Chapter 1: Background

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1.1. Electrification and renewable energy in Africa

Energy is essential for economic development (International Energy Agency 2004). Consequently there are two major challenges which sub-Saharan Africa currently faces. The first is reaching a maintainable rate of positive economic growth to cope with urban growth. The second is to become sufficiently industrialised to provide basic energy services to off-grid rural communities (United Nations Energy Commission for Africa 2008). The difference between the energy supply and demand in Africa has widened in the last three decades. Experts predict that this disparity will continue with the unfortunate result, so-called, "energy poverty" which is a great hindrance to socio-economic growth (United Nations Energy Agency 2007).

The world's population which is without electricity (2002 and projected to 2030) is shown in Figure 1-1. The startling prediction which is manifest in the map is that it is projected that electrification levels in sub-Saharan Africa will decrease rather than increase until 2030.

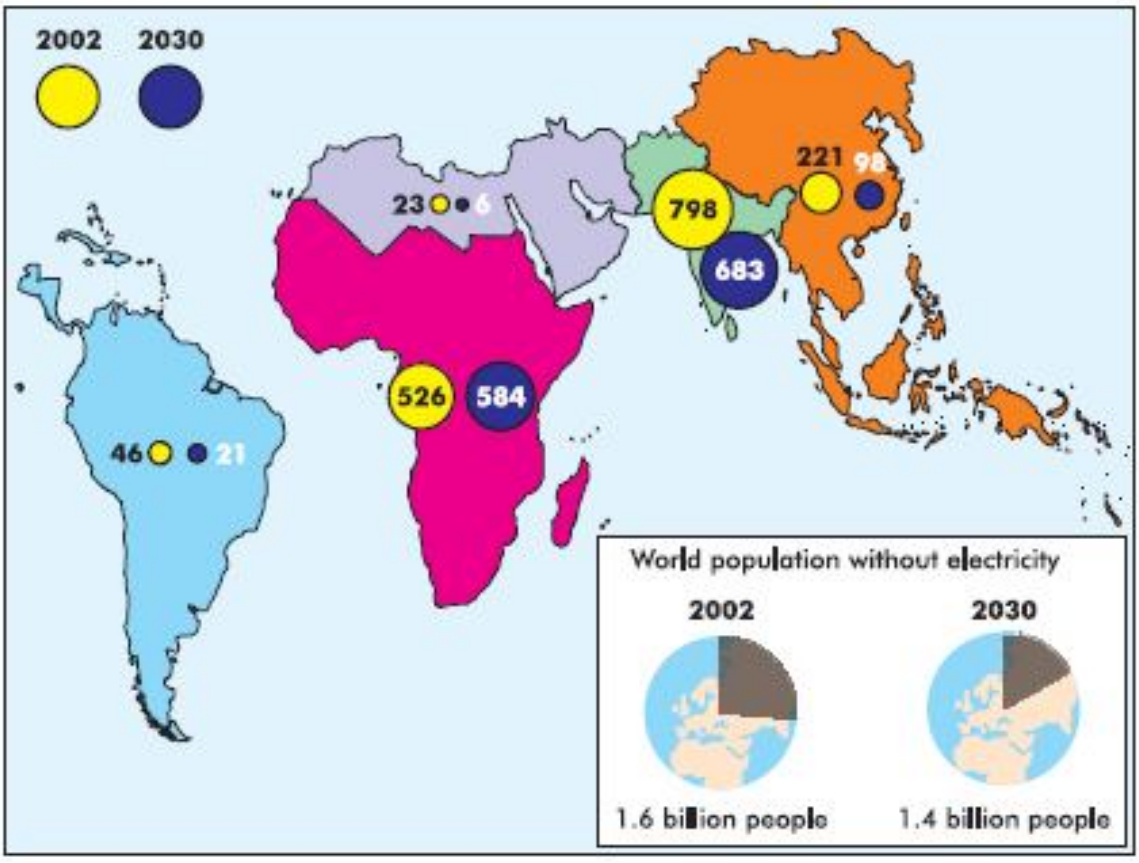


Figure 1-1: Electricity Deprivation (million) (International Energy Agency 2004)

According to the world energy outlook report for 2004 (International Energy Agency 2004), "two-thirds of the increase in global energy demand will come from developing countries". The socio-economic development of any country is dependent on energy and increasing utilisation of energy is related to the economic growth and

improvement of people's living standards (Nguyen 2007). This is critical in the case of developing countries. Africa has the lowest per capita use of energy of all continents primarily because there is an insufficient supply of energy. The cost of energy is too high for the majority of the population, inefficient distribution models are used, and there is a low security of supply (United Nations Energy Agency 2007).

The use of renewable energies is advocated to improve this situation for the reasons listed - renewable energy technologies are modular (low initial investment which can be incrementally expanded); the use of renewable energy technologies would imply less dependence on fossil-based fuels (these need to be imported in most cases and are subject to external price fluctuations); diversification of energy generation contributes to energy security provided that efficient, affordable and cost effective technologies are selected (United Nations Energy Agency 2007). Renewable energies are those obtained from a natural, recurring and continuous outflow of energy in the existing environment. They have the obvious advantage of inherent sustainability and no carbon emissions (Twidell et al. 2006 as cited in United Nations Energy Agency 2007)).

The use of renewable energy is seen as essential to ensure the security of the world's energy supply and to lessen the reliance of the world energy supply on fossil-fuels. When fossil fuels are not used, the generation of green house gases can be lessened (International Energy Agency 2007).

1.2. State of sustainable energy

> *"Although the environmental rationale for promoting renewables and energy efficiency in Africa is weak, there are strong energy security and socioeconomic reasons for promoting sustainable energy in Africa."* – (United Nations Industrial Development Organisation 2007a)

To determine whether renewable energy can provide a solution for the electrification challenges in Africa, it is necessary to investigate the state of sustainable energy. The state of sustainable energy and the consequent development goals of countries differ vastly. The electrification rate by region in terms of the percentage of the population which has access to electricity is shown in Table 1-1. The table shows that in 2002 only 24% of sub-Saharan Africa was electrified and the projections show that by 2030 only 51% of sub-Saharan Africa will be electrified.

Table 1-1: Electrification rates by region in terms of percentage of the population in developing countries (International Energy Agency 2004)

Region	2002	2015	2030
Africa	36 %	44 %	58 %
North Africa	*94* %	*98* %	*99* %

Region	2002	2015	2030
Sub-Saharan Africa	*24* %	*34* %	*51* %
South Asia	43 %	55 %	66 %
East Asia and China	88 %	94 %	96 %
Latin America	89 %	95 %	96 %
Middle East	92 %	96 %	99 %
Total for developing countries	**66 %**	**72 %**	**78 %**

A more detailed breakdown of the 2002 data per region is shown in Table 1-2. Note that sub-Saharan Africa has the lowest rates for both rural and urban electrification. Africa has the lowest rate of electrification for developing countries and sub-Saharan Africa has the all time low electrification rate of only 23.6%.

Table 1-2: Urban, rural and total electrification rates by region in 2002 (International Energy Agency 2004)

	Population (million)	Urban Population (million)	Population without electricity (million)	Population with electricity (million)	Rate (%)	Urban rate (%)	Rural rate (%)
North Africa	143	74	9	134	93.6	98.8	87.9
Sub-Saharan Africa	688	242	526	162	23.6	51.5	8.4
Total Africa	831	316	535	295	35.5	62.4	19
China and East Asia	1,860	725	221	1,639	88.1	96	83.1
South Asia	1,396	390	798	598	42.8	69.4	32.5
Total developing Asia	3,255	1,115	1,019	2,236	68.7	86.7	59.3
Latin America	428	327	46	382	89.2	97.7	61.4
Middle East	173	114	14	158	91.8	99.1	77.6
TOTAL DEVELOPING COUNTRIES	4,687	1,872	1,615	3,072	65.5	85.3	52.4
TRANSITION ECONOMIES AND OECD	1,492	1,085	7	1,484	99.5	100	98.2
TOTAL WORLD	**6,179**	**2,956**	**1,623**	**4,556**	**73.7**	**90.7**	**58.2**

Detailed 2002 electrification rates for the countries in sub-Saharan Africa are shown in Table 1-3. The two countries with the highest electrification rate are Mauritius and

South Africa respectively after which electrification rates fall below 51% with Ethiopia at the lowest electrification rate of 2.6%.

Table 1-3: Electrification rates for sub-Saharan African countries in 2002 (International Energy Agency 2004)

Country	Electrification rate (%)	Population without electricity (million)	Population with electricity (million)
Mauritius	100.0%	0	1.2
South Africa	67.1%	14.7	30
Côte d'Ivoire	50.7%	8.1	8.3
Ghana	48.5%	10.5	9.9
Gabon	47.9%	0.7	0.6
Nigeria	44.9%	66.6	54.3
Zimbabwe	40.9%	7.6	5.3
Cameroon	40.7%	9.3	6.4
Namibia	34.7%	1.3	0.7
Senegal	31.4%	6.8	3.1
Sudan	31.0%	22.7	10.2
Botswana	26.4%	1.3	0.5
Benin	24.8%	4.9	1.6
Congo	19.6%	2.9	0.7
Eritrea	18.4%	3.3	0.7
Zambia	18.4%	8.7	2
Togo	17.0%	4	0.8
Burkina Faso	10.0%	11.4	1.3
Tanzania	9.2%	33	3.3
Kenya	9.1%	28.7	2.9
Mozambique	8.7%	16.9	1.6
DR Congo	8.3%	46.9	4.3
Madagascar	8.3%	15.5	1.4
Other Africa	7.0%	83.9	6.3
Malawi	5.8%	11.2	0.7
Angola	5.0%	12.5	0.7
Lesotho	5.0%	1.7	0.1
Uganda	4.0%	24	1
Ethiopia	2.6%	67.2	1.8
Sub-Saharan Africa	**23.5%**	**526.3**	**161.7**

The electrification rates of the majority of Africans are clearly very low - 526.3 million Africans do not have access to electricity. To improve these figures and meet the millennium development goals of the UN shown in Figure 1-3 (International Energy Agency 2004), approximately 500 million people worldwide will need to gain access to electricity by 2015 and approximately 600 million people worldwide will have to switch from traditional biomass energy (combustible renewables such as fuel wood, charcoal and agro-residues) for cooking and heating as shown in Figure 1-2.

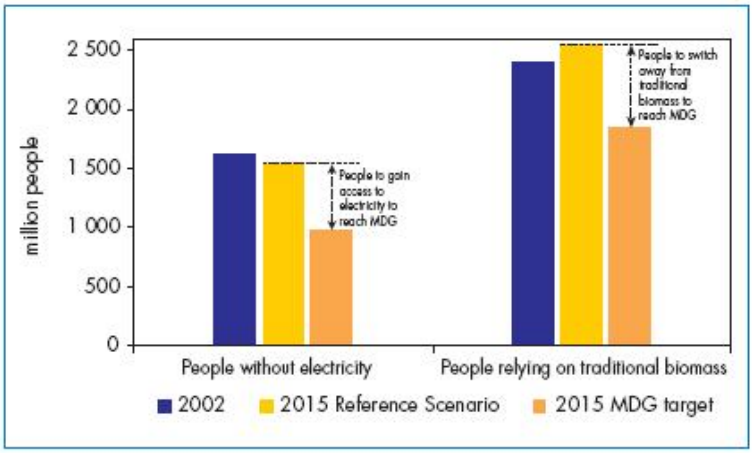


Figure 1-2: Energy implications of meeting the Millennium Development Goals of the UN (International Energy Agency 2004)

In September 2000, the member states of the United Nations adopted what they called the "Millennium Declaration". Following consultations with the World Bank, the International Monetary Fund, the OECD and the specialised agencies of the United Nations, the General Assembly recognised eight specific goals as part of the road map for implementing the declaration:

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve maternal health.
6. Combat HIV/AIDS, malaria, and other diseases.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.

Yardsticks were established for measuring results and targets for 2015. They concern not just developing countries but also the rich countries that are helping to fund development programmes and the international organisations that are helping countries implement them.

Figure 1-3: The millennium development goals of the UN (International Energy Agency 2004)

The current production in terms of primary energy supply for Africa is less than ten percent of the world's energy (United Nations Industrial Development Organisation 2007a). As indicated in Table 1-4 less than twenty-six percent of this supply is from renewable sources (United Nations Industrial Development Organisation 2007a). The portion from non-renewable sources is shown in blue and the portion from renewable sources is shown in yellow in Table 1-4. The portion from renewable sources, namely biomass, is being utilised in an inefficient and unsustainable way (United Nations Industrial Development Organisation 2007a).

Table 1-4: Production of energy by source in Africa (United Nations Industrial Development Organisation 2007a)

Type	Amount (Mtoe)	Percentage
Crude oil	418.78	38.08
Coal	139.01	12.64
Gas	129.89	11.82
Petroleum products	128.56	11.69
Nuclear	3.30	0.3
Biomass	272.10	24.74
Hydro	7.30	0.66
Geothermal	0.68	0.06
Solar/wind	0.0058	0.01
Total	1,099.60	100.00

Despite the lack of use of renewable energies in sub-Saharan Africa, this region is ideally suited for the implementation of these technologies. A large number of countries in the region have a daily solar radiation ranging between 4 and 6 kW/m^2. Some parts of the region, especially at the coast, have good potential for wind generation and even in the landlocked regions, wind energy can be used for water pumping. In the east African rift, geothermal energy is available with a potential of producing 9,000 MW of electricity from water/steam based generation. There is further great potential in hydropower exploitation of permanent rivers and streams especially using small hydropower developments (United Nations Industrial Development Organisation 2007a).

Nevertheless, implementation of renewable energy projects in sub-Saharan Africa is not a government priority. Whether this reflects a reaction to the international concern that renewable energy implementation be impelled by the need to protect the environment and avoid climate change, or not, is not clear. The fact remains that

carbon emissions in Africa are not currently perceived to be at detrimental levels and poverty alleviation is at the top of the African agenda (United Nations Industrial Development Organisation 2007a). In this context, the benefits of electrification using renewable energy in Africa should be promoted taking several factors into account, such as job creation, economic development, rural electrification, energy security, decreased dependence on fluctuating oil prices, poverty alleviation, improved quality of life, physical security, increased safety and availability of funding.

- *Job creation*. Renewable energy technology must be installed and maintained (Prasad and Visagie 2005). The job creation possibility for various types of energy technologies is shown in Table 1-5. As can be seen from the table, the potential for job creation in renewable energies is much higher than that of conventional energies (United Nations Industrial Development Organisation 2007a). Electrification also enables the creation of new opportunities for work, for example, welding, battery charging and electronic repair (United Nations Energy Commission for Africa 2008).
- *Economic development*. People become economically active as they gain access to electricity and poverty may consequently be alleviated (Prasad and Visagie 2005; United Nations Energy Agency 2007). Enhanced income from agricultural products becomes a possibility because agro-processing can be used (United Nations Energy Commission for Africa 2008) and this boosts the competitiveness of agricultural products (United Nations Industrial Development Organisation 2007a). Agricultural produce can also be preserved which leads to a reduction in harvest losses and support laboratories can be placed closer to the poor to facilitate artificial insemination (United Nations Energy Commission for Africa 2008).

Table 1-5: Estimated job creation possibilities for various energy technologies (United Nations Industrial Development Organisation 2007a)

Energy option	Construction, manufacturing and installation (employees/MW)	Operation and maintenance (employees/MW)	Total employment (employees/MW)
Geothermal	4.00	1.70	5.70
Wind	2.51	0.27	2.78
Natural gas	1.00	0.10	1.10
Coal	0.27	0.74	1.01

- *Rural electrification*. Rural areas can be electrified as renewable energy technologies are modular and can be implemented on a small scale. Prasad and Visagie (2005) state that renewable energy technologies can also be implemented at a lower cost than connection to the national grid. This means

that the poor in scattered communities who do not currently have access to electricity can have access to power (United Nations Industrial Development Organisation 2007a). Decentralised renewable energy technologies can be located closer to the demand so that distribution and transmission costs are reduced; additionally, their operation is independent of fuel, and these energies are clean (Nguyen 2007). However, according to Brent and Rogers (2010) the cost of rural electrification was found to be high in a study in South Africa given the subsidies available, consequently this item will need to be further investigated.

- *Energy security*. The current conventional energy supply in Africa is unreliable (United Nations Industrial Development Organisation 2007a). Renewable energy technologies, if implemented correctly, can contribute to national energy security through diversification of supply (Prasad and Visagie 2005) and can influence production and competitiveness in this way (United Nations Energy Agency 2007).
- *Decreased dependence on fluctuating oil prices*. Most sub-Saharan countries import oil and with the current instability of the oil price, the balance of payments of these countries is adversely affected. The implementation of renewable energies can reduce this dependence (United Nations Industrial Development Organisation 2007a).
- *Poverty alleviation.* Renewable energy technologies can give affordable access to electricity to the poor which improves quality of life and enables economic participation (United Nations Industrial Development Organisation 2007a). Cogeneration schemes can also be used to ensure that revenue flows to poor communities (United Nations Industrial Development Organisation 2007a).
- *Improved quality of life.* Improved health care and education is possible with electrification. Another benefit, especially for women and children, is that they no longer have to spend hours gathering firewood (Prasad and Visagie 2005). This also translates into an increase in household income as income generating activities can be taken up after daylight hours (United Nations Energy Commission for Africa 2008). Medical and educational personnel are more likely to stay in rural areas where electricity and modern services are available.
- *Physical security*. Improved physical security is the result of lighting in public places which can reduce crime (United Nations Energy Commission for Africa 2008).

- *Increased safety.* Kerosene lamps and candles are replaced with electric light resulting in fewer accidents related to fire and house fires (United Nations Energy Commission for Africa 2008).
- *Availability of funding*. Although Africa makes a minimal contribution to greenhouse gases, there is funding available for renewable energy technologies which Africa can access as local environmental improvements also benefit the global scenario (United Nations Energy Commission for Africa 2008).

Given the current lack of access to energy by the population in sub-Saharan Africa, it is obvious that the implementation of renewable energy technologies must be addressed.

1.2.1. Current state of renewable energy implementation in Africa

There is evidence of renewable energy implementations in Africa which points to a less than successful outcome. Renewable energy projects are not always successful and for that both technical and non-technical factors are to blame (Mabuza*, et al.* 2007). Technical challenges include: incorrect design and lack of installation skills; quality control and warranties; maintenance and after sales service; training of locals for installation, maintenance and repair; local technical infrastructure availability (United Nations Industrial Development Organisation 2007b). The non-technical challenges include: lack of public awareness of reliability and cost of renewable energy; lack of government support with consequent non-supportive policies and regulations; lack of capital in rural areas to pay for implementation of renewable energies, and lack of ownership by the community (United Nations Industrial Development Organisation 2007b).

Because of the lack of financial as well as skilled human resources in sub-Saharan Africa, it is important that the correct technology for a given situation is chosen to ensure cost effectiveness. Forsyth (2010) states that not enough competent Africans are currently trained to fill technical positions. Currently, the most important factors to consider when selecting renewable energy projects in Africa have not been researched and prioritised.

The literature on the status of renewable energy projects in Africa does not contain a framework of the factors which can be used when selecting renewable energy technologies for Africa. *The aim of this study is to generate a structured framework and obtain empirical support for the framework*.

1.3. Project and technology selection

Project and technology selection fall into the fields of project management and technology management respectively. The literature on project and technology

selection is analysed in detail in Chapter 3 of this study. A generic selection process which is applicable to most of the selection methodologies is shown in Figure 1-4.

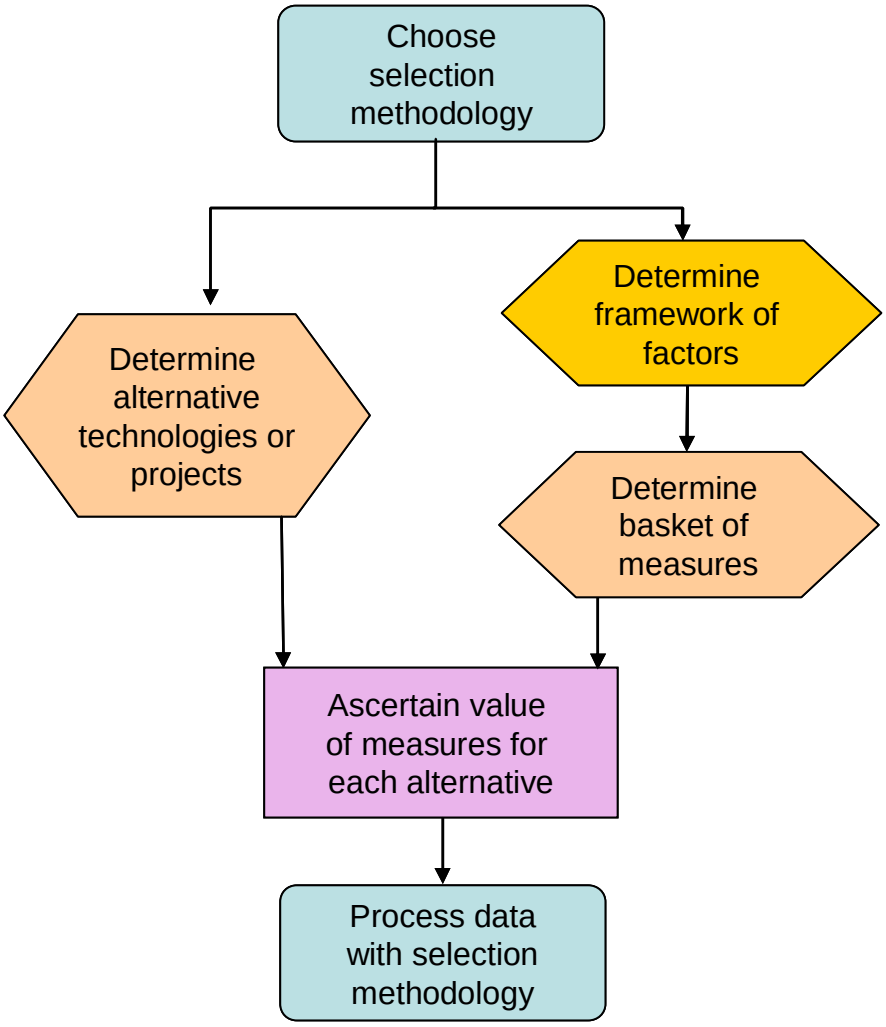


Figure 1-4: Generic selection process

For any selection methodology chosen, the various alternative technologies from which the selection is to be made must be determined. In terms of renewable energy technologies for use in Africa, the alternatives are summarised in Chapter 3. The list of alternatives will however grow as more research is done into renewable energy technologies.

A framework of factors which is applicable for the specific environment in which the technology will be applied has to be generated. A basket of measures for each factor also needs to be determined. The value for each measure can then be determined for each alternative technology and the data processed with the selection methodology chosen.

Many methodologies exist for project, technology, portfolio and programme selection. These methods can be summarised into the following categories:

- *Economic methods.* These methodologies compute the cost benefit of a technology or project. The factors taken into account by these methods are limited to economic data. The problem with these methodologies is that the data required are not easily available during the selection phase and take a lot of time and resources to compile (Cetron, *et al.* 1971; Lowe, *et al.* 2000; Martino 1995).
- *Combination of economic and other approaches.* These methodologies still focus on the cost benefit or economic factors but also take non-economic factors into account (Sefair and Medaglia 2005; Silverman 1981).
- *Comparative models.* These methods compare different projects or technologies to each other by considering the important factors for selection and then using theoretical models or simulations to select the best alternative (Archer and Ghasemzadeh 1999; Cook and Seiford 1982; Hall and Nauda 1990; Helin and Souder 1974; Martino 1995; Mohanty 1992; Souder 1978; Souder 1978).
- *Optimisation models.* These types of methods seek to optimise some objective function or functions subject to specified resource constraints. Different authors use a number of different objective functions, which are normally economically based, and different constraints to formulate the project selection problem (Carazo, *et al.* 2009; Chapman, *et al.* 2006; Cook and Seiford 1982; Saen 2006; Sener and Karsak 2007; Wang and Hwang 2007).
- *Strategic models.* These models allow allocations of resources to multiple organisational elements, organisational constraints and resources and multiple time periods are considered (Archer and Ghasemzadeh 1999; Bergman and Buehler 2004; Costello 1983; Haung, *et al.* 2009; Kim, *et al.* 1997; Lee and Song 2007; Lowe, *et al.* 2000; Martino 1995; Pecas, *et al.* 2009; Phaal, *et al.* 2006; Singh 2004).
- *Two phase methodologies.* These methodologies normally apply two filters to the selection process. The first filter is designed to filter out the non-promising alternatives and the second filter to select the optimal alternatives(Bard and Feinberg 1989; Khouja and Booth 1995; Shehabuddeen, *et al.* 2006; Yap and Souder 1993).
- *Combination methodologies.* These methodologies combine some of the models already mentioned (Hsu, *et al.* 2010; Kengpol and O'Brien 2001; Kengpol and Tuominen 2006; Lee and Hwang 2010; Malladi and Mind 2005; Prasad and Somasekhara 1990; Shen, *et al.* 2009; Tolga, *et al.* 2005; Yurdakul 2004).

- *Ad hoc methods.* These methods cannot be categorised into the abovementioned categories (Archer and Ghasemzadeh 1999; Hall and Nauda 1990; Martino 1995).

For renewable energy technologies, many alternatives exist, all of which have the ultimate goal of supplying energy in a given situation. The models discussed above can mostly be used to select between the alternatives. The selection of the alternative which will present the best long term impact and sustainable solution depends on the type of data that are used to populate the selected method.

For the purposes of this study, the type of data to be used is referred to as a *framework of factors*. A factor is defined as "a circumstance, fact, or influence that contributes to a result " (Oxford Dictionary 2010). In any selection problem an infinite number of factors can contribute to whether an alternative will provide the best long term solution or not. But it is impossible to consider all these factors in one model and for that reason a framework of factors which addresses the most essential factors is used. The framework of factors has to be selected in such a way that the factors which are crucial for long term impact are included. The framework of factors selected is then imported into one of the selection models and the alternative selected depends on how well the framework of factors has been defined and selected.

To date research has been done on the failure and or success of some renewable technology implementations in Africa. The results of these studies have not been synthesised to produce a framework of factors which can be used to ensure long term impact and sustainability of the renewable energy technology alternative selected. This study therefore focuses on the identification, selection, prioritisation and verification of a framework of factors which can be used to populate one of the selection methodologies discussed, so as to select sustainable renewable energy alternatives in Africa.

1.4. Research motivation and objective

Renewable energy technologies are required in Africa to contribute to sustainable development. Currently many selection methodologies exist for the selection of technology and projects. However, to select the most appropriate alternative, most of these methodologies are dependant on a framework of factors. Currently the framework of factors which needs to be taken into account for the selection of renewable energy technologies in Africa is not clearly defined.

The objective of this research was to develop a structured framework of factors which is empirically validated and can be used for the selection of renewable energy technology alternatives in Africa to ensure long term sustainability of these technologies,

1.5. Research strategy

The new theoretical proposition in the form of a framework of factors was achieved by using a focus group and a Delphi study while testing of the new framework of factors was done with case studies. The new framework of factors generated is a first generation theory as it will still need to be tested in future studies.

The research strategy is shown in Figure 1-5.

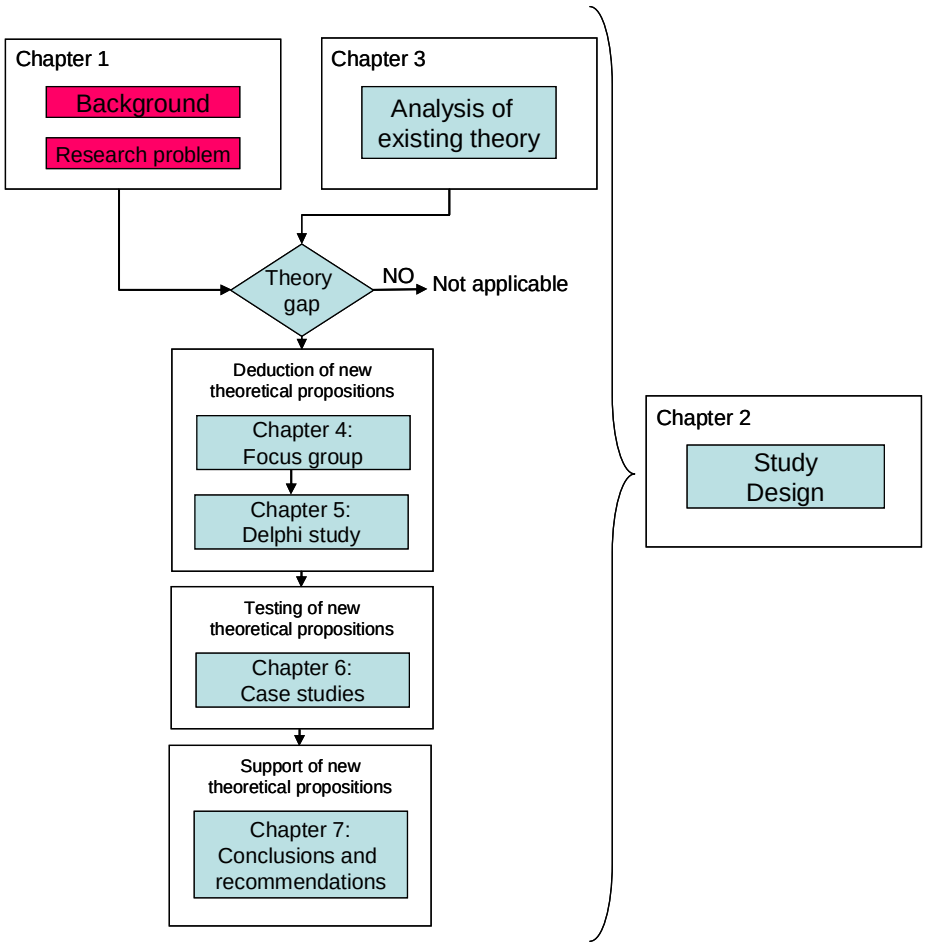


Figure 1-5: Study block diagram

Each of the chapters indicated in Figure 1-6 are discussed in more detail in paragraph 1.6.

1.6. Outline of chapters

Chapter 1 sketches the background to the problem, the research questions and the summarised rationale or methodology of the study.

Chapter 2 addresses the study design and discusses why the various research instruments were selected.

Chapter 3 is an analysis of the current literature on the state of renewable energy technologies and their implementation in sub-Saharan Africa, and also discusses selection methodologies.

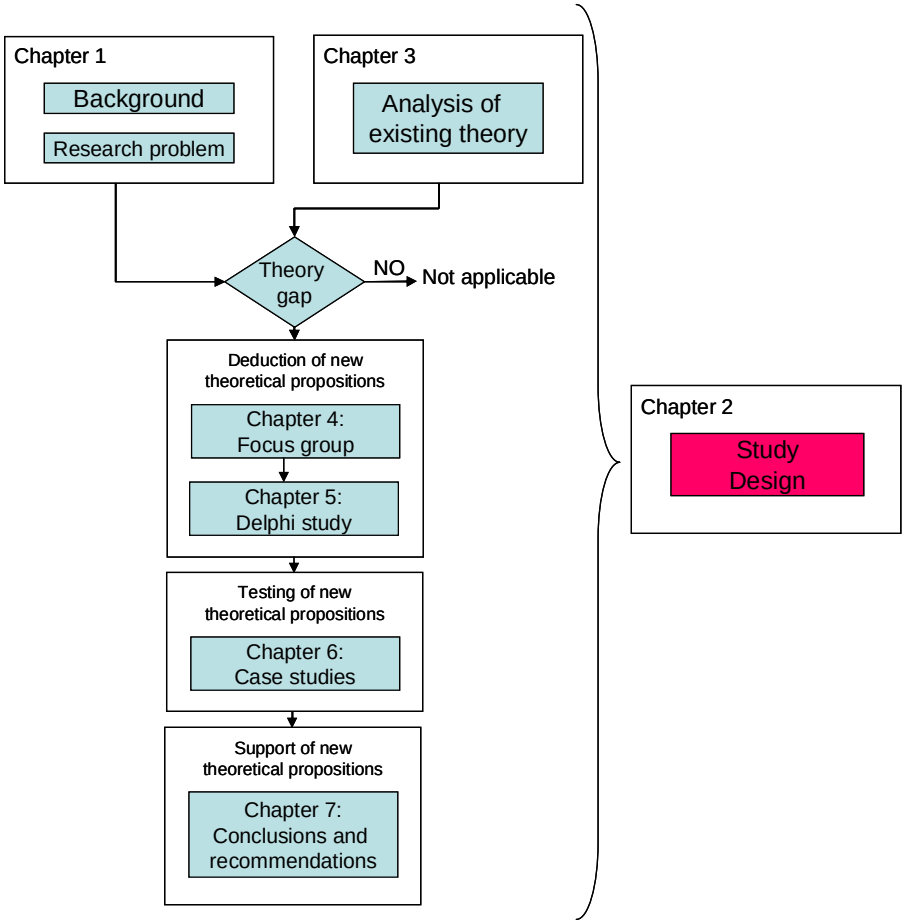
Chapter 4 describes the design, planning, execution and results of the focus group to elicit the first order factors from a group of three experts. This resulted in 38 factors being identified.

Chapter 5 describes the design, planning, execution and results of the Delphi study that used the factors identified in the focus group as a basis and used the expert opinion of seven people over two rounds to identify the eleven most important factors for project selection.

Chapter 6 describes the design, planning, execution and results of the case studies which was conducted in three countries with the goal of validating the factors identified by the Delphi study. The case study confirmed the eleven factors identified during the Delphi study and identified a further two factors that need to be added to the framework.

Chapter 7 discusses the proposed framework, including proposed measures, for the selection of renewable energy technologies in Africa and contains the conclusions and recommendations of the study.

Chapter 2: Study design



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2.1. Research strategy

In the literature on research philosophy, two major research paradigms are discussed namely logical positivism and idealism (Deshpande 1983). The former is a hypothetico-deductive quantitative paradigm whilst the latter is an inductive qualitative paradigm (Deshpande 1983). According to Locke (2007) inductive methods can be successfully used to build theory as an inductive approach proceeds from observed effects to the causes of these effects, whilst the deductive method starts with a theory from which deductions are then made. The theory is built on a accumulation of a great deal of positive data which supports the conclusions drawn with no contradictory evidence. This study is of a theory building nature. Literature exists on the implementation of renewable energy technologies in Africa but a framework for the selection of such technologies has not yet been developed.

True inductive theorising may take many years or even decades (Locke 2007). The approach of this study is to use an inductive approach to develop a first order framework for the selection of renewable energy technologies in Africa that can then be further tested in practice. Inductive research methods such as the focus group, Delphi study and Case studies have been selected.

Any chosen research method will have inherent flaws and the choice of method will always limit the conclusions which can be drawn (Scandura and Williams 2000). For this reason it is essential to obtain corroborating evidence by using a variety of methods. This is also known as triangulation. The use of a variety of methods in examining a topic might result in findings with a higher external validity (Scandura and Williams 2000). In a study on the patterns of research methods in management research across the middle 1980s and 1990s it was found that researchers were increasingly employing research strategies and methods that use triangulation to improve research integrity (Scandura and Williams 2000).

The important factors which need to be taken into account in research design are: generalisability to the population that supports external validity, precision in measurement, control of behavioural variables which affect the internal and construct validity, and realism of context (McGrath, 1982 as cited in Scandura and Williams 2000).

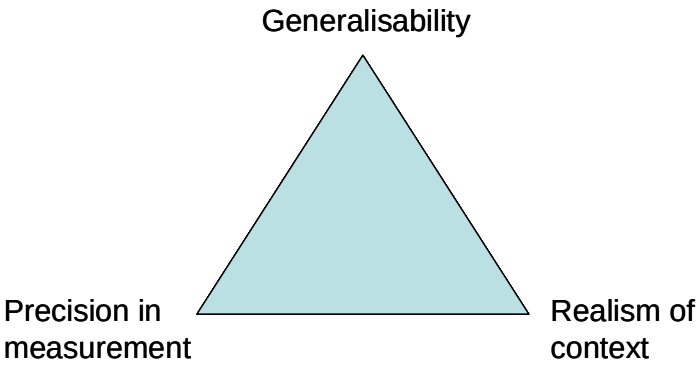

Figure 2-1: Important factors to consider in research design

The methods most commonly used in management research, as evidenced in the Academy of Management Journal, Administrative Science Quarterly and the Journal of Management, are shown in Table 2-1 together with mapping which is also done in terms of generalisability, realism of context and precision of measurement for each research method.

Generalisability to the external population supports the issue of external validity; precision of measurement relates to the control of the behavioural variables affecting internal and construct validity; realism of context relates to how closely the findings are based on available evidence (Scandura and Williams 2000).

Table 2-1: Methods used in management research (adapted from Scandura and Williams 2000)

Description	Explanation	Generalisability	Realism of context	Precision of measurement
Formal theory/ literature surveys	Literature is analysed and summarised in order to conceive models for empirical testing which can involve inductive reasoning and may also present new theories.	↑↑*	↓**	↓
Sample survey	A questionnaire sent to a portion of a population, the results of which are then generalised to the population.	↑↑	↓	↓
Laboratory experiments	Participants are brought into a laboratory and experiments are performed through which the researcher tries to minimise the effect of the laboratory on the results.	↓	↓	↑↑
Experimental simulation	The researcher uses simulated situations or scenarios to obtain data which are then analysed.	↓	↑	↑***

Description	Explanation	Generalisability	Realism of context	Precision of measurement
Field study: Primary data	Investigation of behaviour in its natural setting where the data is collected by the researchers.	↓	↑↑	↓
Field study: Secondary data	Investigation of behaviour in its natural setting where the data is collected by persons or agencies other than the researchers.	↓	↑↑	↓
Field experiment	This involves collecting data in the field but manipulating behavioural variables.	↓	↑	↑
Judgement task	Participants in the study judge or rate behaviour in a contrived setting.	↑	↓	↑
Computer simulation	Data are created artificially or by the simulation of a process.	↑	↑	↓

* ↑↑ - Very high
** ↓ - Low
*** ↑ - High

For this study the following four methods were used for triangulation: literature survey, focus group, Delphi survey, case study. The rating of this study in terms of the most important factors to be taken account for research is shown in Table 2-2.

Table 2-2: Rating of study in terms of most important factors

Description	Generalisability	Realism of context	Precision of measurement
Literature surveys	↑↑	↓	↓
Judgement task – Focus group	↑	↓	↑
Judgement task – Delphi study	↑	↓	↑
Field study: Primary data – Case study	↓	↑↑	↓

Generalisability or external validity of this study is improved by the literature survey and the two judgement tasks. The information gained in the case study is generalised to the theory and not to the larger population. Precision of measurement relates or the control of the behavioural variables affecting internal and construct validity, are high for the two judgement tasks and realism of context is ensured by the use of the case study method.

2.2. Research method

The research method followed in this study is shown in Figure 2-2. The methodologies used are a literature survey to determine the existing literature in the field, a focus group for first order data gathering, a two round Delphi study to confirm factors and to select the most appropriate factors followed by eight case studies in three different countries to confirm the factors in practice. The literature survey is described in detail in Chapter 3. This chapter will describe the methods followed for the focus group, Delphi study and case study respectively.

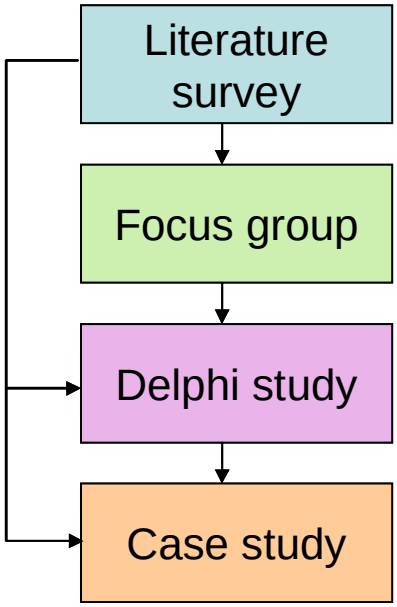

Figure 2-2: Research method

2.2.1. Focus group

The focus group technique is also called the 'group depth interview' or the 'focused interview' in the literature. Different authors ascribe the origin of the focus group method to different sources. Several opinions exist on the growth of the technique: it grew out of group therapy techniques applied by psychiatrists (Hutt 1979), the method originated with market researchers in the 1920s (Robinson 1999) or the technique was developed by Merton and his colleagues for data collection on the effectiveness of World War II training and propaganda films (Blackburn 2000).

Regardless of the origin of focus groups, they have been used successfully in many areas of research. By definition, focus groups are organised discussions or interviews, with a selected small group of individuals (Blackburn 2000; Gibbs 1997), discussing a specific, predefined and limited topic under the guidance of a facilitator or moderator (Blackburn 2000; Robinson 1999). A focus group is also a collective activity, in which several perspectives on the given topic can be obtained, and the data are produced by interaction (Gibbs 1997). A focus group is made up of

individuals with specific experience in the topic of interest, which is explored during the focus group session (Gibbs 1997).

The focus group has the following purposes: basic research where it contributes to fundamental theory and knowledge, applied research to determine programme effectiveness, formative evaluation for programme improvement, and action research for problem solving (Robinson 1999). In this study, the focus group technique was used for basic research with the goal of contributing to the fundamental theory and knowledge of important factors for the selection of energy technologies in Africa.

One of the common uses of focus groups is during the exploratory phase, to inform the development of later stages of a study (Bloor*, et al.* 2001; Robinson 1999). One of the four basic uses of a focus group is problem identification (Morgan 1998). For this reason, it was decided to use the focus group technique in this study to explore the factors which would later be confirmed and rated in the Delphi study.

Focus group research has also been used in many applications. These include: determination of respondent attitudes and needs (Robinson 1999), exploration and generation of hypotheses (Blackburn 2000; Gibbs 1997) development of questions or concepts for questionnaire design (Gibbs 1997), interpreting survey results (Blackburn 2000), pretesting surveys (Ouimet*, et al.* 2004), counselling (Hutt 1979), testing research methods and action learning (Blackburn 2000), identification of strengths and weaknesses and information gathering at the end of programmes to determine outputs and impacts (Robinson 1999).

Focus group research has been applied in many fields including the social sciences, medical applications, market research, media, political opinion polls, government improvements, business, consulting, ethics, entrepreneurship research (Gibbs 1997), education (Ouimet*, et al.* 2004) and health care (Robinson 1999).

The benefits for the focus group participants include the opportunity to be involved in decision making, the fact that they feel valued as experts, and the chance to work in collaboration with their peers and the researcher (Gibbs 1997). Interaction in focus groups is crucial as it allows participants to ask questions as required, and to reconsider their responses (Gibbs 1997).

The advantages of the focus group method are many and include:

(i) An effective method of collecting qualitative data as common ground can be covered rapidly and inputs can be obtained from several people at the same time (Hutt 1979; Ouimet*, et al.* 2004).

(ii) During discussions, the synergistic group effort produces a snowballing of ideas which provokes new ideas (Blackburn 2000; Gibbs 1997).

(iii) Data of great range, depth, specificity and personal context are generated (Blackburn 2000).

(iv) In the process, the researcher is in the minority and the participants interact with their peers (Blackburn 2000).

The disadvantages include:

(i) Not all respondents are comfortable with working in a group environment and may find giving opinions in the bigger group intimidating (Gibbs 1997; Ouimet, *et al.* 2004).

(ii) The outcome can be influenced by the group effect in that the opinion of one person dominates, or some are reluctant to speak and an opportunity is not given for all participants to air their views (Blackburn 2000).

(iii) The researcher has less control over the data than in, for example, a survey because of the open-ended nature of the questions (Gibbs 1997).

The disadvantages can be mitigated by ensuring that the moderator has sufficient skills, that the data collection is reliable and that rigorous analytical methods are used (Blackburn 2000).

The purpose of the focus group in this study was to obtain the opinions of the group at the Council for Scientific and Industrial Research (CSIR), tasked with assisting the New Partnership for Africa's Development (NEPAD) to select sustainable energy research projects for Africa, in terms of the most important factors for the selection of these projects.

The main objectives of the focus group were as follows:

- Inform the focus group participants of the purpose and future plans of the study.
- Identify as many factors as possible which should be considered when selecting sustainable energy projects in Africa to be used as an input to the Delphi study.
- Identify knowledgeable participants for the Delphi study.

2.2.2. Delphi technique

2.2.2.1. Introduction

The Delphi technique, as first pioneered at Rand by Dalkey, Helmer and Rescher is an example of Lockean inquiry (Mitroff and Turoff 1974). The Lockean philosophy is based on the premise that truth is experiential and consequently the content of a system is entirely associated with its empirical content. Every complex proposition can be broken down into simple empirical observations. The validity of simple observations is obtained by agreement between human observers. The truth of the model does not rest on any theoretical considerations.

A Delphi study is Lockean as it uses raw data in the form of expert opinion and the validity of the resulting judgment is measured in terms of the consensus between experts (Mitroff and Turoff 1974).

Lockean inquiry systems should be used when the problem is well-structured and a strong consensual position exists on the nature of the problem situation. This makes a consensus-oriented Delphi appropriate for technological forecasting but inappropriate for technology assessment, objective or policy formulation, strategic planning and resource allocations analyses (Mitroff and Turoff 1974).

The Leibnizian philosophy on the other hand is based on the premise that truth is analytic and therefore based on theory. The truth of a model is based on its potential to offer a theoretical explanation for a range of general phenomena. The truth of the model further does not rest on any raw data from the external world. The theoretical model is not only considered to be separate from the raw data but is also considered to be prior to it (Mitroff and Turoff 1974).

In terms of Delphi, Leibnizian philosophy is often used to attack the scientific nature of Delphi studies. This happens when “being scientific” is equated with what is Leibnizian. Delphi studies have been improved by these criticisms but in the final analysis our understanding of human thought and decision processes is still too rudimentary to expect a generally valid formal model of the Delphi process (Mitroff and Turoff 1974).

Kantian philosophers believe that the truth is synthetic and both theoretical and empirical components are required (Mitroff and Turoff 1974). A Kantian model is measured in terms of its potential to associate every theoretical term with an empirical referent and how the underlying collection of every empirical observation can be associated with the theoretical referent. In this case neither the data input nor the theory has priority. The Kantian philosophy further advocates the examination of as many alternatives as possible.

Kantian Delphis have the explicit purpose of eliciting as many alternatives as possible so that a comprehensive overview of the issue can be taken. The design structure allows for many informed individuals in different disciplines or specialties to contribute information or judgments to a problem area to cover a much broader scope of knowledge than any one individual possesses.

Singerian-Churchmanian philosophy is based on the premise that truth is pragmatic (Mitroff and Turoff 1974). This means that the truth content of a system is relative to the overall goals and objective of the inquiry. In this philosophy, a model of a system is explicitly goal oriented. It is based on holistic thinking as no single aspect of the system has fundamental priority over any other aspect.

The Delphi used in this study was made up of a combination of the above philosophies. The focus group was Kantian in nature as panel members were asked to identify as many possible factors as that they could think of. The first round of the Delphi was also of a Kantian nature. The Delphi as a whole was Kantian as many experts from diverse fields of expertise on sustainable energy projects were asked to

participate. This included technical experts, non governmental experts, academics, social scientists and researchers.

The later rounds of the Delphi were Lockean as an attempt was made to reach consensus on the most important factors for the selection of sustainable energy projects.

The entire study had a Singerian-Churchmanian approach in that an attempt was made to use holistic thinking through a triangulation of methods.

2.2.2.2. Contrasting Delphi with other methods

Various factors need to be considered before selecting a research method. This is a problem which does not have previous research or models to support it. A group decision making process is required as experts are available who have experience in the field. It is a complex open ended problem. When insufficient or contradictory information is available on a subject, a consensus method such as the interacting group method, brainstorming, nominal group technique or Delphi survey, can be used (Delbecq*, et al.* 1975; Hasson*, et al.* 2000).

The interacting group method is an unstructured meeting which is held to arrive at a decision (Delbecq*, et al.* 1975). The nominal group technique is based on a structured meeting in which members of the group write down their ideas before there is any discussion. The ideas are then recorded and presented to the group by round robin sharing. The ideas are discussed and then a vote is taken. Priority or consensus is mathematically derived through rank ordering or rating (Delbecq*, et al.* 1975).

The Delphi technique involves a structured series of questionnaires or surveys which is sent to participants for individual comment and rating. The results are then collated and fed back to the participants for reconsideration given the comments of the other participants (Crichter and Gladstone 1998). The Delphi study may involve several rounds. Priority or consensus is also mathematically derived. A comparison in terms of group interaction between the interacting group method, nominal group technique and the Delphi technique is shown in Table 2-3.

Table 2-3: Comparison of group interaction issues for group decision techniques (adapted from Delbecq, *et al.* 1975)

Group interaction issue	Interacting group method	Nominal group technique	Delphi technique
Role orientation of groups	Social-emotional focus	Balanced socio-emotional and task instrumental focus	Task-instrumental focus
Normative behaviour	Inherent conformity pressures	Tolerance for non-conformity	Freedom not to conform

Group interaction issue	Interacting group method	Nominal group technique	Delphi technique
Equality of participation	Member dominance	Member equality	Respondent equality in pooling of independent judgements
Methods of conflict resolution	Person-centred: Smoothing over and withdrawing	Problem-centred: Confrontation and problem solving	Problem-centred: Majority rule of pooled independent judgements
Closure to decision process	Lack of closure: Low perception of accomplishment	High closure: High perception of accomplishment	High closure: Medium perception of accomplishment

From Table 2-3 it can be seen that in terms of group interaction, the nominal group technique and Delphi technique seem to deliver the best results.

Table 2-4 shows a comparison between the different group techniques in terms of task related issues. From this table it is clear that the nominal group technique and Delphi technique deliver the best results. The nominal group technique is slightly superior because participants have better task motivation as a result of the social interaction.

Table 2-4: Comparison of task related issues for group decision techniques (adapted from Delbecq, *et al.* 1975)

	Interacting Group method	Nominal group technique	Delphi technique
Relative quantity of ideas	Low; focused "rut effect"	High; independent thinking	High; isolated thinking
Relative quality and specificity of ideas	Low quality; generalisation	High quality; high specificity	High quality; high specificity
Search behaviour	Reactive; short problem focus; task avoidance tendency; new social knowledge	Proactive; extended problem focus; high task centeredness; new social and task knowledge	Proactive; controlled problem focus; high task-centeredness; new task knowledge
Task motivation	Medium	High	Medium

Table 2-5 shows a comparison of the practical considerations for the different group decision making techniques. The table clearly shows that participant costs are lowest for the Delphi technique if participants are not geographically co-located and that the participant working hours is the lowest for the Delphi technique. The problems of course are that the calendar time taken is longer and that the administrative effort is higher. For this specific study however, participants were geo-

graphically dispersed and it was not possible to get them together for face to face meetings. Calendar time was also not of high importance. As long as this part of the study could be completed in about two months, which is possible using the Delphi technique, it was deemed acceptable.

Table 2-5: Comparison of practical considerations for group decision techniques (adapted from Delbecq, *et al.* 1975)

	Interacting Group method	Nominal group technique	Delphi technique
Participant working hours	High amount of hours required	High amount of hours required	Few hours required compared to other methods
Participant costs	High if not geographically co-located	High if not geographically co-located	Low
Calendar time	Relatively short	Relatively short	Relatively long
Administrative cost	Low	Low	High

Face to face meetings, especially when using the interacting group method, often lead to direct confrontation which can force participants to hastily formulate preconceived ideas and to close their minds to new ideas. There is also a tendency to defend a specific standpoint or be predisposed to change a standpoint because of the persuasiveness of other ideas. Delphi on the other hand is more conducive to independent thinking because it allows participants to gradually formulate and consider opinions (Dalkey and Helmer 1963).

Several different definitions are given for the Delphi technique. Delphi is a process for structuring group communication so that it is effective in allowing a group of individuals to deal with a complex problem (Linstone 1974). It is further a method of aggregating the judgments of a number of experts to improve the quality of decision-making (Delbecq, *et al.* 1975).

Another element of the technique is that participants can reconsider judgements and that is especially useful when the problem does not lend itself to precise analytical techniques (Crichter and Gladstone 1998). The technique is useful when objective data are scarce or the development of a mathematical computer model is too difficult or expensive (Gibson and Miller 1990).

In the Delphi process there are a number of rounds and feedback is given to the participants after which they are given an opportunity to modify their responses. Another element of the technique is anonymity of the responses. Delphi studies vary in application in panel size, composition and selection of panel, questionnaire design, number of rounds, form of the feedback and modes of reaching consensus. In

Delphi studies good research practice both in terms of qualitative and quantitative research should be followed (Mullen 2003).

In the literature numerous advantages of Delphi are given, including:

- Participants are forced to think through the complexity of the problem and submit specific, high quality responses because of pressure of a written response (Delbecq, *et al.* 1975)
- The anonymity of the method implies that participants will be free from conformity (Crichter and Gladstone 1998; Delbecq, *et al.* 1975; Gibson and Miller 1990). Anonymity also enables individuals to respond as individuals and not as members of the organisations they belong to (Crichter and Gladstone 1998). Participants can give an honest expression of views without intimidation, peer pressure or inhibition (Mullen 2003).
- Isolated idea generation produces high quality ideas (Delbecq, *et al.* 1975).
- The fact that responses are written allows experts to fit Delphi into their busy schedules (Gibson and Miller 1990).
- Participants have proactive search behaviour as they do not react on the ideas of others (Delbecq, *et al.* 1975)
- There is equality of participation because ideas and judgements are pooled (Delbecq, *et al.* 1975)
- Participants have a moderate sense of closure .and accomplishment on completion of the study (Delbecq, *et al.* 1975)
- The technique is suitable for studies in which the experts are geographically isolated and when it is not practical or too expensive to bring them together (Crichter and Gladstone 1998).
- Participants benefit from learning from the responses of the other participants as they are fed back to them during the study (Gibson and Miller 1990).
- Participants can revise their initial opinions in the light of other expert responses (Gibson and Miller 1990). This means that participants can change their viewpoints without public exposure.(Crichter and Gladstone 1998; Mullen 2003)(Hasson, *et al.* 2000).
- The technique is effective in developing consensus when solving complex problems (Delbecq, *et al.* 1975).

The Delphi technique has disadvantages which include the lack of opportunity for socio-emotional rewards in problem group solving, the lack of opportunity for verbal clarification which can create communication and interpretation difficulties. The pooling of ideas and adding of votes promotes majority rule which means that conflicts are not necessarily resolved (Delbecq, *et al.* 1975).

There are drawbacks in applying the Delphi technique. Delphi technique was severely criticised as it was averred by Sackman (1974) that the Delphi technique was scientifically suspect on the following grounds:

- A crude questionnaire design
- A lack of minimum professional standards for opinion item analysis and pilot testing
- A highly vulnerable concept of expert
- A poor possibility for reliable measurement and scientific validation of findings
- A confusing aggregation of raw opinion with systematic prediction
- Virtually no serious literature to test basic assumptions and alternative hypotheses
- No disclosure of names and consequently no individual accountability

According to Delphi commentators, Sackman (1974) did make a valid point in terms of the way in which the technique is often applied. Sackman's criticisms were however successfully refuted by Goldschmidt (1975). Delphi deals with areas which do not lend themselves to traditional scientific approaches and a Delphi survey is not an opinion poll as in survey research and therefore the same criteria cannot be applied (Mullen 2003). Woudenberg (1991) concludes that the main claim of Delphi that it removes negative effects of unstructured, direct interaction cannot be substantiated. He further notes that Delphi is good at obtaining consensus but that this is as a result of strong group pressure to conform. His study focused on quantitative Delphis which he evaluated negatively. Crichter and Gladstone (1998) wrote that a lot of the criticism against Delphi results from the fact that Delphi straddles the divide between quantitative and qualitative research and has hybrid epistemological status.

Gibson and Miller (1990) added to the debate by agreeing that although Delphi cannot be considered to be a quantitatively rigorous procedure, it is the best alternative solution when data are scarce and resources for a large-scale model are not available. They maintained that usefulness may prove to be the most important criterion for determining the success of this type of study in that it can help identify and specify the issues on which the greatest difference of opinion exists. Delphi can further identify areas of general agreement and enable the discovery of new ideas and solutions to problems which were not recognized before.

Crichter and Gladstone (1998) noted that Delphi presents technical difficulties in that the method has to be readapted every time it is applied. They further pointed out the difficulties of balancing closed and open-ended responses. They showed that the estimation of time for completion to give participants an indication of how much of their time is required for the questionnaire can be problematic and that one has to be careful not to construct artificial consensus when using the method. In summary, they stated that as with any social science tool, Delphi can be applied inappropriately by accident or through intent. To offset this potential difficulty Reid (1998, as cited in

Hasson, *et al.* 2000) suggests that the decision to employ the Delphi technique should be based on appropriateness of possible alternatives.

It was decided to use the Delphi technique in this part of the study with due caution. Firstly, a group decision technique needed to be selected as individual judgements needed to be investigated and combined to determine the most important factors for sustainable energy project selection. Much has been written in the literature about selection methods. However, only expert knowledge is available on the factors important for the selection of sustainable energy technologies in Africa. Secondly the persons with the necessary expertise on the subject were geographically dispersed. A further advantage of the Delphi technique was the fact that the time required from participants was minimised to ensure participation.

Other research methods, including a literature survey, the focus group technique and case study were used in conjunction with the Delphi method in this study.

The comparison between the Delphi method and the traditional survey method is shown in Table 2-6.

Table 2-6: Comparison of traditional survey with Delphi method (adapted from Okoli and Pawlowski 2004)

Evaluation criteria	Traditional survey	Delphi study
Summary of procedure	A questionnaire addressing the relevant issues is designed. Various issues concerning the validity of questions must be considered to develop a good survey. The survey can solicit qualitative and or quantitative data. A population that the hypotheses applies to is selected and the survey is then administered to a random sample of this population. The respondents choose to fill out the survey and return it. The usable responses are then analysed to investigate the research questions.	The issues about survey validity are also applicable to a Delphi study. An appropriate group of experts is selected on the basis of their qualification to answer the questions. The survey is administered and a next survey developed based on the analysis of the first survey. The second survey gives feedback to the participants and asks them to revise their original responses based on the feedback. The process is repeated until a satisfactory degree of consensus is reached. The respondents are anonymous to each other throughout the process.
Representative sample	Statistical sampling techniques are used to select a representative sample of the population of interest.	Questions normally investigated using the Delphi method are those with high uncertainty. A general population or subset of one might not have sufficient knowledge to answer the Delphi question properly. Delphi is a group decision technique used to overcome this by consulting expert opinion.

Evaluation criteria	Traditional survey	Delphi study
Sample size for statistical power and significant findings	A statistically significant sample size is required to detect statistically significant effects in the population. Power analysis is required to determine appropriate sample size.	The size of the Delphi panel is not dependant on statistical power but rather on group dynamics for arriving at consensus among experts. The literature recommends between 7 and 20 experts on a Delphi panel.
Individual vs group response	Researchers use the average of the individual's responses to determine the average response for the sample which is then generalised to the general population.	Studies have consistently shown that when questions require expert judgement, the average group response produces a better result than the average individual response. Research has shown that the Delphi method bears this out.
Reliability and response revision	An important criterion for the evaluation of surveys is the reliability of the measures. This is usually assured by pretesting and retesting to ensure test-retest reliability	Pretesting is also an important reliability assurance for the Delphi method. However, test-retest reliability is not relevant, since the method is based on the idea that participants will revise their responses.
Construct validity	Construct validity is assured by careful survey design and pretesting	Construct validation can be employed by asking participants to validate the researcher's interpretation and categorisation of the variables.
Anonymity	Respondents are always anonymous to each other and often to the researcher.	Respondents are always anonymous to each other but not necessarily to the researcher. This presents the researcher with the opportunity to follow up with the respondent for clarification and further qualitative data.
Non-response issues	Researchers need to investigate the possibility of non-response bias to ensure that the sample remains representative of the population.	Non response is typically very low in Delphi surveys if respondents are personally contacted and encouraged to participate. The research also shows that those who agree to participate are not necessarily biased.
Attrition effects	This is not applicable to single surveys but in multi-step surveys; attrition should be investigated to ensure that it is random and non-systematic.	As with non-response, attrition tends to be low in Delphi studies and the cause can easily be ascertained by contacting the drop outs.
Richness of data	The richness of data obtained by surveys is dependant on the form and depth of the questions asked. Follow-up is often limited as researchers might be unable to track respondents.	Delphi studies inherently provide richer data because of the iterations and the fact that open questions are asked. Delphi respondents tend to be open to follow-up interviews.

The survey technique which is statistically more valid could not be used in this study. In the first place the population of possible respondents was not large enough and in the second place the problem was not well defined enough to lend itself to the survey method.

2.2.3. Case study

2.2.3.1. Introduction

There are certain generic factors which have necessarily to be taken into account when selecting sustainable energy projects in Africa. These factors have been defined and prioritised during the Delphi study. The purpose of the case study research is to determine whether the factors identified during the Delphi study influence the success of implementation of renewable energy technologies in sub-Saharan Africa in the real-world context.

There are several steps to follow for a successful case study implementation. A combination of what is advocated by George and Bennett (2005) and Yin (2003) in terms of the phases of a case study is shown in Figure 2-3.

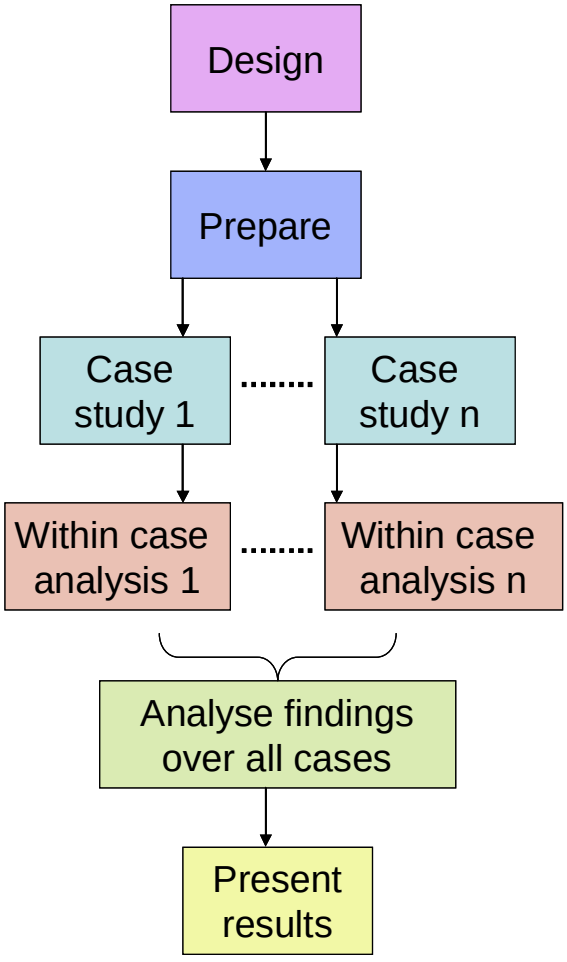

Figure 2-3: Phases of a case study

These were the phases that were applicable to this case study. The phases consisted of the design of the case studies; preparation for the case studies by drawing up questionnaires with the outputs from the Delphi study; performing the case study interviews and collecting the secondary data; analysing each case study on its own; analysing the findings over all the cases; and presenting the results of the case studies.

2.2.3.2. Definition of the case study method

A case study is a research strategy which is used to test a contemporary phenomenon in a real-life scenario and is especially helpful where the boundaries between the phenomenon and the scenario are not clearly defined (Yin 2003). The following areas make use of the case study method according to the literature - psychology, sociology, political science, social work, business, community planning, economics, teaching devices.

The case study undertaken in this study was to test whether the factors which had been identified from the literature survey and the two judgement tasks (i.e., the Focus group and Delphi study) were implemented in practice, would be useful in practice and could be implemented in practice.

George and Bennett (2005) propose the following six theory building research objectives for case studies namely:

- *Theoretical/ configurative idiographic case studies.* These studies do not directly contribute to theory but provide good descriptions for use in subsequent theory building research. Many of the current case studies in renewable energy technologies in Africa are of this nature.
- *Disciplined configurative case studies.* These studies use existing theory to explain a case by testing theory.
- *Heuristic case studies.* These studies are used to identify new variables, hypotheses, causal mechanisms and causal paths.
- *Theory testing case studies.* These studies are used to test the validity and scope conditions of single or competing theories.
- *Plausibility probes.* These studies are used to test untested theories and hypotheses to determine whether more in depth testing is warranted.
- *Building block studies.* These are single case studies or multiple case studies with no variance which can be used as parts of larger contingent generalisations and typological studies.

Eisenhardt (1989) proposes the use of case studies for building theories and proposes the following steps: definition of the research question and possible a priori constructs; case selection based on theoretical sampling; crafting multiple data collection instruments and protocols; collecting data whilst overlapping with within

case analysis; shaping of hypotheses by tabulation of evidence for each construct; comparison with conflicting and similar literature; and reaching closure.

In his seminal paper on case study research, Flyvbjerg (2006) notes that there are five main misunderstandings around case study research. These misunderstandings and the way that he proposes to clarify them are summarised in Table 2-7.

Table 2-7: Summary of misunderstandings and clarifications (Flyvbjerg 2006)

Misunderstanding	Clarification
General theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge	Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals.
One cannot generalise on the basis of an individual case; therefore the case study cannot contribute to scientific development	One can often generalise on the basis of a single case, and the case study may be central to scientific development via generalisation as supplement or alternative to other methods. But formal generalisation is overvalued as a source of scientific development, whereas "the force" of example is underestimated.
The case study is most useful for generating hypotheses; that is, in the fist stage of a total research process, whereas other methods are more suitable for hypothesis testing and theory building	The case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone.
The case study contains a bias towards verification, that is, a tendency to confirm the researcher's preconceived ideas.	The case study contains no greater bias toward verification of the researcher's preconceived notions than other methods of inquiry. On the contrary, experience indicates that the case study contains a greater bias toward falsification of preconceived notions than toward verification.
It is often difficult to summarise and develop general propositions and theories on the basis of specific case studies	It is correct that summarising case studies is often difficult especially as concerns case process. It is less correct in respect of outcomes. The problems in summarising case studies however, are more often the result of the properties of the reality studied than the case study as a research method. Often it is not desirable to summarise and generalise case studies. Good studies should be read as narratives in their entirety.

2.2.3.3. Quality in case studies

Yin (2003) lists the following tests that are applicable to case study research to ensure that they are of the highest quality: construct validity; internal validity; external validity and reliability. These tests, together with the case study tactics to improve quality and the phases in which these tactics are applicable.

2.2.3.4. Case study design

> *Certainly the case study as normally practiced should not be demeaned by identification with the one-group post-test-only design – Cook & Campbell (1979, as cited in Yin 2003)).*

The first phase in any case study application is research design. Research design is the plan for getting from "here" i.e., the current knowledge to "there", i.e., the conclusions of the study. This is graphically shown for this study in Figure 2-4. In this study "here" is defined as the factors that were confirmed during the Delphi study. In order to get to "there" which is the practical validity of the factors, the case study research questions were formulated, it was decided which data is relevant and should be collected and it was decided how to analyse the results.

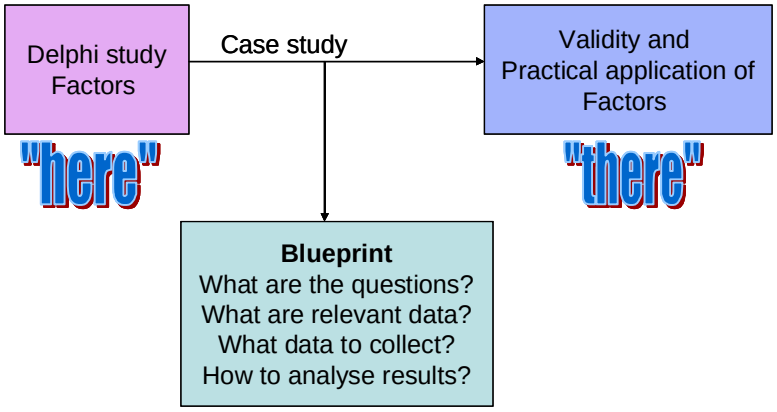

Figure 2-4: Graphical presentation of the research design (adapted from Yin 2003)

Yin (2003) lists the following five components to consider for a research design namely, questions of the study, propositions of the study if any, unit(s) of analysis to use, the logic linking the data to the propositions and the criteria to be used to interpret the findings. The steps in the design of a case study as advocated by George and Bennett (2005) are shown in Figure 2-5. This design process is iterative and may require several iterations.

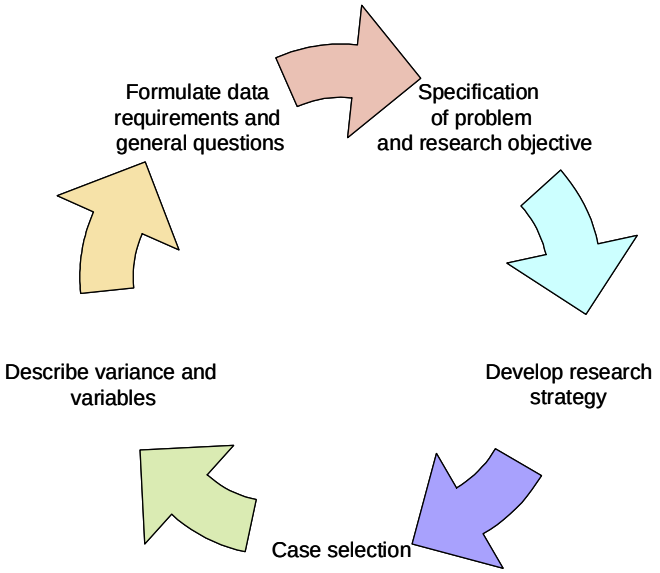

Figure 2-5: Steps in case study design (George and Bennett 2005)

For purposes of this study the approaches advocated by George and Bennett (2005) and that of Yin (2003) were combined into the following steps:

1. *Specification of problem and research objective.* For this step the questions and propositions as advocated by Yin (2003) were defined.
2. *Development of research strategy*. In this step the unit of analysis was determined, the dependant and independent variables were defined, and the logic linking the data and propositions was defined.
3. *Case selection.* Cases with variance in the dependant variables were selected. A preliminary questionnaire was sent out to enable the researcher to select suitable cases.
4. *Description of variance in variables.* The variance in each variable selected in step 1 was described in terms of the type of evidence, either quantitative or qualitative outcomes.
5. *Formulation of data requirements and general questions*. This step indicated the logic linking the data to the propositions as well as the criteria used for interpreting the data. This step also specified the type of data collection method e.g. fieldwork, archival records, verbal reports, observations, ethnography etc.

2.3. Conclusion

This chapter was a discussion of the research method followed in this study. There was an evaluation of the triangulation process utilised with specific emphasis on the three methods used, namely, the focus group, the Delphi technique and the case study. In conclusion, it was decided to use a focus group to gather the initial factors, followed by a Delphi study to prioritise the factors. The Delphi study was then followed by case study research to confirm the factors identified and prioritised during the Delphi study. In the chapters which follow, the process and results for each of these methods is discussed in detail.