will improve solar generating technology.
36	Wind	+	Technological innovation will improve wind generating technology.

When RE generating capacity is deployed where good grid and access infrastructure exists, what casual links are evident on the other 35 drivers?

32. Infrastructure			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	A good existing grid structure and good management thereof will facilitate energy mix diversification.
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	Good infrastructure facilitates new generation capacity distribution/transmission and hence improves energy security.
11	Market Liberalisation	+	Good infrastructure facilitates new generation capacity distribution/transmission for IPPs and hence market liberalisation.
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	New grid needs lead to employment opportunities.
20	Economic Development	+	New grid being bought into areas with no grid leads to economic development.
21	Social Development	+	New grid leading to new employment opportunities leads to social development.
22	Skills Development	+	New grid will require new skills for deployment and maintenance.
23	Primary Industry	+	Grid availability is a key driving factor for RE deployment and this will be heavily considered when new primary industry is being established.
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	+	New requirements for grid will call on new engineering skills to develop better transmission/distribution lines.
27	Cost of Capital	0	
28	Cost Competitiveness	+	The availability of grid, with capacity can make RE projects more viable to connect to the grid and hence the facility will be more cost competitive.
29	Reliable Profits	+	Good grid infrastructure and operation will lead to more reliable profits (less down time).
30	Risk	-	Good grid availability and functioning will reduce transmission and distribution related risks.
31	Technology Innovation	+	The need for better grid technology to deploy RE generation capacity will lead to technological innovation iniatives.
33	Maintenance	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE generating capacity is deployed and facilities start generating, RE technology maintenance needs increase, what casual links are evident on the other 35 drivers?

33. Maintenance

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	+	Good maintenance regime will improve life span of existing infrastructure. In addition if maintenance on traditional power generation plants becomes onerous a positive move to greener generation methods will be encouraged.
6	Internalisation of Emissions	0	
7	Environment	0	
8	Health	0	
9	Weather	0	
10	Energy Security	+	Good maintenance will ensure down time of generating plant will be minimised and energy security is stablised.
11	Market Liberalisation	0	
12	Resistance	0	
13	Big Players	0	
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	New generation capacity will require new maintenance skills as new technologies are deployed. This leads to new employment opportunities.
20	Economic Development	+	New employment opportunities create a platform for economic development.
21	Social Development	+	New employment opportunities create a platform for social development.
22	Skills Development	+	New employment opportunities create a platform for to develop the new skill sets for the maintenance.
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	+	New maintenance needs will require new engineer skills and hence there will be development of engineering skills.
27	Cost of Capital	0	
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	New maintenance needs will require new technology development.
32	Infrastructure	0	
34	Deployment Time	0	
35	Solar	0	
36	Wind	0	

When RE generating capacities are set and a need to bring new facilities on line quicker than traditional generation methods and deployment times decrease, what casual links are evident on the other 35 drivers?

34. Deployment Time

Driver No:	Driver	Effect	Comment
1	Diversification	+	Quicker deployment time means potentially bigger diversification.
2	RE Target Capacity	+	Quicker deployment means the RE target capacities are reached quicker.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Age of Existing Infrastructure	+	Quicker deployment of time of newer generation methods will reduce the pressing needs to upgrade or build new older generation plants as energy demand increases.
6	Internalisation of Emissions	0	
7	Environment	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to reducing environmental damage, through reduced GHG emissions.
8	Health	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to reducing health implications from older generation methods through reduced GHG emissions.
9	Weather	+	Quicker deployment time will mean that newer generation methods can come on line faster and start reducing adverse weather conditions through reduced GHG emissions.
10	Energy Security	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to energy security.
11	Market Liberalisation	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to reducing environmental damage.
12	Resistance	0	
13	Big Players	-	Quicker deployment time of new technologies may see big players lose market share quicker.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	+	Pressure on political governance to react to climate change will entice authorities to deploy quick solutions. Reduced deployment time of RE generation methods will be a key driving force in this process.
17	International Opinion / Reputation	+	Quick deployment will be evidence to the international community that green generation methods are being installed and will improve reputation etc.
18	International Policy Agreements	+	Quick deployment time will see adherence to international commitments to climate change policy.
19	Employment	0	
20	Economic Development	0	
21	Social Development	0	
22	Skills Development	0	
23	Primary Industry	0	
24	Services	0	
25	Non-RE Sector	0	
26	Engineering Skills	0	
27	Cost of Capital	+	Quick deployment time see capital costs and terms reduced as the time period for deployment meaning less risk and the plant can come online quicker and start generating revenue.
28	Cost Competitiveness	0	
29	Reliable Profits	+	Quicker deployment means that a new generation facility can start generating electricity sooner and hence start generating revenue sooner. This leads to reliable profits.
30	Risk	-	Quicker deployment means less risk at the higher level as economic factors/political change/financing costs etc over a shorter period are less likely to affect the projects.
31	Technology Innovation	+	Quicker deployment needs will drive technology innovation to improve technology.
32	Infrastructure	+	Quicker deployment means that new generation facilities need to be connected to the grid sooner and will drive infrastructure deployment times down.
33	Maintenance	0	
35	Solar	0	
36	Wind	0	

When RE generating capacity is increased and solar technology is widely deployed, what casual links are evident on the other 35 drivers?

35. Solar

Driver No:	Driver	Effect	Comment
1	Diversification	+	If local solar resource is good, this will allow for solar technology to be deployed and hence help diversification.
2	RE Target Capacity	0	
3	Energy Cost	+	Initially, solar generation methods will be more expensive and will drive energy costs up.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Solar generation methods produce no GHG emissions. Therefore more solar deployment will lead to less GHG and a better environment.
8	Health	+	Solar generation methods produce no GHG emissions. Therefore more solar deployment will lead to less GHG and contribute to better health conditions.
9	Weather	+	Solar generation methods produce no GHG emissions. Therefore more solar deployment will lead to less GHG and reduce adverse weather patterns and conditions.
10	Energy Security	+	Increased solar generation capacity will localise generation and reduce the reliance on imported energy. Therefore energy security is more likely.
11	Market Liberalisation	+	Solar technology and need for local deployment will create opportunities for IPPs to enter the market and lead to liberalisation.
12	Resistance	+	Various parties will oppose solar deployment, quoting intermittency/unsightliness/ loss in agricultural potential etc as reason not to deploy solar facilities.
13	Big Players	+	Solar technology will see market share taken away from traditional generators.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Solar technology will create various job opportunities in manufacturing/installation/maintenance etc. These can be temporary during deployment and permanent during operation.
20	Economic Development	+	Employment opportunities lead to economic development.
21	Social Development	+	Employment opportunities lead to social development.
22	Skills Development	+	New technology will need new skill sets and hence will lead to skills development.
23	Primary Industry	+	Solar target capacity dependent, new primary industry may be invested in, in terms of manufacturing facilities etc.
24	Services	+	Increased solar needs will require new support services like security services, washing panels/troughs etc.
25	Non-RE Sector	-	New solar capacity deployed will reduce the market share of traditional energy generators market.
26	Engineering Skills	+	Solar technology is relatively immature and costs still need to be reduced. Hence this will require engineering skills.
27	Cost of Capital	+	More efficient and proven solar technology will see lower costs of capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	Solar technology is still maturing and will need to be improved, especially in efficiency. This will drive technological innovation.
32	Infrastructure	0	
33	Maintenance	+	A different skill set for maintaining solar projects will be needed, depending on solar technology used.
34	Deployment Time	0	
36	Wind	0	

When RE generating capacity is increased and wind technology is widely deployed, what casual links are evident on the other 35 drivers?

36. Wind

Driver No:	Driver	Effect	Comment
1	Diversification	+	If local wind resource is good, this will allow for wind technology to be deployed and hence help diversification.
2	RE Target Capacity	0	
3	Energy Cost	+	Initially, wind generation methods will be more expensive and will drive energy costs up.
4	FDI / Investment	0	
5	Age of Existing Infrastructure	0	
6	Internalisation of Emissions	0	
7	Environment	+	Wind generation methods produce no GHG emissions. Therefore more wind deployment will lead to less GHG and a better environment.
8	Health	+	Wind generation methods produce no GHG emissions. Therefore more wind deployment will lead to less GHG and contribute to better health conditions.
9	Weather	+	Wind generation methods produce no GHG emissions. Therefore more wind deployment will lead to less GHG and reduce adverse weather patterns and conditions.
10	Energy Security	+	Increased wind generation capacity will localise generation and reduce the reliance on imported energy. Therefore energy security is more likely.
11	Market Liberalisation	+	Wind technology and need for local deployment will create opportunities for IPPs to enter the market and lead to liberalisation.
12	Resistance	+	Various parties will oppose solar deployment, quoting intermittency/ loss in agricultural potential/aesthetics/efficiency etc as reason not to deploy wind facilities.
13	Big Players	+	Wind technology will see market share taken away from traditional generators.
14	Culture / Mindset	0	
15	Administration / Bureaucracy	0	
16	Climate Politics	0	
17	International Opinion / Reputation	0	
18	International Policy Agreements	0	
19	Employment	+	Wind technology will create various job opportunities in manufacturing/installation/maintenance etc. These can be temporary during deployment and permanent during operation.
20	Economic Development	+	Employment opportunities lead to economic development.
21	Social Development	+	Employment opportunities lead to social development.
22	Skills Development	+	New technology will need new skill sets and hence will lead to skills development.
23	Primary Industry	+	Wind target capacity dependent, new primary industry may be invested in, in terms of manufacturing facilities etc.
24	Services	+	Increased wind technology needs will require new support services like security services, washing blades etc.
25	Non-RE Sector	-	New wind capacity deployed will reduce the market share of traditional energy generators market.
26	Engineering Skills	+	Wind technology is relatively immature and costs still need to be reduced. Hence this will require engineering skills.
27	Cost of Capital	+	More efficient and proven wind technology will see lower costs of capital.
28	Cost Competitiveness	0	
29	Reliable Profits	0	
30	Risk	0	
31	Technology Innovation	+	While wind technology is relatively mature compared to other RE technologies, there is room for improvement in turbine sizes and especially in efficiency. This will drive technological innovation.
32	Infrastructure	0	
33	Maintenance	+	A different skill set for maintaining solar projects will be needed, depending on solar technology used.
34	Deployment Time	0	
35	Solar	0	

Appendix C – Revised Non-Policy Drivers Casual Links for Draft Model

A. Local Energy Constraints

By increasing the energy mix by deploying more RE generation capacity, what affect does it have on the 23 other drivers?

1. Diversification			
Driver No:	**Driver**	**Effect**	**Comment**
2	RE Target Capacity	+	A move away from fossil fuels.
3	Energy Cost	+	Greater use of expensive RE is initially at a higher cost.
4	FDI / Investment	+	Attracts investment in new projects.
5	Common Good Elements	+	Reduced GHG emissions leads to less negative impact on the environment, health and weather.
6	Energy Security	+	Less reliance on imported energy.
7	Market Liberalisation	+	RE induced Independent Power Producers and can dilute previously monopolistic markets.
8	Resistance	0	
9	Big Players	-	New generation methods reduce market share of existing power producers.
10	Administration / Bureaucracy	+	Increased power generation pool requires greater administration and hence bureaucracy.
11	Climate Politics	+	Increased lobbying for and against RE generation will be experienced.
12	Climate Change Initiatives	+	Reducing reliance on fossil fuels is seen in a positive light as it reduces the tragedy of the commons phenomenon.
13	Employment	+	New generation methods provide employment opportunities throughout the project life cycle, from development to decommissioning.
14	Socio-Economic Development	+	Greater dependability on energy resource and increased employment opportunities corresponds with increases in socio-economic development.
15	Skills Enhancement	+	Through a new industry, a new skill set is required and this will drive skills training and development.
16	Industry Development	+	A new industry requires the value chain to be established, depending on the local capacity. Generally, opportunities exist to grow primary industry involved with manufacturing and deployment of RE technology. However, support services are also required and hence also benefit.
17	Non-RE Sector	-	Increasing diversification can lead to traditional generators losing market share.
18	Cost of Capital	0	
19	Cost Competitiveness	-	Initially, RE technology is not cost competitive with traditional generation methods.
20	Reliable Profits	0	
21	Risk	-	A new industry / sector brings uncertainty and therefore greater risk.
22	Technology Innovation	+	New generation methods need to mature and there is scope to improve and refine them. Hence new technological developments are spurred by diversification.
23	Existing Infrastructure	+	Connecting new RE generation facilities to the grid will require existing and new infrastructure to be built/adapted.
24	Deployment Time	0	

By setting capacity targets for RE generation, what casual links are evident to the other 23 drivers?

2. RE Target Capacity			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	Targets for RE capacity lead to potential diversification.
3	Energy Cost	-	Expensive RE in large capacities is initially costly to society.
4	FDI / Investment	+	Attractive capacities helps attract investment.
5	Common Good Elements	+	Large capacity potentially reduces negative affect on environment, health and weather.
6	Energy Security	+	Greater RE capacity, potentially means less reliance on imported energy.
7	Market Liberalisation	+	The greater the targeted capacity, the greater the space for IPP's to enter the market and liberlise it.
8	Resistance	0	
9	Big Players	-	Myopic traditional utilities will have their market share reduced as RE target capacities increase.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased lobbying for and against RE target capacities will be experienced.
12	Climate Change Initiatives	+	Setting realisable RE targets will see improved country reputation and compliance to climate change programmes.
13	Employment	+	Larger capacities bring greater opportunities for employment.
14	Socio-Economic Development	+	Larger capacities correspond with increases in socio-economic activity, both through employment opportunities and energy dependability.
15	Skills Enhancement	+	Capacity drives market size. The bigger the market the greater the need for skills development.
16	Industry Development	+	Capacity drives market size. The bigger the market the greater the need for localisaton, both for primary and support service industry.
17	Non-RE Sector	+	Greater RE capacity will see market share lost by traditional energy generators.
18	Cost of Capital	-	Greater RE capacity, means a larger potential market and hence competitive funding rates.
19	Cost Competitiveness	-	Greater RE capacity, means a larger potential market and hence competition to bring costs down as producers compete for customers.
20	Reliable Profits	+	The greater the capacity the greater the market and IPPs can forecast industry growth and profits.
21	Risk	-	Greater RE capacity will see more risk shared by more players and hence reduce over all risk.
22	Technology Innovation	0	Greater RE capacity, means a larger potential market and hence competition to bring costs down as producers and hence investment in R&D to find cheaper and newer technology.
23	Existing Infrastructure	+	The greater the targeted capacity, the greater the need for grid capacity, which may not be available.
24	Deployment Time	0	

By increasing energy cost through the deployment of RE generating capacity, what casual links are evident on the other 23 drivers?

3. Energy Cost

Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	-	Increased energy cost could be met with resistance and hence hinder further diversification.
2	RE Target Capacity	-	Increased energy cost may see larger RE capacities seen as unaffordable and hence set low RE target capacities.
4	FDI / Investment	+	The greater the cost of electricity coupled with attractive RE target capacities can attract FDI/investment.
5	Common Good Elements	-	The higher the cost, the less socially acceptable and hence reduced deployment. Trend to use traditional methods and similar environmental, health and weather impacts exist.
6	Energy Security	-	The higher the cost, the less socially acceptable and hence reduced deployment. Therefore continued reliance on imported energy.
7	Market Liberalisation	-	Increased energy cost the less socially acceptable and less future target capacities will be set. This will stunt the entry of IPPs and hence reduce the potential to liberalise the market.
8	Resistance	+	High cost of energy increase resistance.
9	Big Players	-	Higher energy costs allow existing power producers to compete on price for customers.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased lobbying against RE target capacities will be experienced.
12	Climate Change Initiatives	0	
13	Employment	0	
14	Socio-Economic Development	-	Increased energy cost increases cost of production/business in economy and profit margins are reduced. This leads to reduced socio-economic development.
15	Skills Enhancement	-	Increased energy cost leads to reduced economic development and in turn less need for skills development.
16	Industry Development	-	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This reduces amount of opportunities to primary and related service industries.
17	Non-RE Sector	+	Increased energy cost leads to resistance from society and RE falls out of favour. Less favour leads to reduced plans to deploy RE capacity. This maintains traditional generation methods in favour.
18	Cost of Capital	0	
19	Cost Competitiveness	-	Increased energy cost does not allow for RE deployment and hence a road to cost competitiveness is not achieved.
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

By attracting FDI / Investment as a result of increased RE generation capacity needs, what casual links are evident on the other 23 drivers?

4. FDI / Investment

Driver No:	Driver	Effect	Comment
1	Diversification	+	Investment will spur further RE deployment.
2	RE Target Capacity	+	Investment will increase capacity from RE.
3	Energy Cost	0	
5	Common Good Elements	0	
6	Energy Security	+	Investment will increase local RE generation capacity and hence improve energy security.
7	Market Liberalisation	+	Investment will increase the number of IPPs and hence increase market players.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased lobbying for RE target deployment will be experienced quoting investor appetite a as good reason.
12	Climate Change Initiatives	0	
13	Employment	+	Increased funding for RE projects leads to employment opportunities.
14	Socio-Economic Development	+	Investment into a new industry has positive spin offs for local socio-economic development.
15	Skills Enhancement	+	Investment into a new industry has positive spin offs for local skills development.
16	Industry Development	+	Investment into a new industry has positive spin offs for the developing a primary RE industry and related support services.
17	Non-RE Sector	-	Less investment for traditional generation methods and hence less growth.
18	Cost of Capital	+	Increased investor appetite creates competition and hence competitive access to capital results.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Increased investment indicates lower perceived risk.
22	Technology Innovation	+	Increased investment, where profits can be reinvested to improve of technological development.
23	Existing Infrastructure	0	
24	Deployment Time	+	Easier access to capital/investment allows for quicker deployment.

B. Encouraging a RE Industry

When increased RE generation capacity reduces GHG emissions and has positive effects on the environment, health and weather what casual links are evident on the other 23 drivers?

5. Common Good Elements			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	Increased diversification.
2	RE Target Capacity	+	Target capacities may be revised spurring further RE deployment.
3	Energy Cost	0	
4	FDI / Investment	0	
6	Energy Security	0	
7	Market Liberalisation	0	
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	+	Increased regulation in environmental, health and weather protection leads to more administration and bureaucracy through Management Practices etc.
11	Climate Politics	+	Improved environmental, health and weather conditions can lead to further lobbying to deploy more RE generating capacity.
12	Climate Change Initiatives	+	Recognising the need to protect the environment, health and weather will harbor a positive international response.
13	Employment	+	New industry that aims to protect the environment, health and weather will create work opportunities.
14	Socio-Economic Development	+	Increased employment opportunities lead to socio-economic development.
15	Skills Enhancement\	+	Increased employment opportunities in a new industry lead to skills development.
16	Industry Development	+	New primary and related support service industry that aims to protect the environment, health and weather.
17	Non-RE Sector	-	New industries having a positive impact on the environment, health and weather will see old industries fall out of favour and hence loose market share.
18	Cost of Capital	0	
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

When increased localised RE generation is deployed and energy security is increased, what casual links are evident on the other 23 drivers?

6. Energy Security

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	+	Increased energy security leads to higher energy cost initially, but lower cost in the long run with less reliance on imported energy and exposure to international markets.
4	FDI / Investment	0	
5	Common Good Elements	0	
7	Market Liberalisation	+	With greater local generation there is opportunity to use more IPPs and hence liberalise the local market.
8	Resistance	0	
9	Big Players	+	Less reliance on imported energy may be met with resistance from existing energy suppliers.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased pressure to achieve energy security can add pressure to the political circles to use RE generating sources.
12	Climate Change Initiatives	+	Positive affect if energy security and common good protection is achieved through deployment of RE technologies.
13	Employment	+	Greater energy security leads larger local industry which will create employment opportunities.
14	Socio-Economic Development	+	A bigger local energy sector leads to greater socio-economic development.
15	Skills Enhancement	+	Greater energy security using RE technology will require a different skill set and hence a need to develop skills.
16	Industry Development	+	Greater energy security using RE technology will develop a new primary and related service industry.
17	Non-RE Sector	-	Newer localised energy generating capacity will see traditional methods loose market share.
18	Cost of Capital	+	Less volatility in energy price can lead to lower capital costs.
19	Cost Competitiveness	-	Initially, newer localised RE generation methods will not be cost competitive.
20	Reliable Profits	0	
21	Risk	-	Increased energy security will reduce energy security risk of relying on imported fuel sources.
22	Technology Innovation	+	Newer localised energy generating capacity will see newer methods being sought out to harness local resource.
23	Existing Infrastructure	0	
24	Deployment Time	0	

When RE target capacities attract IPPs and energy monopolies experience competition, what casual links are evident on the other 23 drivers?

7. Market Liberalisation

Driver No:	Driver	Effect	Comment
1	Diversification	+	The more IPPs the greater use of different resources to generate electricity.
2	RE Target Capacity	+	The more IPPs the greater the chance of reaching set RE targets.
3	Energy Cost	-	Liberalised markets introduce a greater level of competition and hence drive down cost.
4	FDI / Investment	+	Liberalised markets with good policy mechanisms will attract investment.
5	Common Good Elements	0	
6	Energy Security	+	Liberalised markets that make use of RE generation methods lead to local energy security.
8	Resistance	-	The greater the liberalised market the less resistance by public to reduce energy costs etc.
9	Big Players	+	The greater the threat of IPPs joining into a liberalised market the greater the resistance from traditional method generating players.
10	Administration / Bureaucracy	+	Increased IPPs leads to greater administrative processes needed.
11	Climate Politics	-	The more liberalised a market the less need to lobby politically to achieve greater competition.
12	Climate Change Initiatives	+	Greater the liberalisation and use of RE technology the more adherence to climate change initiatives will be.
13	Employment	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment.
14	Socio-Economic Development	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment and hence socio-economic development
15	Skills Enhancement	+	Greater liberalisation leads to increased IPPs which in turn leads to more employment and hence a need for skills development.
16	Industry Development	+	Greater liberalisation leads to increased IPPs which will build primary industry and related service industries.
17	Non-RE Sector	-	Greater liberalisation and an increase in RE generation methods will see traditional methods of generation diminish.
18	Cost of Capital	+	A new industry with little track record will carry greater risk. Greater risk equates to increased capital costs.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Liberalisation and increased alternative generating capacity reduces energy security risks and risk over all.
22	Technology Innovation	+	In liberalised markets competition drives price. Hence newer generation methods and efficiencies will drive technological innovation.
23	Existing Infrastructure	0	
24	Deployment Time	0	

C. Local Conditions

When the cost of RE generation to the consumer or loss of market share from existing power producers, increases, resistance, what casual links are evident on the other 23 drivers?

8. Resistance			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	-	Stunted diversification.
2	RE Target Capacity	-	RE target capacities may be lowered.
3	Energy Cost	+	Traditional generation methods may be retained with a lower cost of energy.
4	FDI / Investment	0	
5	Common Good Elements	-	Greater the resistance to deploy clean technology the greater the continued negative affect on the environment, health and weather.
6	Energy Security	-	Greater the resistance to deploy clean technology the greater the continued reliance on imported fuels and hence less energy security.
7	Market Liberalisation	-	Greater resistance leads to no RE targets being set and hence reduced IPPs entering the market, and hence lower potential to liberalise the energy market.
9	Big Players	+	Resistance to market share loss.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased resistance to more expensive RE generation methods leads to political lobbying and pressure.
12	Climate Change Initiatives	0	
13	Employment	-	Greater resistance to a RE sector being formed the lower the opportunities available for employment in a new industry.
14	Socio-Economic Development	-	Greater resistance to a RE sector being formed the reduced possibility for socio-economic development.
15	Skills Enhancement	-	Greater resistance to a RE sector being formed the reduced possibility for new skills development.
16	Industry Development	-	Greater resistance to a RE sector being formed the reduced possibility for new primary and related service industries to take root.
17	Non-RE Sector	0	
18	Cost of Capital	0	
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

When increases in RE generation leads to the loss of market share for big players, what casual links are evident on the other 23 drivers?

9. Big Players

Driver No:	Driver	Effect	Comment
1	Diversification	-	Pressure to maintain existing generation methods leads to low RE deployment and hence diversification.
2	RE Target Capacity	-	Less potential to reach set RE target capacities.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Common Good Elements	0	
6	Energy Security	-	Big players that rely on imported fuels will resist developing energy security.
7	Market Liberalisation	-	Many big players will provide big barriers to entry and hence reduce market liberalisation.
8	Resistance	+	Big players will resist changes to their business environment.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Big players will exercise their lobbying departments in political circles.
12	Climate Change Initiatives	0	
13	Employment	0	
14	Socio-Economic Development	0	
15	Skills Enhancement	0	
16	Industry Development	0	
17	Non-RE Sector	+	Big players will promote their own industry and hence there will be greater resistance to RE deployment.
18	Cost of Capital	0	
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	+	Big players are less likely to invest in RE R&D as this will affect their core business.
23	Existing Infrastructure	0	
24	Deployment Time	0	

When increased RE generating capacity is deployed and policy mechanisms require increased administration and bureaucratic hurdles, what casual links are evident on the other 23 drivers?

10. Administration / Bureaucracy

Driver No:	Driver	Effect	Comment
1	Diversification	-	The greater the admin/bureaucracy the lower the possibility for diversification.
2	RE Target Capacity	-	The greater the admin/bureaucracy the lower the possibility of reaching target capacities.
3	Energy Cost	+	The greater the admin/bureaucracy the lower the possibility of diversifying the energy mix and hence energy cost will be kept lower with traditional generation methods.
4	FDI / Investment	-	The greater the admin/bureaucracy the less easily FDI / Investment will flow in.
5	Common Good Elements	0	
6	Energy Security	-	The greater the admin/bureaucracy the less likely RE will deployed in large enough capacity to see energy security achieved.
7	Market Liberalisation	-	The greater the admin/bureaucracy the less likely RE will deployed in large enough capacity to see market liberalisation.
8	Resistance	0	
9	Big Players	0	
11	Climate Politics	0	
12	Climate Change Initiatives	0	
13	Employment	-	Too onerous the bureaucracy the slower employment opportunities will be made available.
14	Socio-Economic Development	-	Too onerous the bureaucracy the slower employment opportunities and RE generation capacity deployed and so too will socio-economic development will be slow.
15	Skills Enhancement	-	Too onerous the bureaucracy the slower employment opportunities and RE generation capacity deployed and so too will skills development.
16	Industry Development	-	Too onerous the bureaucracy and the stunted the deployment of primary and related service industries will be.
17	Non-RE Sector	0	
18	Cost of Capital	+	The greater the admin/bureaucracy the greater the cost of capital.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	+	The greater the admin/bureaucracy the more risk that is introduced to the sector.
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	+	The greater the admin/bureaucracy the longer it may take to deploy the RE generation facility.

When RE generation capacity is increased and proponents/opponents to RE generation increase pressure on political leaders, what casual links are evident on the other 23 drivers?

11. Climate Politics

Driver No:	Driver	Effect	Comment
1	Diversification	+	Positive climate politics lobbying will lead to diversification.
2	RE Target Capacity	+	Positive climate politics lobbying will lead greater capacity deployed.
3	Energy Cost	-	Positive climate politics lobbying will see energy cost increase initially as the sector takes root.
4	FDI / Investment	+	Positive climate politics lobbying will attract FDI / Investment
5	Common Good Elements	+	Positive climate politics lobbying will improve environmental, health and weather protection through RE deployment.
6	Energy Security	+	Positive climate politics lobbying will increase energy security by localising generation facilities.
7	Market Liberalisation	+	Positive climate politics lobbying will increase the drive to introduce IPPs.
8	Resistance	+	Positive climate politics lobbying will increase resistance from individuals if costs increase.
9	Big Players	+	Positive climate politics lobbying will affect big players in the energy use/generation sector.
10	Administration / Bureaucracy	0	
12	Climate Change Initiatives	+	Positive climate politics lobbying will encourage RE deployment and hence adherence to climate change initiatives will be achieved.
13	Employment	0	
14	Socio-Economic Development	0	
15	Skills Enhancement	0	
16	Industry Development	+	Positive climate politics lobbying will pave the way for a RE sector to be formed and hence the primary and related service industries will benefit.
17	Non-RE Sector	-	Positive climate politics will force the reduction in traditional generation methods.
18	Cost of Capital	0	
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

When a country adopts international climate change policies and as a result deploys renewable energy generating capacity, what casual links are evident on the other 23 drivers?

12. Climate Change Initiatives

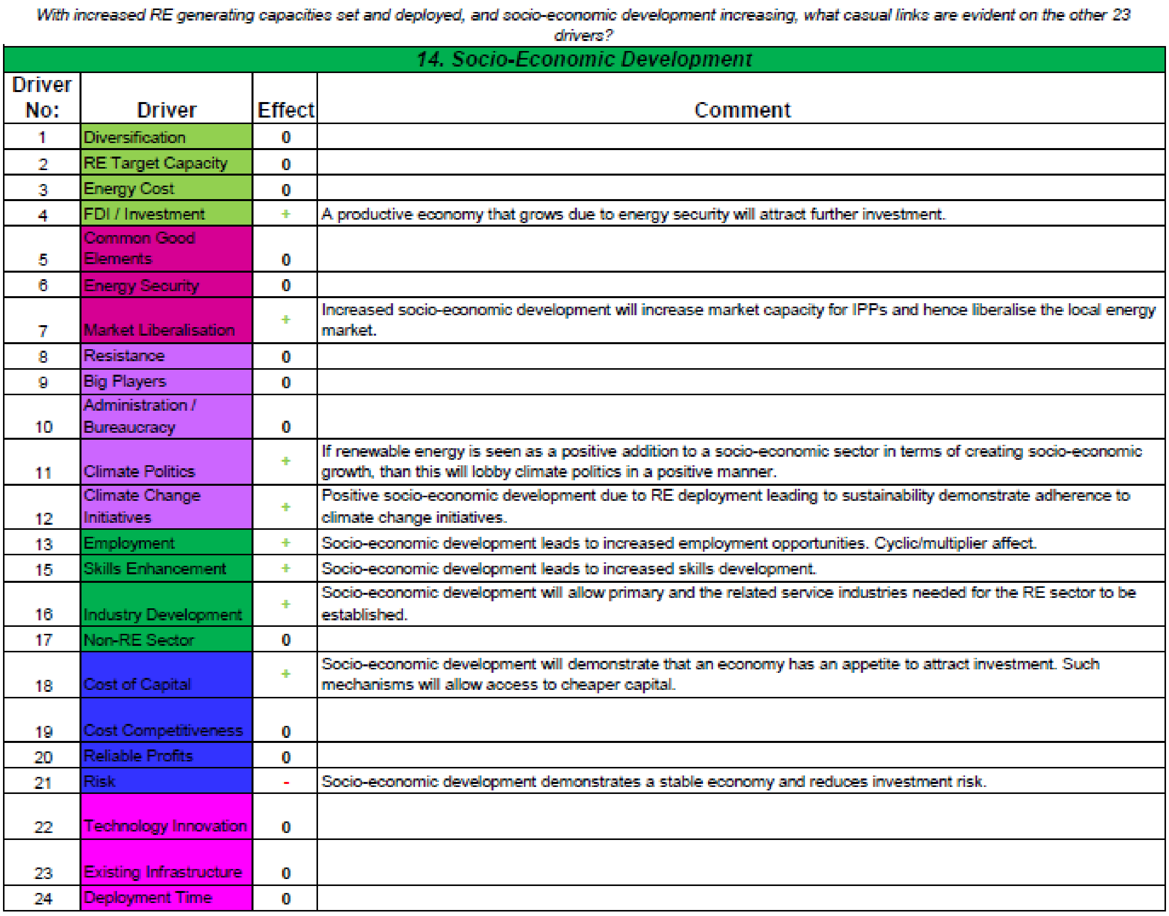
Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	Ratifying climate change initiatives and hence encouraging RE generation will see an increase in FDI / Investment.
5	Common Good Elements	0	
6	Energy Security	0	
7	Market Liberalisation	0	
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Adherence to climate change initiatives should encourage further improvements in positive climate politics.
13	Employment	0	
14	Socio-Economic Development	0	
15	Skills Enhancement\	0	
16	Industry Development	0	
17	Non-RE Sector	0	
18	Cost of Capital	+	Ratifying climate change initiatives and hence encouraging RE generation will see a reduction in capital costs.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Ratifying climate change initiatives will reduce overall country risk.
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

D. Economics

With increased RE generating capacities set and deployed, and employment opportunities increasing, what casual links are evident on the other 23 drivers?

13. Employment

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Common Good Elements	0	
6	Energy Security	0	
7	Market Liberalisation	0	
8	Resistance	0	
9	Big Players	-	By establishing a new sector with new employment opportunities, jobs from the old generation methods will be reduced and this will be met with resistance from big players.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	A greater need for employment will see lobbying efforts to present the new renewable energy sector as an opportunity to create employment.
12	Climate Change Initiatives	0	
14	Socio-Economic Development	+	Establishing a new renewable sector will lead to job creation and hence socio-economic development.
15	Skills Enhancement	+	Establishing a new renewable sector will lead to job creation and needs for new skills. These skills will need to be developed.
16	Industry Development	0	
17	Non-RE Sector	-	A increase in renewable energy sector employment, will lead to a reduction in traditional energy generation sector employment.
18	Cost of Capital	0	
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Better employment opportunities will reduce the risks associated with disgruntled citizens revolting as they cannot access the economy.
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	



With increased RE generating capacities set and deployed, and socio-economic development increasing, what casual links are evident on the other 23 drivers?

14. Socio-Economic Development

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	A productive economy that grows due to energy security will attract further investment.
5	Common Good Elements	0	
6	Energy Security	0	
7	Market Liberalisation	+	Increased socio-economic development will increase market capacity for IPPs and hence liberalise the local energy market.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	+	If renewable energy is seen as a positive addition to a socio-economic sector in terms of creating socio-economic growth, than this will lobby climate politics in a positive manner.
12	Climate Change Initiatives	+	Positive socio-economic development due to RE deployment leading to sustainability demonstrate adherence to climate change initiatives.
13	Employment	+	Socio-economic development leads to increased employment opportunities. Cyclic/multiplier affect.
15	Skills Enhancement	+	Socio-economic development leads to increased skills development.
16	Industry Development	+	Socio-economic development will allow primary and the related service industries needed for the RE sector to be established.
17	Non-RE Sector	0	
18	Cost of Capital	+	Socio-economic development will demonstrate that an economy has an appetite to attract investment. Such mechanisms will allow access to cheaper capital.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Socio-economic development demonstrates a stable economy and reduces investment risk.
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

With increased RE generating capacities set and deployed, and skills development (including engineering) increasing, what casual links are evident on the other 23 drivers?

15. Skills Enhancement

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Common Good Elements	0	
6	Energy Security	0	
7	Market Liberalisation	0	
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Increased skills enhancement demonstrate that governmental goals are being met and if influenced by the new renewable energy sector, than a positive view of climate politics will be the result.
12	Climate Change Initiatives	+	Increased skills enhancement demonstrates that governmental goals are being met and if influenced by the new renewable energy sector, than adherence to climate change initiatives is demonstrated.
13	Employment	+	Improved pool of skills, the greater the job opportunities available to individuals.
14	Socio-Economic Development	+	Improved pool of skills, the greater the job opportunities and hence the greater the potential for economic development.
16	Industry Development	+	Improved skills tailored to the RE industry will deploy local skills rather than importing them.
17	Non-RE Sector	+	Improved skills can be transferred across industry sectors and help redeploy displaced workers from industries that have lost market share.
18	Cost of Capital	+	Increased local skills will reduce the reliance on imported skills and hence reduce the capital needs and cost.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	-	Increased local skills enhancement will reduce the risk related to a low supply of the essential skills needed to realise renewable energy sector deployment and capacity.
22	Technology Innovation	+	Improved skills will supply skills needed for technological development.
23	Existing Infrastructure	0	
24	Deployment Time	0	

With increased RE generating capacities set and deployed, and both primary and support service RE related industry increasing, what casual links are evident on the other 23 drivers?

16. Industry Development

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	If local RE generation capacity is significant enough, new industry can access markets to raise the funds to establish permanent manufacturing facilities locally.
5	Common Good Elements	0	
6	Energy Security	+	Developing industry to deliver RE capacity deployment will reduce deployment times and increase local energy security.
7	Market Liberalisation	+	Developing industry to deploy RE capacity will facilitate/accelerate market liberalisation as they will be able to supply the needs of IPPs and their projects.
8	Resistance	+	Established local industry will resist new industry from developing.
9	Big Players	-	Increased RE industry will reduce market share from existing big players.
10	Administration / Bureaucracy	+	Increased RE industry will require increased administration to ensure fairness and transparency.
11	Climate Politics	+	New RE industry establishing themselves in a new market will lobby authorities to protect deployment and use climate politics to achieve this.
12	Climate Change Initiatives	0	
13	Employment	+	Developing industry will create employment opportunities.
14	Socio-Economic Development	+	Increased RE industry leads to greater employment opportunities, greater supply to create RE generation methods and hence socio-economic development.
15	Skills Enhancement	+	Developing industry will require new skills and hence facilitate local skills development.
17	Non-RE Sector	-	Developing RE industry will reduce the market share for supplying the non-RE sector.
18	Cost of Capital	+	Developing industry will allow local supply and hence the costs involved to import components and skills will reduce the cost of RE deployment.
19	Cost Competitiveness	+	As industry is developed and the market grows, competition is introduced and hence facilitates cost competitiveness.
20	Reliable Profits	0	
21	Risk	-	By developing local RE industry associated risk with importing components and skills is reduced.
22	Technology Innovation	+	As industry is developed and the market floods, technological innovation will drive costs down.
23	Existing Infrastructure	0	
24	Deployment Time	+	Developing local industry will reduce lead times on items needed for RE projects and facilities and hence improve delivery times.

With increased RE generating capacities set and deployed, and the non-RE related industry decreasing, what casual links are evident on the other 23 drivers?

17. Non-RE Sector

Driver No:	Driver	Effect	Comment
1	Diversification	0	
2	RE Target Capacity	+	Decreasing market share for traditional generators will help meet set RE target capacities.
3	Energy Cost	-	Reducing Non-RE sector will see energy costs increase initially.
4	FDI / Investment	0	
5	Common Good Elements	-	Increased traditional generation methods will increase environmental, health and weather degradation.
6	Energy Security	-	Increased traditional generation methods will not remove the reliance on international energy markets and hence not improve energy security.
7	Market Liberalisation	-	Increased traditional generation methods from existing players will not allow market liberalisation to occur.
8	Resistance	+	Traditional generators will resist new, greener technologies from entering the market.
9	Big Players	+	Traditional generators will lobby with big industry players to oppose deployment of RE technology and generation capacity. They try to avoid losing them as customers to IPP using greener generation methods.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Traditional generators will use lobbying in the political field to protect their market. They will advocate anti-climate change reasons and research.
12	Climate Change Initiatives	+	Traditional generators will oppose climate change initiatives and cite reasons when climate change is not really occurring.
13	Employment	+	Traditional generation facilities do provide more employment than RE in the long term.
14	Economic Development	+	Traditional generation methods supply baselaod and this, if sufficient capacity exists in the system, will encourage socio-economic development.
15	Skills Enhancement	+	Traditional generation methods will need to maintain a pipeline of skills.
16	Industry Development	0	
18	Cost of Capital	+	Bigger, established utilities with long track records have access to larger markets and can fundraise at preferential rates.
19	Cost Competitiveness	0	
20	Reliable Profits	0	
21	Risk	0	
22	Technology Innovation	0	
23	Existing Infrastructure	+	Traditional generators will have a firm handle on transmission and distribution needs and plan for various scenarios. They will also influence gird availability to IPPs.
24	Deployment Time	+	Access to grid connections and incorporation of feeds to the grid can be heavily influenced by traditional system operators that can affect RE deployment.

F. Financial

When RE generating capacity targets are being financed and the cost of the finance is high or low, what casual links are evident on the other 23 drivers?

18. Cost of Capital

Driver No:	Driver	Effect	Comment
1	Diversification	+	High capital costs could hinder diversification and visa versa.
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	+	High capital costs could discourage FDI / Investment if investor appetite sees this as a deterrent.
5	Common Good Elements	0	
6	Energy Security	+	The greater the cost of capital the less likely RE generation capacity will be deployed and hence energy security will be lagging.
7	Market Liberalisation	+	The greater the cost of capital the less likely RE generation capacity will be deployed and hence market liberalisation will be stunted.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	0	
12	Climate Change Initiatives	0	
13	Employment	-	If capital costs are high and investment is stunted, then employment opportunities will diminish.
14	Socio-Economic Development	+	Cheaper access to capital will allow for investment and hence socio-economic development.
15	Skills Enhancement	+	Cheaper access to capital will allow for investment and increased skills enhancement.
16	Industry Development	+	Cheaper access to capital will allow for investment in primary and related service industries.
17	Non-RE Sector	-	Cheaper access to capital will lead to RE sector deployment and once this barrier is removed, the market share of the traditional generators will be reduced.
19	Cost Competitiveness	-	Lower capital costs will maintain profit margins and allow the sector to invest in R&D which will ultimately see deployment costs diminish and allow RE to become cost competitive.
20	Reliable Profits	+	Cheaper access to capital increase the potential for reliable profits.
21	Risk	+	Cheaper access to capital reduces the risk of a project being shelved due to the economics.
22	Technology Innovation	+	Cheaper access to capital allows for greater investment into technology innovation.
23	Existing Infrastructure	0	
24	Deployment Time	0	

When RE projects/installations are deployed and become cost competitive with traditional generation methods, what casual links are evident on the other 23 drivers?

19. Cost Competitiveness			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	As RE generation becomes more cost competitive further deployment is envisaged and leads to diversification.
2	RE Target Capacity	+	The more cost competitive the RE technology is the greater the potential to meet RE target capacities.
3	Energy Cost	+	The more cost competitive the RE technology is the lower the cost to deploy and hence energy costs will be lower.
4	FDI / Investment	0	
5	Common Good Elements	+	The more cost competitive the sooner the RE generating technology will become the standard and hence the reduced level of environmental, health and weather degradation as GHG emissions are reduced.
6	Energy Security	+	The more cost competitive the RE technology is the lower the cost to deploy and hence mass local deployment will increase energy security.
7	Market Liberalisation	+	The more cost competitive the RE technology is the lower the cost to deploy and hence the more IPPs will be attracted and hence market liberalisation can be facilitated.
8	Resistance	-	The more cost competitiveness a technology is the less resistance there will for its deployment.
9	Big Players	-	The more cost competitiveness the greater the threat to big players, as it makes switching costs lower.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	The more competitiveness a technology than the less pressure needed to lobby in political circles.
12	Climate Change Initiatives	0	
13	Employment	+	The more cost competitive a technology the greater the potential deployment and hence the greater employment opportunities.
14	Socio-Economic Development	+	The more cost competitive a technology the greater the potential deployment and employment, and hence the greater the potential socio-economic development.
15	Skills Enhancement	+	The more cost competitive a technology the greater the potential deployment and hence the greater the potential for skills enhancement.
16	Industry Development	+	The more cost competitive a technology is and earmarked for mass deployment, the more the economics to establish primary and related service industries are.
17	Non-RE Sector	-	The more cost competitive a technology is that greater potential for deployment and hence the reduced capacity for expansion in the traditional generation facilities.
18	Cost of Capital	+	The more cost competitive and mature a technology with a proven record, the lower the investment risks and hence the cost of capital will be lower.
20	Reliable Profits	+	The more mature the technology the more cost competitive it will be and hence profits generated will be more reliable.
21	Risk	-	The more cost completive a technology is the more mature it will be and hence new technology risk is reduced.
22	Technology Innovation	-	The more cost competitive a technology the less need to improve the technology.
23	Existing Infrastructure	0	
24	Deployment Time	0	

When RE generation projects/installations are deployed and a reliable stream of income and profit is generated over the operational life span, what casual links are evident on the other 23 drivers?

20. Reliable Profits

Driver No:	Driver	Effect	Comment
1	Diversification	+	Reliable profits will see greater diversification as more IPPs will enter the market.
2	RE Target Capacity	+	Reliable profits with greater RE capacities will see greater capacity deployed.
3	Energy Cost	+	Reliable profits with greater RE target capacities will see greater deployment and hence drive energy costs down in the long run.
4	FDI / Investment	+	Reliable profits will see greater investment being attracted.
5	Common Good Elements	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence reduced GHG emissions and reduce environmental, health and weather impact.
6	Energy Security	+	Reliable profits will see greater deployment of RE capacity and hence more electricity will be generated using greener technology and hence increase local generation and reduced reliance on imported energy.
7	Market Liberalisation	+	Reliable profits will see greater deployment of RE capacity and hence provide more incentives for IPPs to enter the market and hence liberalise it.
8	Resistance	+	Reliable profits usually come at a high cost to society and can increase resistance.
9	Big Players	-	Reliable profits will dilute the market for big players and make them loose market share.
10	Administration / Bureaucracy	+	Reliable profits usually come at a high cost to society and need to be managed to ensure fairness and transparency. More authority control is needed.
11	Climate Politics	+	Reliable profits may meet public resistance and influence politics.
12	Climate Change Initiatives	0	
13	Employment	+	Reliable profits allow long term investments to be made and hence greater employment opportunities.
14	Socio-Economic Development	+	Reliable profits allow long term investments to be made and hence greater socio-economic development is possible.
15	Skills Enhancement	+	Reliable profits allow long term investments to be made and hence greater potential for skills enhancement.
16	Industry Development	+	Reliable profits allow long term investments to be made and hence greater potential to establish primary and related service industries.
17	Non-RE Sector	-	Reliable profits allow long term investments to be made and hence greater potential to reduce the market share of traditional generators.
18	Cost of Capital	+	Reliable profits allow long term investments and stability which leads to lower capital costs for future RE projects.
19	Cost Competitiveness	+	Reliable profits lead to investment in technological development and a drive towards driving costs down and bringing RE technology to a cost competitive position.
21	Risk	-	Reliable profits lead to long term planning and hence reduce risks of the industry being stunted due to economic issues.
22	Technology Innovation	+	Reliable profits lead to investment in technological development and hence innovation.
23	Existing Infrastructure	0	
24	Deployment Time	0	

When RE generating capacity is deployed and risks leading to this deployment have been minimised (country, political, financial, economic etc), what casual links are evident on the other 23 drivers?

21. Risk			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	-	Too much risk leads to less investment and hence less diversification.
2	RE Target Capacity	-	Too much risk leads to less investment and hence less likelihood of reaching RE capacity targets.
3	Energy Cost	-	Too much risk leads less deployment of RE generation methods and energy costs are exposed to international markets and can drive costs up.
4	FDI / Investment	-	Too much local risk can detract investment.
5	Common Good Elements	-	Too much risk can lead to less deployment of RE generating capacity and hence not reduce GHG emissions, hence continuing environmental, health and weather degradation.
6	Energy Security	-	Too much risk can lead to less deployment of RE generating capacity and continued reliance on imported energy and hence reduced energy security.
7	Market Liberalisation	-	Too much risk can lead to less deployment of RE generating capacity and not enticing IPPs to enter the market and hence liberalise it.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Too much risk can lead to increased lobbying to make conditions more favorable for RE deployment.
12	Climate Change Initiatives	0	
13	Employment	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available.
14	Socio-Economic Development	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available and therefore less socio-economic development can occur.
15	Skills Enhancement	-	Too much risk reduces RE deployment potential and hence fewer employment opportunities are made available and there less skills enhancement can occur.
16	Industry Development	-	Too much risk reduces RE deployment potential and less of a drive to establish a primary and related service industry sectors.
17	Non-RE Sector	+	Too much risk will help maintain the existing market for traditional generation methods.
18	Cost of Capital	-	Too much risk can lead to increased costs in capital.
19	Cost Competitiveness	0	
20	Reliable Profits	-	Too much risk can lead to reduced profits.
22	Technology Innovation	0	
23	Existing Infrastructure	0	
24	Deployment Time	0	

F. Technology

When RE generating capacity is deployed and an industry is grown, with ever increasing competition and reducing tariffs, the increased technological innovation to maintain profit margins increases. What casual links are evident on the other 23 drivers?

22. Technology Innovation			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	The greater the technological innovation the greater potential to diversify the energy mix.
2	RE Target Capacity	0	
3	Energy Cost	+	The greater the technological innovation the greater the reduction in technology cost and hence the cost of energy.
4	FDI / Investment	+	The greater the technological innovation the greater the chance to deploy new technologies and start attaining a track record. The more mature the technology the greater attraction of investment.
5	Common Good Elements	+	The more technological innovation, the greater the possibility to create/improve ways to generate greener electricity and hence reduce GHG emissions.
6	Energy Security	+	Technological innovation allows the harnessing of local renewable resources and can increase energy security.
7	Market Liberalisation	+	Technological innovation allows new technology costs to be reduced, bringing about cost competitiveness. This will allow a greater number of IPPs to enter a market and help liberalise it.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	0	
12	Climate Change Initiatives	0	
13	Employment	+	Employment opportunities are created as technological innovation needs people to drive the processes.
14	Socio-Economic Development	+	Employment opportunities are created as technological innovation needs people to drive the processes and this leads to socio-economic development.
15	Skills Enhancement	+	Employment opportunities are created as technological innovation needs people to drive the processes and this leads to skills enhancement.
16	Industry Development	+	Employment opportunities are created as technological innovation needs people to drive the processes. This will create a new primary industry for innovation.
17	Non-RE Sector	0	
18	Cost of Capital	+	Technological innovation will improve technology, thereby improving efficiencies and proving technology. This will bring the capital costs down.
19	Cost Competitiveness	+	As RE technology improves and in greater resource fields, the sector becomes more cost competitive with traditional generation methods.
20	Reliable Profits	+	Technological innovations leads to better technology which will be more efficient and will be able to produce better energy outputs leading to more reliable profits.
21	Risk	-	By improving technology, risk for untested technology is removed hence reducing technology risk.
23	Existing Infrastructure	0	
24	Deployment Time	+	Technology innovation will improve ways to deploy RE generating capacity.

When RE generating capacity is deployed where good grid and access infrastructure exists, what casual links are evident on the other 23 drivers?

23. Existing Infrastructure			
Driver No:	**Driver**	**Effect**	**Comment**
1	Diversification	+	A good existing grid structure and good management thereof will facilitate energy mix diversification.
2	RE Target Capacity	0	
3	Energy Cost	0	
4	FDI / Investment	0	
5	Common Good Elements	0	
6	Energy Security	+	Good infrastructure facilitates new generation capacity distribution/transmission and hence improves energy security.
7	Market Liberalisation	+	Good infrastructure facilitates new generation capacity distribution/transmission for IPPs and hence market liberalisation.
8	Resistance	0	
9	Big Players	0	
10	Administration / Bureaucracy	0	
11	Climate Politics	0	
12	Climate Change Initiatives	0	
13	Employment	+	New grid needs lead to employment opportunities.
14	Socio-Economic Development	+	New grid being bought into areas with no grid leads to socio-economic development.
15	Skills Enhancement	+	New grid will require new skills for deployment and maintenance.
16	Industry Development	+	Grid availability is a key driving factor for RE deployment and this will be heavily considered when new primary industry is being established.
17	Non-RE Sector	0	
18	Cost of Capital	0	
19	Cost Competitiveness	+	The availability of grid, with capacity can make RE projects more viable to connect to the grid and hence the facility will be more cost competitive.
20	Reliable Profits	+	Good grid infrastructure and operation will lead to more reliable profits (less down time).
21	Risk	-	Good grid availability and functioning will reduce transmission and distribution related risks.
22	Technology Innovation	+	The need for better grid technology to deploy RE generation capacity will lead to technological innovation initiatives.
24	Deployment Time	0	

When RE generating capacities are set and a need to bring new facilities on line quicker than traditional generation methods and deployment times decrease, what casual links are evident on the other 23 drivers?

24. Deployment Time

Driver No:	Driver	Effect	Comment
1	Diversification	+	Quicker deployment time means potentially bigger diversification.
2	RE Target Capacity	+	Quicker deployment means the RE target capacities are reached quicker.
3	Energy Cost	0	
4	FDI / Investment	0	
5	Common Good Elements	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to reducing environmental, health and weather damage, through reduced GHG emissions.
6	Energy Security	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to energy security.
7	Market Liberalisation	+	Quicker deployment time will mean that newer generation methods can come on line faster and start contributing to reducing environmental damage.
8	Resistance	0	
9	Big Players	-	Quicker deployment time of new technologies may see big players lose market share quicker.
10	Administration / Bureaucracy	0	
11	Climate Politics	+	Pressure on political governance to react to climate change will entice authorities to deploy quick solutions. Reduced deployment time of RE generation methods will be a key driving force in this process.
12	Climate Change Initiatives	+	Quick deployment will be evidence to the international community that green generation methods are being installed and demonstrate adherence to climate change initiatives.
13	Employment	0	
14	Socio-Economic Development	0	
15	Skills Enhancement	0	
16	Industry Development	0	
17	Non-RE Sector	0	
18	Cost of Capital	+	Quick deployment time see capital costs and terms reduced as the time period for deployment meaning less risk and the plant can come online quicker and start generating revenue.
19	Cost Competitiveness	0	
20	Reliable Profits	+	Quicker deployment means that a new generation facility can start generating electricity sooner and hence start generating revenue sooner. This leads to reliable profits.
21	Risk	-	Quicker deployment means less risk at the higher level as economic factors/political change/financing costs etc over a shorter period are less likely to affect the projects.
22	Technology Innovation	+	Quicker deployment needs will drive technology innovation to improve technology.
23	Infrastructure	+	Quicker deployment means that new generation facilities need to be connected to the grid sooner and will drive infrastructure deployment times down.

Appendix D – Letter to Experts for External Validation

Dear *[Respondents Name]*,

MBA Research Report: The drivers of effective renewable energy policy.

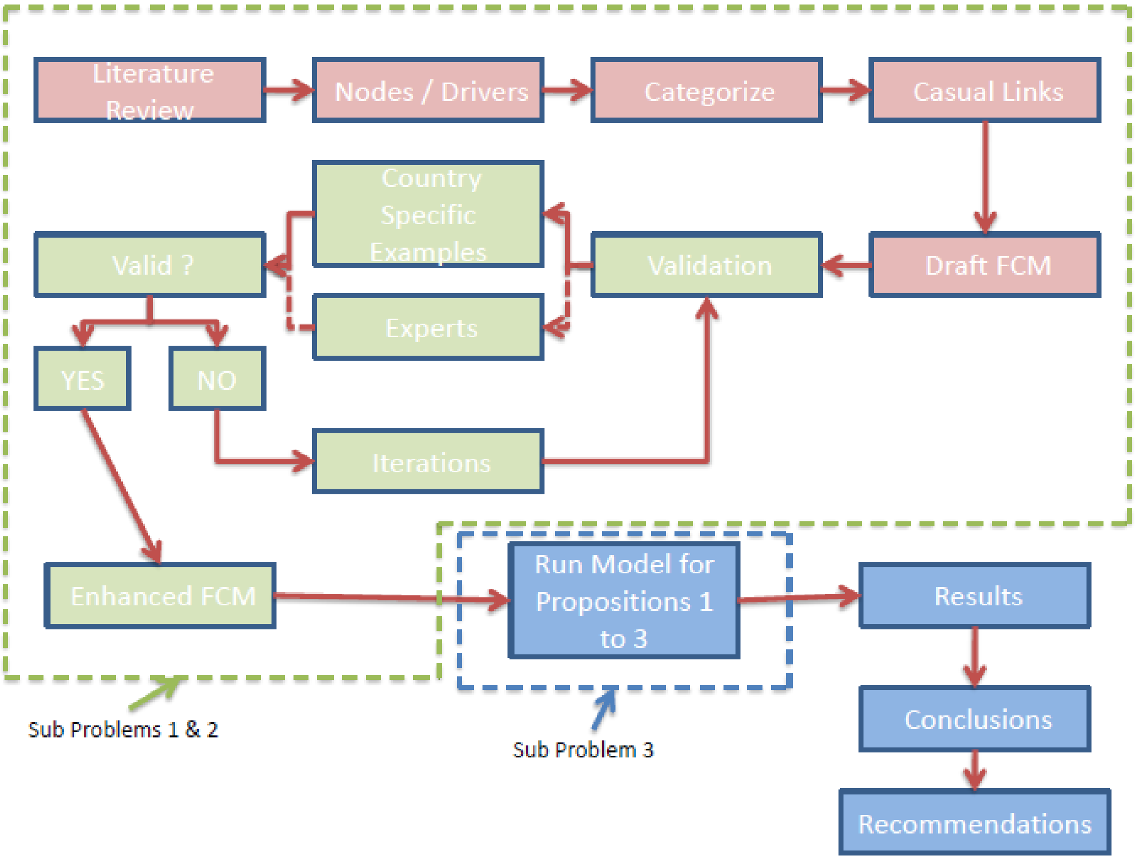
Thank you for agreeing to provide your valuable input into my research. As part of the Wits MBA, a research report needs to be carried out to fulfill the requirements of the WITS MBA. The research is aimed at instilling an appreciation for the processes involved with academic research. It is up to the student to propose a topic and to carry out adding to a body of knowledge in collaboration with an academic supervisor from the institution.

I have chosen to focus my research on the clean technology sector and more specifically at the policies employed by authorities to encourage the development of a renewable energy sector. This specific topic choice has its origins in renewable energy courses complete at *Instituto Empresa*, Madrid (2010). The Spanish market development is more mature then South Africa, which has yet to deploy its first large grid connected farm. When we asked why Spanish investors had not turned their attention to the attractive REFIT's on offer in SA, a common response was given: "the regulatory and policy environment is too underdeveloped to warrant taking the risk".

From this my research topic was born: to see what high level policy needs to be deployed and which drivers are needed to encourage a sustainable industry. My research has thus far concluded the literature review section, identifying all the drivers and high level policies. From the literature review, I have chosen to use a qualitative research tool of Fuzzy Cognitive Mapping (FCM) to model the outcomes of deploying different or hybrid policies to develop a sustainable renewable energy sector. From this, I am at the point of having compiled a draft FCM. I now need to validate this draft model and enhance it. This validation process will be done in two ways:

a) By applying country specific examples where renewable energy sectors are maturing and I have used The Danish and The UK RE sector and available literature , and
b) Through experts within industry and academia that can comment on whether the casual links and drivers are indeed key facets of a developing renewable energy sector.

Below is a process map showing the path taken to get to this point:



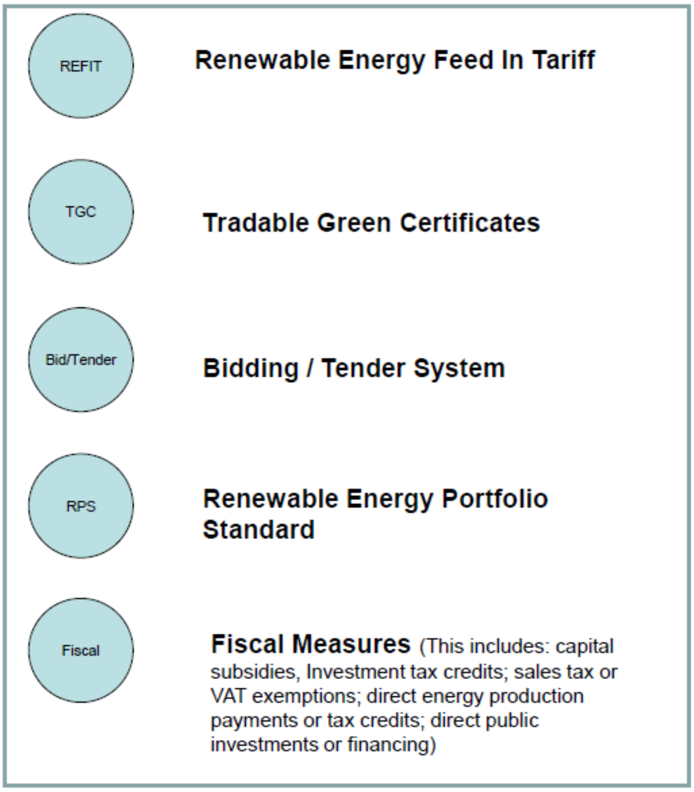
At present, I have completed the model validation using the country examples of Denmark and The UK and the results seem to indicate that the model is indeed a good reflection of reality and hence displays signs of validity. In order to further enhance and validate the model, I have chosen to use external validation from various experts involved in the RE sector, both local (SA) and international. I am doing this to ensure the model is indeed the best it can be.

To summarise the key findings so far:

Literature Review:

From the literature review, I have concluded that the following high level policies exist that a country can choose to deploy to ignite an RE sector:

High Level Policies:



These have formed the policy nodes within the FCM and are the trigger points for the modeling.

Drivers:

In addition to the high level policies, 35 drivers were initially identified that play a role in the choice and development of an RE sector. These initial 35 drivers were used and eventually redundancies were discovered and hence the model was simplified to 24 drivers. The drivers have been grouped (categorised) accordingly into 6 groups, which are shown below, with an extract highlighting the original 35 drivers, which have subsequently been reduced to 24.

1) Local Energy Constraints:

Factor	**Explanation**
Diversification	The need to diversify the energy mix away from fossil fuels.
Target Capacity	The need to reach the government or regional targets for RE capacity.
Energy Cost	The need to consider the cost of RE in relation to existing electricity costs.
Investment Potential	The need to consider the attractiveness of the market size and country specific conditions.
Age of Existing	The need to consider how new/old the existing infrastructure is.

Infrastructure	
Internalisation of Emissions	The need to consider the level of GHGs and how the local policy is incorporating this into the cost of energy.

2) Encourage Renewable Energy:

Factor	**Explanation**
Environment	The need to protect the environment and preservation of common good items.
Health	The need to recognise that GHGs increase health issues and to mitigate against them.
Weather	GHGs are affecting global weather patterns and there is a need to reduce GHG emissions to reduce adverse weather. Changing weather patterns have implications of agricultural yield, induced natural disasters etc.
Energy Security	The need to reduce reliance on imported fossil fuel based energy and generate electricity locally.
Market Liberalisation	The need to recognise that energy market liberalisation leads to increased efficiency and competition drives costs down.

3) Local Conditions:

Factor	**Explanation**
Resistance	Change generates resistance especially when there are cost implications or loss of market share. Resistance can be from consumers bearing the higher energy costs or current generators having to invest in new generation methods or losing market share.
Big Players	Depending on the level of liberalisation, monopolies or parastatals may influence the renewable sector and promote their own goals.
Culture / Mindset	Acceptance of renewable energy generation depends on how accepting and aware local stakeholders are. This feeds into resistance.
Administration / Bureaucracy	Onerous administrative hurdles may stunt the deployment of renewable generation capacity. The ease of establishing a RE sector is highly influenced by administrative authorities.
Climate Politics	The goals of governing political bodies may have other national goals that cannot accommodate the growth of this sector.

	Increasing energy costs can be detrimental to political survival.
International Opinion / Reputation	International pressure to meet global standards of sustainability which does not align with local policies can see exclusion from trade agreements and reputational damage. This may spur the investment in a RE sector.
International Policy Agreements	Ratification of international initiatives to reduce GHG emissions and tackle climate change issues may call for deployment of cleaner technologies and thus spur the RE sector.

4) Economics:

Factor	**Explanation**
Employment	Establishing a new sector has various players in the value chain and this has job creation opportunities. Conversely, reducing the fossil fuel based generation sector, can lead to job losses.
Economic Development	Energy is needed to run an economy. Energy is directly related to industry and economic growth. By deploying RE generation capacity, energy security is encouraged and hence the economy can rely on a more stable supply of energy in order to grow.
Social Development	Access to energy drives up the standard of living and allows people to empower themselves to escape poverty.
Skills Development	A new sector requires new skills. Deploying new technologies require a new skill set and the adaptation of existing local skills.
Primary Industry	Existing industries can tailor their services and products to this industry. Additionally, new manufacturing sectors can be established to support the new sector.
Services	Support services will also receive a boost. This can include legal, financial, advisory, consulting, technical, maintenance etc.
Non-RE Sector	By establishing a new energy sector, the old energy sector will experience market share loss or the need to evolve their generation methods. Implications include job loss, closing of the concern etc. This can also affect the support services to this sector.
Engineering Skills	Due to the high level of innovation needed in this sector and the new technicalities required to establish the sector, there is a causal relationship with engineering skills. Will the skills need to be imported and/or developed locally to reduce reliance on foreign supply?

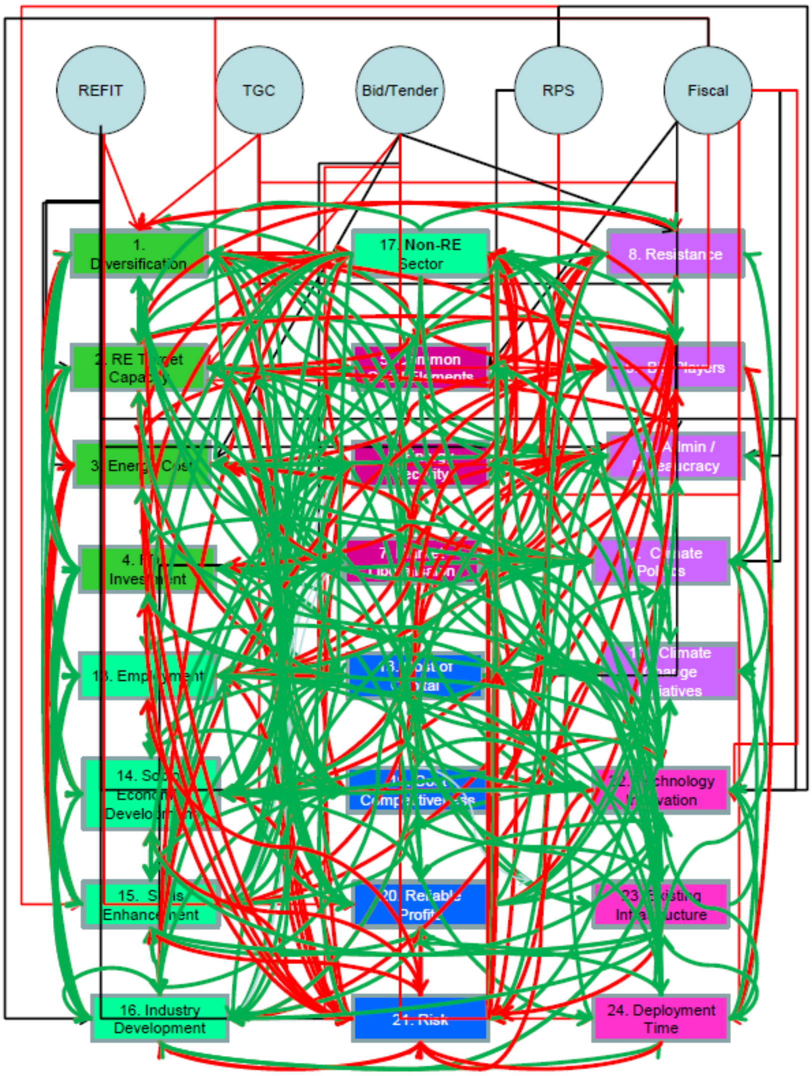
5) Financial:

Factor	Explanation
Cost of Capital	Renewable energy deployment requires large capital investments. Private sector involvement is a common trend. Depending on the level of risk associated the project the cost of capital can hinder deployment.
Cost Competitiveness	Renewable energy cost is greater than traditional fossil fuel derived energy. Support is required to bring new technologies and installations to a competitive plain.
Reliable Profits	The use of private sector and independent power producers need to see reasonable returns to attract their investment. This is major factor in realising RE deployment.
Risk	The associated risks can be too large to warrant investment. Risk levels have a direct affect on the level of RE deployment.

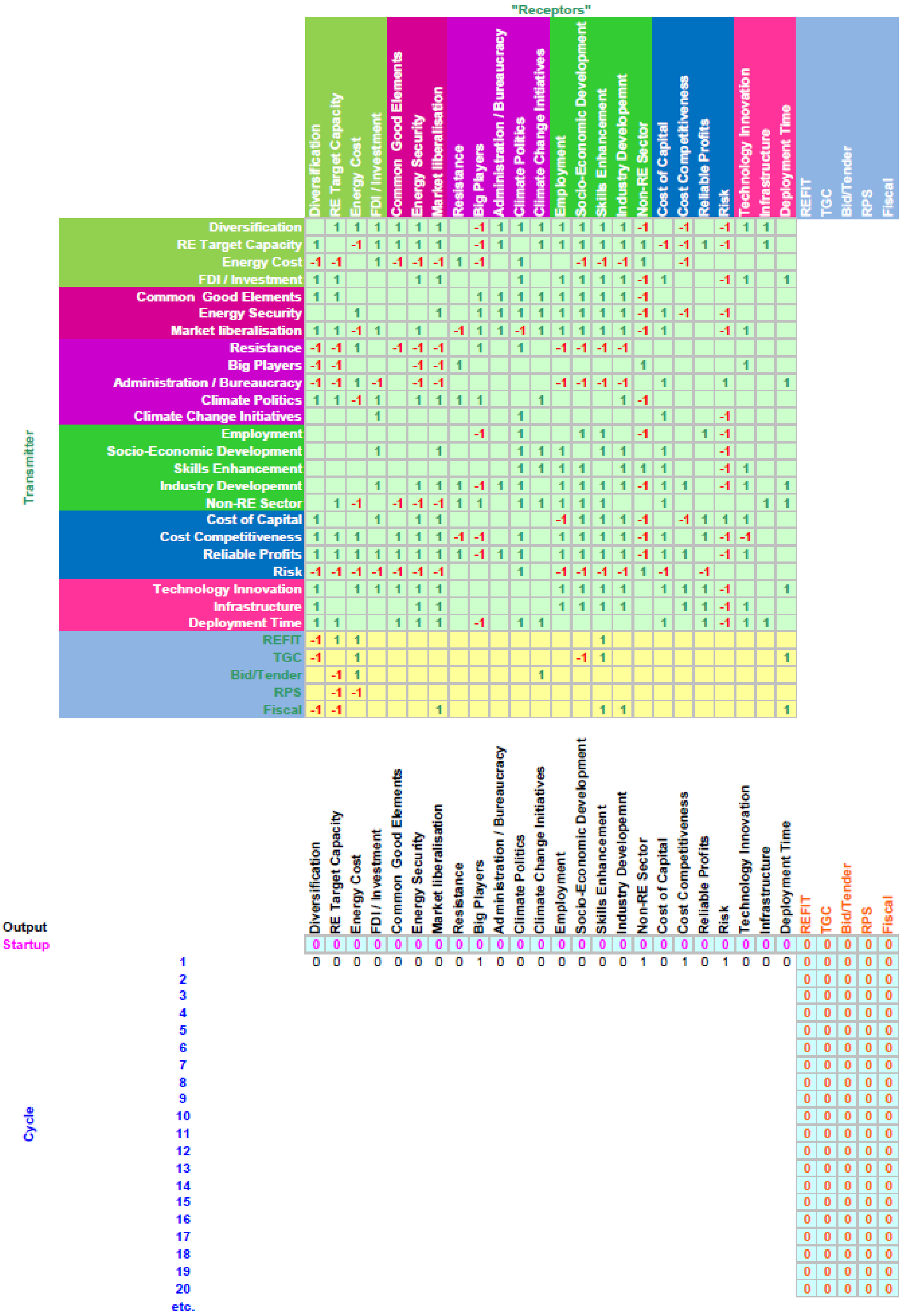
6) Technology:

Factor	Explanation
Technology Innovation	The need to drive costs down and make newer technologies viable, drives innovation. This also creates a new industry.
Infrastructure	The issue of grid connection is a crucial one. The availability and willingness of utility companies to assist in connecting IPPs schemes to the national grid. In addition distance to grid is a crucial element.
Maintenance	Renewable energy plants require less operational inputs and less maintenance compared to traditional power plants. The lower levels of maintenance can encourage the deployment of RE.
Deployment Time	RE establishment follows shorter timelines and can see larger deployment compared to traditional generations plants.
Solar	Solar technology is reaching maturity and deployment internationally is growing significantly. This is a common technology choice across countries developing RE capacity.
Wind	Wind technology is reaching maturity and deployment internationally is growing significantly. This is a common technology choice across countries developing RE capacity.

The policies above coupled with the drivers have been organized to show the casual links (positive or negative) to show the influence they have on one another, if any at all. This has formed the basis of the model, which can be depicted (drawn) as follows:



Or represented as a matrix (FCM) as follows:



"Receptors"

Transmitter	Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Diversification		1	1	1	1	1	1		-1	1	1	1	1	1	1	1	-1		-1		-1	1	1						
RE Target Capacity	1		-1	1	1	1	1		-1	1		1	1	1	1	1	1	-1	-1	1	-1		1						
Energy Cost	-1	-1		1	-1	-1	-1	1	-1		1			-1	-1	-1	1		-1										
FDI / Investment	1	1				1	1				1		1	1	1	1	-1	1			-1	1		1					
Common Good Elements	1	1							1	1	1	1	1	1	1	1	-1												
Energy Security			1				1		1	1	1	1	1	1	1	1	-1	1	-1		-1								
Market liberalisation	1	1	-1	1		1		-1	1	1	-1	1	1	1	1	1	-1	1			-1	1							
Resistance	-1	-1	1		-1	-1	-1		1		1		-1	-1	-1	-1													
Big Players	-1	-1				-1	-1	1									1					1							
Administration / Bureaucracy	-1	-1	1	-1		-1	-1						-1	-1	-1	-1		1			1			1					
Climate Politics	1	1	-1	1		1	1	1	1			1				1	-1												
Climate Change Initiatives				1							1							1			-1								
Employment									-1		1			1	1		-1			1	-1								
Socio-Economic Development				1			1				1	1	1		1	1		1			-1								
Skills Enhancement											1	1	1	1		1	1	1			-1	1							
Industry Developemnt				1		1	1	1	-1	1	1		1	1	1	1	-1	1	1		-1	1		1					
Non-RE Sector		1	-1		-1	-1	-1	1	1		1	1	1	1	1			1					1	1					
Cost of Capital	1			1		1	1						-1	1	1	1	-1		-1	1	1	1							
Cost Competitiveness	1	1	1		1	1	1	-1	-1		1		1	1	1	1	-1	1		1	-1	-1							
Reliable Profits	1	1	1	1	1	1	1	1	-1	1	1		1	1	1	1	-1	1	1		-1	1							
Risk	-1	-1	-1	-1	-1	-1	-1				1		-1	-1	-1	-1	1	-1		-1									
Technology Innovation	1		1	1	1	1	1						1	1	1	1		1	1	1	-1			1					
Infrastructure	1					1	1						1	1	1	1			1	1	-1	1							
Deployment Time	1	1			1	1	1		-1		1	1						1		1	-1	1	1						
REFIT	-1	1	1												1														
TGC	-1		1											-1	1									1					
Bid/Tender		-1	1									1																	
RPS		-1	-1																										
Fiscal	-1	-1					1								1	1								1					

Cycle

Output	Diversification	RE Target Capacity	Energy Cost	FDI / Investment	Common Good Elements	Energy Security	Market liberalisation	Resistance	Big Players	Administration / Bureaucracy	Climate Politics	Climate Change Initiatives	Employment	Socio-Economic Development	Skills Enhancement	Industry Developemnt	Non-RE Sector	Cost of Capital	Cost Competitiveness	Reliable Profits	Risk	Technology Innovation	Infrastructure	Deployment Time	REFIT	TGC	Bid/Tender	RPS	Fiscal
Startup	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0
2																									0	0	0	0	0
3																									0	0	0	0	0
4																									0	0	0	0	0
5																									0	0	0	0	0
6																									0	0	0	0	0
7																									0	0	0	0	0
8																									0	0	0	0	0
9																									0	0	0	0	0
10																									0	0	0	0	0
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14																									0	0	0	0	0
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16																									0	0	0	0	0
17																									0	0	0	0	0
18																									0	0	0	0	0
19																									0	0	0	0	0
20																									0	0	0	0	0
etc.																													

It is the above model that has been run, with various inputs from the 2 country examples to validate the model. It is this model that requires your review and input to add further impetus to the validation process, in order to enhance it and make it more valuable.

Requirements (from respondents):

I would be grateful if you could review this model and provide a response to the following essential questions:

1) Does this study reflect what is observed in the real world? Does this model indeed provide an accurate reflection of the policies, drivers and casual links that are experienced in an RE sector?
2) Does the model and research reflect what is observed in your field of expertise?
3) Are there any areas where essential improvements can be made?

I would appreciate it if you review the research report and provided written feedback that can be used to enhance the model and add further value. If you could also include a short exert on your particular field of expertise and relevant experience to complement the written feedback supplied.

The above supplied information are extracts from the research report and intended to introduce the respondent to the key findings thus far. I have attached the full research project in its current form. The research has not modelled the problems or propositions as put forward in the body of the report and final editing and review is not complete yet. These are all dependent on this external review and additional validation.

I have attached the full report (in its current form). I would like to note that the literature review on the current RE policy in South Africa (REFIT) was correct at the time of the literature review. It is acknowledged that this has evolved to a form of bidding system and this section will be updated upon final submission.

I would also like to walk you through the research thus far. I believe this will be beneficial as it will help present the project to you and facilitate the answering of any questions you may have. I will be in touch to establish a convenient time.

In terms of timing, I am hoping to complete my first final draft by the mid December 2011, with a view to submit my final copy by mid January 2012. So a response within 14 days of the signed date below would be greatly appreciated.

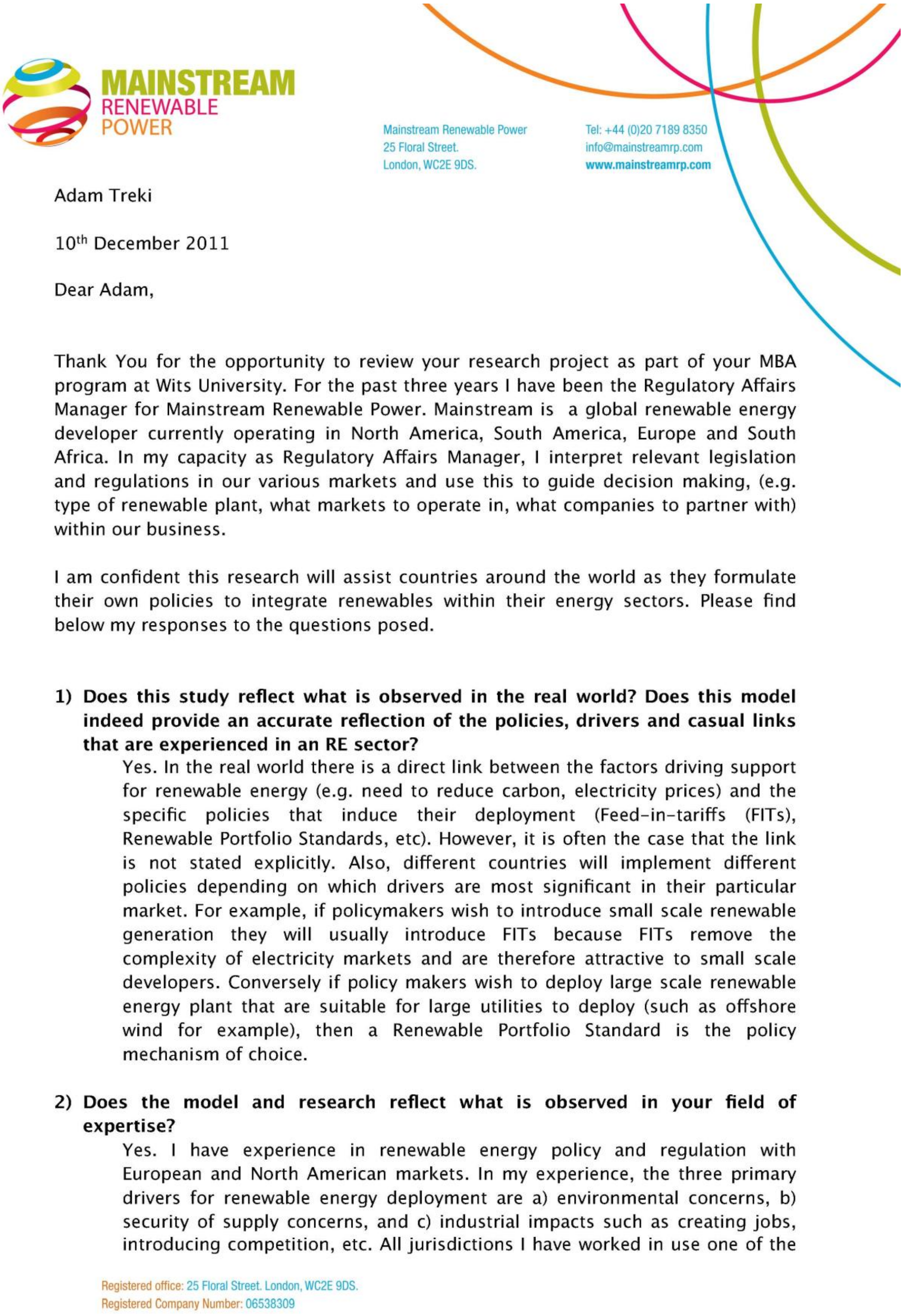
Any information/response collected will be treated as confidential. In addition, a completed copy of the will be provided to you once available. Should you wish to discuss any aspect of the research with my supervisor from the WITS Business School, Professor Boris Urban, you are welcome to contact him on 00 27 11 717 3762. Or, feel free to contact me on 00 27 (0) 83 785 2279 or AdamTreki@yahoo.com

Once again, thank you for the willingness to participate in this study.

Kind Regards

Adam Treki, 3rd December 2011.

Appendix E – Responses from Respondents



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Adam Treki

10th December 2011

Dear Adam,

Thank You for the opportunity to review your research project as part of your MBA program at Wits University. For the past three years I have been the Regulatory Affairs Manager for Mainstream Renewable Power. Mainstream is a global renewable energy developer currently operating in North America, South America, Europe and South Africa. In my capacity as Regulatory Affairs Manager, I interpret relevant legislation and regulations in our various markets and use this to guide decision making, (e.g. type of renewable plant, what markets to operate in, what companies to partner with) within our business.

I am confident this research will assist countries around the world as they formulate their own policies to integrate renewables within their energy sectors. Please find below my responses to the questions posed.

1) **Does this study reflect what is observed in the real world? Does this model indeed provide an accurate reflection of the policies, drivers and casual links that are experienced in an RE sector?**

   Yes. In the real world there is a direct link between the factors driving support for renewable energy (e.g. need to reduce carbon, electricity prices) and the specific policies that induce their deployment (Feed-in-tariffs (FITs), Renewable Portfolio Standards, etc). However, it is often the case that the link is not stated explicitly. Also, different countries will implement different policies depending on which drivers are most significant in their particular market. For example, if policymakers wish to introduce small scale renewable generation they will usually introduce FITs because FITs remove the complexity of electricity markets and are therefore attractive to small scale developers. Conversely if policy makers wish to deploy large scale renewable energy plant that are suitable for large utilities to deploy (such as offshore wind for example), then a Renewable Portfolio Standard is the policy mechanism of choice.

2) **Does the model and research reflect what is observed in your field of expertise?**

   Yes. I have experience in renewable energy policy and regulation with European and North American markets. In my experience, the three primary drivers for renewable energy deployment are a) environmental concerns, b) security of supply concerns, and c) industrial impacts such as creating jobs, introducing competition, etc. All jurisdictions I have worked in use one of the support mechanisms you have considered (FITs, RPS, etc). The choice of which policy best brings about renewables deployment really depends on local market issues. FITs are usually most effective in markets where renewable energy is just starting whereas portfolio standards or certificate based systems seem to work best when there is already a significant penetration of renewable energy on the system.

3) Are there any areas where essential improvements can be made?

I cannot find any significant need for improvement. However, there are a few areas where you could build upon this research.

A) Cost is almost always a primary concern amongst policy makers and so an evaluation of which policies promote renewable energy at the least cost would be quite useful. This would be like a measure of the "efficiency" of support schemes. As I alluded to, this would likely be dependent on market specific conditions.

B) Most countries have almost no significant amount of renewables and those that do (e.g. Spain, Denmark) are starting to reach levels where there are questions about how the grid will cope with significant amounts of renewables. For example, what happens when the wind stops blowing? Or how does the transmission system need to be changed to accommodate renewables. So I think it would be interesting to look at how the ideal renewables policy changes with the level of renewables on the system.

I hope these comments have been useful. Don't hesitate to contact me if you need anything further.

Yours sincerely

Nick Fedorkiw
Regulatory Affairs Manager
Mainstream Renewable Power

Adam Treki

22nd February 2012

Dear Adam,

Thank you for the opportunity to review and provide feedback on your MBA research project. Your research has been conducted in an interesting area given that South Africa is currently in the process of implementing the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP).

Please find below my responses to the questions posed.

1) Does this study reflect what is observed in the real world? Does this model indeed provide an accurate reflection of the policies, drivers and casual links that are experienced in an RE sector?

Yes; the UK and Danish case studies conducted in your research project adequately illustrate that there is a causal link between the factors driving support for renewable energy and the policies that promote RE deployment. My main criticism is the applicability of the FCM tool to the developing country South Africa given that both the UK and Danish case studies are based on developed countries; developed and developing countries tend to have different policy objectives, namely socio-economic development objectives.

2) Does the model and research reflect what is observed in your field of expertise?

Yes. Based on my experience in the South African RE sector and research on international RE markets, the primary drivers for renewable energy deployment are the following:

1. Environment & Health (Climate Change)
2. Energy Diversification & Energy Security
3. Job creation

However, specific policy objectives and local market issues within any given country will fundamentally drive which policy support mechanism is implemented. In the real world, it has been shown that FITs are the most effective policy in nascent RE markets because they reduce the risk for developers and investors by offering a fixed price for RE and they reduce the administrative burden for RE developers.

3) Are there any areas where essential improvements can be made?

I would suggest that further research is done into the South African policy landscape focusing on the Renewable Energy Independent Power Producer Procurement Programme, to ensure that the FCM tool is correctly applied in the South African case study. However, it is acknowledged that the South African policy landscape has recently undergone a transition from a REFIT to bidding process (REIPPPP).

It is also recommended that a case study is conducted on a developing country such as Brazil, China or India in order to validate the outcome of the FCM tool before applying the tool to the South African case.

Thank you for this opportunity to review and provide feedback on your MBA research report. Please let me know if you have any queries regarding my feedback.

Yours sincerely,
Mary Waller

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21st February 2012

Dear Adam,

RE: Review of research project: "Drivers of effective renewable energy policy".

I have reviewed your research project as part of your MBA program at Wits Business School. You have already responded and incorporated the specific comments I sent through 18th February 2012.

For the past 10 years I have been actively involved with establishing the renewable energy sector in South Africa and have run and commercialised Genesis Eco-energy since 2002. I have also worked in a strategy and policy advisory capacity with Government to help create the market and environment for renewables in South Africa. In 2009 Eco-Genesis for a joint venture with Mainstream Renewable Power to form Mainstream South Africa and I am director of corporate affairs, commercial and market development, focusing on lobbying government on regulatory issues, shaping the market opportunities and indeed policy formation.

Please find below my responses to the questions raised in your covering letter:

1) **Does this study reflect what is observed in the real world? Does this model indeed provide an accurate reflection of the policies, drivers and casual links that are experienced in an RE sector?**

   In principal, yes. The central issue is that as a reader at a distance, and having understood what you are aiming at, some of the parameters and how you draw the conclusions you do, and how the model runs from a FCM point of view don't tie in with some of the intuitive assumptions one makes. Though you have used the validation from UK etc (and thus show the model/methodology hold true) there are extraneous 'curved ball factors' that are hard to include in such a model. These anomalies in the system are hard to deal with outside of full information being included and an in depth look at the connections between some of the drivers. However, the theory cited and used to develop the research and the model does in principal reflect reality.

2) Does the model and research reflect what is observed in your field of expertise?

As above, in principal it does, but dealing with the extraneous factors is difficult to model. Take for example Treasury's negative stance on FITs: for the industry it is still unclear whether this stems from principal, individual views on market principals; a lack of credible information; sheer politics; interdepartmental differences or as cited, the cost to SA. So it's murky territory at best. Yet, this has a major impact on policy, direction, strategy and ultimately a developmental path that we need to follow.

Another point worth noting on FITs and the policy decisions, with the shift to REBID, is to contextualise it with the pressures SA's manufacturing sector is under. RE is seen as a panacea for the failing policy in other areas i.e. government wrecked manufacturing through their failed fiscal and regulatory policies, and now think the RE programme and local content will cure all ills and rescue us from impending implosion. This is a tall order for a new sector that is already being squeezed on price through competitive bidding.

So, in the contest of FCM and the methodology how does one account for these vagaries in the system?

3) Are there any areas where essential improvements can be made?

I have provided specific comments that I am satisfied have been included. No essential changes are therefore required. I think this is a good analysis and next steps are to see how it fits with human logic and political decision-making. Question: if the FCM shifts us in the direction of sound, good rational decision-making around RE (born out of logical rational northern thinking) then how does this apply in a cultural context where collective cyclical helix type thinking and decision-making (or lack thereof) dominates?

I would like to suggest that you also look at this work in the context of some of the portfolio approach work done by Shimon Awerbuch and his followers (www.awerbuch.com).

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I hope my comments have been worth something in this clearly complex and intriguing world. This research report has opened up some new thinking for me, so thanks for the opportunity to comment and to learn from you. All the best in closing out this final hurdle.

Yours sincerely

Davin Chown
Director: Corporate Affairs, Commercial and market Development
Mainstream Renewable Power South Africa