Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Overview of the Study

Climate change response decisions that solve the twin problem of responding to the risks posed while simultaneously providing maximum value for an organisation hold tremendous worth. Decision making in response to climate change challenges is being complicated by a number of factors, including the heterogeneous nature of stakeholders and the associated diversity of their vested interests; the need for concerted effort globally, thus requiring cooperation while still competing; the length of the cause-effect-mitigation-results cycle (spans many decades and generations); the multiplicity and often conflicting objectives; the limited scientific and social understanding of the ecological phenomenon at play; and the uncertainty of mitigation and/or adaptation results and outcomes. Most businesses face the daunting challenge of being champions of sustainable economic development as called for by the King III, the Global Reporting Initiative (GRI), Principles of Responsible Investing and other corporate governance standards. The fact that the impacts of climate change can potentially undermine business progress and economic sustainability calls for methodologies and tools that allow for calculated and well thought through responses and investment choices.

Decision making involving a world-wide phenomenon such as climate change draws in considerations for interdependencies within society (governments, communities, businesses, individuals and the whole of humanity) and organisational structures, systems, policies and processes, which are often marred by a multitude of risks and uncertainties. Climate change response presents problems and challenges with an assortment of diverse and often conflicting objectives in an organisation (Raymond & Brown, 2011). Often these objectives cannot be represented or measured in monetary units alone. Executives in organisations are faced with judgments that cannot be reduced to indubitable financial numbers. There is no single solution to such problems, instead multiple objectives have to be met and optimised before a solution can be arrived at (Jagannathan & Meier, 2002). When a decision problem concerns multiple objectives, captured by multiple attributes or criteria, the choices become complex, as do the consequences and implications. To effectively arrive at an optimal solution, decision making frameworks and tools are required. In this study, the decision making model developed caters for the following:

- The interconnectedness of climate change response systems (society and business)
- Climate change dependency on national and international policies
- The presence of multiple objectives and their trade-offs
- The difficult task of characterising risks and uncertainties

In the study, decision science valuation methodologies are used to derive information about business executives' values through deliberate processes that help them assess trade-offs among multiple criteria. The ultimate goal of the study is to have executives state their preferred response options to climate change challenges and ultimately arrive at a set of implementable solutions, while recognising that these options do differ along a spectrum of relevant parameters and dimensions, thus suggesting that trade-offs must be made when choosing the most appropriate response strategy.

In his study of the net present value (NPV) model as a decision model, Magni (2009) concluded that decision makers in real life use a subjectively determined hurdle rate as opposed to the computed opportunity cost of capital to make investment choices, in order to cater for context-specific and project-specific aspirations. Jagannathan and Meier (2002) and McDonald (2000) reached similar conclusions, that by using hurdle rates, companies take into account key aspects of the behavioural and organizational contexts in which investment decisions occur. Magni (2009) postulated that actual strategic choice behaviours use the hurdle-rate heuristic as a satisficing strategy (Simon, 1955), allowing decision makers to not confine themselves to equivalent-risk alternatives. Instead, the behaviourally based models of decision making allow executives to have adequate regard for constraints in time, knowledge, computational capacities that humans face (Gigerenzer, 2006), or strategic and expiring investment decisions where first mover advantages or compliance and/or regulatory and social justifications might have commitment, reputational or other values, rather than monetary. These findings suggest that there is merit in making strategic decisions along the bounded-unbounded rationality dichotomy, thus bringing together the normative and the behavioural-based models of decision making.

Multi-criteria decision analysis allows decision makers to choose among, prioritise and generate the most feasible menu of acceptable investment choices and levels based on a multiplicity of

criteria (Steuer & Na, 2003). The solution derived is generally a set of points on a surface, in up to *k* dimensions (where *k* is the number of objectives), that all fit a predetermined definition of an optimum, commonly referred to as Pareto Optimality (Pareto, 1906).

This study utilises the analytical hierarchy process (AHP) method of multi-criteria decision analysis to solve the climate change challenge. The climate change problem is a continuous one, with mathematical models including decision variables, constraints and multiple objective functions (environmental, economic and social). For example, trading off environmental impacts against economic impacts is a challenge for all climate change response strategies, for both businesses and the government (Raymond & Brown, 2011). Similarly, some social repercussions have to be forgone in favour of tackling climate change issues. These and several other trade-off scenarios comprise the multitude of parameters and objectives that any climate change response strategy must address.

1.2 Overview of Multi-criteria Decision Analysis

Recent research and practical work in the decision sciences has focused on ways to help structure and improve the process by which people make environmental risk and resource management decisions (Arvai & Gregory, 2003; Failing *et al.*, 2004; Trousdale & Gregory, 2004; Hostmann, 2005; Gregory *et al.*, 2006; Arvai *et al.*, 2007). Dissatisfaction with classical theory and attempts to replace the basic model of the rational man with alternative decision models are not new. Papers written by Herbert Simons as early as the 1950s have inspired the notion that the procedural aspects, as well as the contexts of decision making in complex environments, are as important as the decisions reached (Simon, 1955; Simon, 1956). Much of this research has been inspired by work stemming from the psychology and economics fields, and more recently finance, which propose that for many unfamiliar and complex decision contexts, decision makers' preferences and preference orders are not well formed. For example, it is not always possible to estimate the values of all upcoming investments options and choices or assign probability distributions to how they will arise (Jagannathan & Meier, 2002). Instead the preferences are constructed, refined and revealed based on how they process certain cues that may be apparent or implicit, iteratively (Arvai *et al.,* 2007; Magni, 2009).

Recent interest in the modelling process, as well as the substance, stems from the observation that decision makers are not equally capable of analysing a situation, even when presented with exact same information (Gigerenzer, 2006). There is also a large variation in the hurdle rates of companies within the same sector facing similar systematics risks. The difference in the economic success of two companies operating within the same industry and geographic boundaries, with comparable financial and other resources, is attributed to these issues. Agency theory, cost of financing, decision makers' values and predispositions towards risk determine the course of action by specific entities, which is consistent with the bounded rationality approach suggested by Simon (1955).

Another complexity brought about by the climate change challenge is that satisfying the three overarching objectives of environmental, economic and social dimensions violates an accepted normative economics and finance standard, termed value additivity. Magni (2009) showed that the net present value of a portfolio of independent projects does not equal the net present value of the individual projects represented therein. This is commonly referred to in the behavioural economics and finance literature as mental accounting (Soman, 2001; Thaler, 1999), which brings about a bias known as framing effects (Kahneman & Tversky, 2000).

The overall goal of multi-objective optimisation is to identify the optimal alternative within a set. The manner in which a decision maker addresses trade-offs is a key part of the process. The main question to be asked repeatedly as the iterations proceed is, how much of one objective (e.g. reputational risks from climate change) is the company willing to give up to obtain higher levels of achievement of another objective (e.g. profitability)? Trade-offs, however, are highly subjective. Experiments and research in the fields of bounded rationality (Simon, 1955; Rubenstein, 1998), behavioural finance (Flyvbjerg *et al.*, 2009, 2005; Klein, 2010) and behavioural economics and behavioural strategy (Lovallo *et al.*, 2007; Baghai *et al.*, 2009; Lovallo & Sibony, 2010) have revealed a plethora of universal human biases, such as loss aversion, over-optimism, anchoring, framing, and mental accounting, that can negatively affect such types of strategic decisions.

1.3 The Concept of Bounded Rationality

Before Simon (1955), it was commonly believed that humans came to optimal decisions in a rational manner, based on the information provided. The rational man theory suggest that decisions are arrived at by taking data that is accessible, weighing the pros and cons and using cognition to arrive at the best possible outcome. Butler (1991: 43-44) described the rational model succinctly as follows: "The overall picture presented by the rational model is of active, highly alert decision makers, clear about their objectives, who search until they are in command of a great deal of information and who are knowledgeable about possible solutions, who are then in a position to choose the best course of action which then proceeds to be authorized and implemented. Decision making is a sequence of steps which, if followed, should lead to the best solution; that is, to action which optimizes the decision maker's utilities". The implication of this statement is that decisions that can be made algorithmically, as by a computer, are rational.

The rational model presumes that problems recur frequently and that solutions for problems do already exist. Simon (1955) argued that making decisions using such a paradigm was too onerous cognitively as there was too much information available. Instead, he argued that humans make choices based more on heuristics, cutting the available information down to a more manageable level, and choosing which information to utilise - termed 'satisficing', from the merger of the two words 'satisfy' and 'suffice'. This expresses the fact that decision makers seek satisfactory rather than optimal solutions (Simon, 1996). Simon (1955) also emphasized the difference between substantive rationality (concerned with the result or goal) and procedural rationality (concerned with the process by which the result is obtained).

The understanding that humans are bounded in many dimensions, particularly in their rationality, self-control and self-interest (Evensky, 2005; Ashraf *et al.,* 2005; Kahneman & Tversky 1979a) has been proven in many everyday applications. Bounded rationality manifests in complex decision making as a result of a limit to the amount of information available, the cognitive limitations of the mind and the amount of time available in which to make a decision. Because of this, humans have been known to appeal to heuristics and rules of thumb when making decisions, particularly in complex decision problems, resulting in biased probability judgments and not maximizing expected utility. Conlisk's 1996 paper identified several studies and areas where humans have been shown to appeal to heuristics and biases, including:

mistaking random data for patterned data; making insufficient adjustments in the face of new information; exhibiting overconfidence in forecasting; making judgments or estimations of the probability of some random event; placing different values on opportunities depending on how they are framed; placing different value on confirming versus disconfirming evidence relative to initial judgments; using irrelevant, out-dated or more vivid information; under-using or ignoring relevant information; making wrong causality inferences; maintaining the status quo; misapplying statistical dependence and independence; failing to discount for the future regularly; making sub-optimal decisions in the face of complexity, etc.

Increased interest in the behavioural-based approaches to finance and economics has been stimulated by the accumulation of evidence that people have cognitive limitations, causing them to make seemingly irrational decisions in certain critical areas (Brekke & Johansson-Stenman, 2008). In a boundedly rational model some information is missing totally, some information is not quite what it should be, and there could even be a surplus of certain types of information, i.e. the information is not perfect for the purposes for which it is meant (Berg & Gigerenzer, 2007). Added to that, only bits and pieces of information available are actually used in decision-making. Because of this, humans were found to appeal to heuristics and the rule of thumb when making decisions, resulting in biased probability judgments, over optimistic choices, anchoring on seemingly irrelevant, unrelated information or the status quo, extreme aversion to losses and not maximising expected utility (Kahneman & Tversky, 1979b). This reduction of informational requirements in complex decision making situations is a key form of procedural rationality (Doyle, 1998), which is the object of this study.

Problems of self-control have also been shown to be linked to suboptimal social behaviour, through the tendency of economic agents to make decisions that are in conflict with their long-term interest (Berg & Gigerenzer, 2007). In an experimental research, Shiv and Fedorikhin (1999) confirmed that long-term considerations are given less weight in cognitively-loaded situations. The problems of limited self-control were found to be partial causes of addictive behaviour (Gruber & Koszegi, 2001), and under saving or procrastination (Thaler & Sustein, 2003; Thaler & Bernartzi, 2004). Much evidence suggests that people do not necessarily pick the options that are best for themselves (decision utility), but instead gravitate towards their experienced utility and well-being (Kahneman *et al.*, 1997; Kahneman & Thaler, 2006).

Researchers (Tversky & Kahneman, 1981; Thaler, 1985; Lovallo *et al.*, 2007) say that this can be partially explained through the restricted cognitive capabilities of decision-makers as well as the will and the value systems of decision-makers. All in all, information is interpreted while being used, thereby making room for human error and bias (Simon, 1955). This is an important concept to understand when dealing with a problem such as climate change, as it involves multiple stakeholders, a multitude of diverse information from diverse backgrounds (climatology, science, economics, sociology, etc.) and seeks to address multiple objectives. All of these actors address problems and their solutions based on their own biases, their world-views, established mind-sets and established organizational structures and systems. Simon had this to say about bounded rationality within an organization:

"'Bounded rationality'" is the concept that identifies that organizations and individuals address problems with a pre-established mind-set – with specific boundaries and limits for behaviour. Organizational values and structure govern these boundaries, allowing some measure of flexibility and adaptability within those boundaries (Simon 1976: 242-243).

Berg and Gigerenzer (2007) argued that most decision theorists who have discussed bounded rationality have not really followed Simon's ideas regarding the topic. Rather, they have either considered how people's decisions might be made sub-optimal by the limitations of human rationality, or have constructed elaborate optimising models of how people might cope with their inability to optimize. Gigerenzer (2006) instead proposed to examine simple alternatives to a full rationality analysis as a mechanism for decision making, and he showed that such simple heuristics frequently lead to better decisions than the theoretically optimal procedure.

1.4 Research Problem, Research Questions and Contributions of Study

1.4.1 The Gap

Although climate change strategies have been extensively studied in management literature, little research has been conducted dealing with tactical strategic choices. The existing literature is largely conceptual (Berkhout *et al.*, 2006; Linnenluecke & Griffiths, 2010; Kolk & Pinkse, 2008, 2005) and primarily focuses on examining the stance of companies in response to externally induced climate change shocks and drivers. A coherent framework for tactical corporate climate change response is still missing. Porter and Reinhardt (2007) proposed a

generic climate change response strategy. This study develops a framework for corporate climate change response by extending Porter and Reinhardt's model. These models have been mostly framed under the general resource-based view of corporate strategy. There is a general omission of how behavioural factors affect strategic decision making in corporations in general, but more specifically in climate change response. A few studies incorporating behavioural factors have done so focusing on how behavioural factors affect investment decisions in renewable energies and renewable energy technologies (Masini & Menichetti, 2010*a*). By extending the scope to the totality of corporate climate change response, this study will contribute by extending the field of bounded rationality to corporate strategic decision making in general.

1.4.2 Research Questions

The study brings in bounded rationality and multi-criteria decision analysis tools and ideas as industrial organisation concepts that assist in understanding corporate behaviour. The aim of this study then, is to answer the following research questions:

1. **What framework can business executives use to respond optimally to the diverse set of risks and opportunities posed by climate change?**
2. **How well does Simon's theory of bounded rationality describe the processes which business executives follow in their decision making processes to respond to climate change challenges?**

The sub questions are:

i. Why does the company not impose more stringent investment criteria for climate change projects? Why?
ii. Why does the company neglect projects that meet these criteria?
iii. Why does the company neglect apparently cost-effective alternatives when making strategic investment decisions?
iv. How can the neglect be overcome in these different types of decisions?

These questions are answered by a comparative case study of two South African companies, Tongaat Hulett, a sugar, starch processing and property development entity with operations in Southern Africa, and Air Traffic and Navigation Services (ATNS), an organisation responsible for the air traffic control of approximately 10% of the world's airspace.

The research questions guided further design of this study inquiry. The study adopted a looser design methodology than a precise hypothesis testing one, and "grounded theory" strategy was not adopted either. Induction was delicately balanced with early structuring (Ferlie *et al.,* 2005) to avoid data analysis paralysis. The research protocol outlines a purposive sampling strategy which guided the field work.

1.4.3 Research Objectives

The Research objectives are to:

1. Develop a climate change decision making framework for selecting among multiple competing alternatives, while maximising the desired opportunities and minimising the risks.
2. Demonstrate the practical application of combining multi-objective optimisation and behavioural finance to a real-life climate change problems.
3. Demonstrate the practical application of bounded rationality in organisations to corporate strategic decision making in general.
4. Analyse the possible contributions of analytical hierarchy process (AHP) as a multi-objective decision making methodology and behavioural finance and strategy techniques to strategy formulation.

1.4.4 Contributions of the Study

Behavioural economics and behavioural finance has been proven in a number of studies based on laboratory experiments (Thaler, 1999, 1992, 1991, 1985; Alm, 2010). Many studies have also investigated the phenomena in single project settings, where decision makers had to pick a

project among competing alternatives (Flyvbjerg *et al.,* 2009; Lovallo *et al.,* 2009), or within situations where project specific attributes and parameter choices had to be made (Hostmann, 2005). Yet a number of research studies have concentrated on explaining and arguing for the acceptance and application of the concepts (Lovallo & Olivier, 2010, Finkelstein *et al.,* 2008; Foss, 2003; Teece *et al*., 2002; Hite, 2003; Bromiley & Flemming, 2002). However to date there are not any known studies where the bounded-unbounded rationality continuum, incorporating normative economics and finance principles with behavioural economics and finance, has been applied in a corporate setting to determine the course of action for an entity in order to inform executives on how they can combine them to formulate and implement winning strategies.

The application of bounded rational perspective (satisficing) principles in real life settings is still limited. In 1982, Piches reached the conclusion that "no general analytical solution to the full blown financing and investment problem of the firm is available". 27 years later, Magni (2009:975) reached the same conclusion, recommending that, "Management must evaluate all options and do the best it can".

In their study of the tracking error of financial market equilibrium, Berg and Geigerenzer (2007) and Todd and Geigerenzer (2007) concluded that behavioural economics and psychology is engendering better decisions, but whether such violations of rationality are beneficial and in which contexts remains debatable. In his recommendation for further studies, Magni (2009) hoped for more views on the interrelationship between bounded rationality and unbounded rationality and how the two should not be treated as "rivals". Gigerenzer and Regier (1996) argued for the non-distinction of the two rationality systems, arguing that the separation is artificial and only useful as a metaphor. Thus a study of a real life situation on the cooperation of bounded and unbounded rationality is long overdue.

The above statements show a lack of advancement in the field over a span of almost five decades, since the theory of bounded rationality was first put forward by Simon (1955). It is important to understand how psychologically plausible features of human behaviour affect the design and working of corporations. It is also important to get feedback from the applied arena on which behavioural tendencies really matter, and to see how the framework can be further developed.

Thus the contribution of this study is to build on and advance the study and application of bounded rationality (behavioural finance and strategy) in a corporate setting, using climate change response as a real-life situation in order to ascertain whether such principles are beneficial in the corporate world.

While the economics of climate change have been modelled at the macro level (national and global perspectives), this research details the micro level corporate economics of responding to climate change, providing clarity and incentives for companies to take decisive, calculated steps in responding to climate change.

In a circular fashion, the insights from bounded rationality help explain some of the debates and paradoxes that agitate the researchers from the climate community.

Climate change provides fertile ground in which to test bounded rationality theories because of the following:

- The field is still very uncertain, providing opportunities for, as Pitz and Sachs (1984) put it, "a trade-off (exists) between cognitive effort and judgmental accuracy."
- For South African companies and most the businesses the world over, there is very limited time in which to act. There is need for these companies to capitalize on first mover advantages as practicable as is possible, using whatever information is currently available.
- Knowledge within this field is still very scarce and fragmented.
- Limited technical capacities and capabilities and very little, if any, experience to piggyback on makes decision making very complex.
- The subject of climate change is still very emotive in the greatest part, bringing all the human processes - both rational and irrational - to the fore.

2. Methodology

This chapter discusses the research methodology employed in the study and is organised into six major sections. The first section explains why a case study is the preferred research methodology. In section 2, the researcher explores the mixed methods approach as the strategy of inquiry, and how it is suited to climate change response decision making. Section 3 describes the bounded rationality concept, with particular emphasis on the behavioural dimension of corporate strategic decision making. This is an important section of the chapter as it gives context to the data collection approaches employed. The construction of the analytical hierarchy process (AHP) tree as it pertains to climate change is explained in the same section. Section 5 highlights the major process flow in the research and shows how the three concepts are merged, culminating in the formulation of the corporate climate change response framework.

2.1 Research Methodology

A case study methodology was employed in the study because it allows for an in-depth focused study and understanding of the concepts of bounded rationality and multi-objective optimization, and their application in the study of a topic as controversial and little understood as responding to climate change. According to Shuttleworth (2008), whilst a pure scientist is trying to prove or disprove a hypothesis, a case study might introduce new and unexpected results during its course and lead to research taking a new direction. This is something which cannot be ruled out in this research topic, which is why a case study is a suitable methodology for this study. A comparative study of two organizations within the same jurisdiction was used. This was to allow for comparison in terms of the businesses' particular environment, rules and behaviours.

A mixed model research design was used that included both quantitative and qualitative research data, techniques and methods in the two stages of the research processes. This design method used mixed data and additional means (statistics and text analysis). Both deductive and inductive scientific methods were employed, as well as multiple forms of data collection (semi-structured interviews, field notes, questionnaires, content analysis of company reports, formal communication etc.). Analyzing quantitative and qualitative data - known as

mixed analysis has been said to be very complex because the researcher must not only be competent in collecting and analysing both quantitative and qualitative data (Onwuegbuzie *et al.*, 2010), but also cognizant about how to mix and embed the analyses so that the inferences, deductions, conclusions and recommendation from the different data sets are a coherent whole (Tashakkori & Teddlie 2003).

The multiplicity of stakeholders within the climate change arena, their vested interests and the interconnectedness of the systems and/or interests produced an avalanche of options which can be arduous to understand; therefore it was important to methodically narrow down to a sustainable answer to the first and second research questions. The interconnectedness and the ripple effects, both direct and indirect of the options, had to be carefully analysed collaboratively among different stakeholders to ensure an optimal solution for the business and involved stakeholder groupings. By conducting a comparative study within the same jurisdiction, the study drilled down into the decision making processes at play, rational or irrational, to understand how the trade-offs were handled and why the resulting strategic direction was preferred for each of the two companies. A qualitative study was used to conduct an in-depth study of what the business value proposition was and how climate change strategies can be incorporated into mainstream corporate studies. Results of the two processes were then used to define and refine the key themes which were used to develop the corporate climate change response framework for the South African company.

Within the two companies, only senior to executive management personnel were targeted because of their closeness and exposure to decision making, strategy formulation, implementation and reporting within an organisation. Strategic decision making in most companies is the privy of senior management, although some lower ranked employees may be involved in parts of the business unit strategy formulation stages. Senior management personnel were included in the study based on their understanding of the climate change and corporate strategy topics and their involvement in the crafting and implementation thereof.

2.2 Design, Instruments and Decisions

A comparative case study research methodology using the mixed method approach as the strategy of inquiry was used. This is due to the fact that the case study research design had the ability to focus on specific and interesting corporate behaviour (Yin, 1994), providing the opportunity to ask penetrating questions and to capture the richness of organisational behaviour (Rocco *et al.*, 2010). Critics of the case study methodology believe that the findings of case studies can offer no theoretical implications that go beyond the cases, arguing that because a case study is such a narrow field, its results cannot be extrapolated to fit an entire question and that the results only show one narrow example. However, this problem has been shown to be capable of being reduced by using theoretical ideal types and predictions to select and frame a problem for explanation (Amenta, 1991). The case study method has been found to be appropriate in research topics involving unique phenomena that warrant intensive, in-depth, and holistic study (Bradshaw & Wallace, 1991; Tellis, 1997; Hammersley & Gomm, 2000), as is the case in the study of behavioural finance and strategy in decision making. The case study method is the appropriate method for developing the climate change response framework and getting an in-depth, intensive and holistic study of a unique phenomenon (Hammersley & Gomm, 2000) such as bounded rationality.

Although the behavioural constructs (the irrationality in strategic decision making) of analysis were identified through a literature review, a pilot case study was used to understand the more pertinent and applicable behaviours and to unearth as far as possible the relationships among the key variables in the study. The pilot study was used to give a preliminary indication of those behavioural categories that were posited to have a major influence on the corporate climate change decision making process.

The case study design included a single, exploratory, in-depth pilot case study that was followed by a more in-depth, cross-case analysis of two firms. The pilot study was conducted in an organisation in the mining industry. Agreement to publicise the company name was withheld. Problems and issues identified in the exploratory pilot case study, particularly with the categorisation of the irrational behaviours in decision making, were used to point to important variables for further investigation during the two-firm comparative study. The flexibility of a

case study approach makes it appropriate in this study in that; whilst a pure scientist is trying to prove or disprove a hypothesis, a case study might introduce new and unexpected results during its course, and lead to research taking new directions. This is especially relevant given that one of the objectives of this research is to advance the theory on behavioural finance and strategy by taking it out of the laboratory settings which to date have been the main domain (Thaler, 2009; Lovallo, 2010) to a practical real-life setting.

2.3 Comparative Case Study

A comparative approach was employed in this study to compare and contrast and provide interpretation about the extent of the relationship between the decision making variables and the alternatives picked by executives in the two firms operating within the same macro-economic environment, which faced similar climate change risks and opportunities due to the common jurisdiction. A comparative study allowed for a more conclusive interpretation of the decision making behavioural patterns and the categorisation thereof. Intra-group triangulation was also possible, thereby increasing the content validity of the research.

Critics of the case study approach argue that the internal validity (within-case data) is strong, but weak on external validity. This criticism of a case-study's generalisability was dealt with by the use of two cases from two different industries but within the same jurisdiction, thereby substantially reducing the risk of prescribing or suggesting a climate change response strategy framework that the institutional differences and micro-economic variability does not take cognisance of. The comparative approach differentiated between factors specific to climate change challenges as distinct from normal corporate strategy formulation processes. Finally, the comparative approach extended ideas about what is possible, while at the same time providing the understanding that must precede any conclusive interpretations.

2.4 Sampling Strategy

Purposive sampling, also known as judgmental, selective or subjective sampling, is the non-probability sampling technique used in this study because of the need to interview knowledgeable experts within the chosen organisations (Tongco, 2007). The purposive

sampling technique is the deliberate choice of an informant due to the qualities the informant possesses. In this case, only certain organisations were deemed to have progressed sufficiently on the climate change response journey to provide meaningful data and answers to the research questions – these formed the population in the thesis.

The purposive sampling technique does not need underlying theories or a set number of informants (Tongco, 2007; Patton, 2002), but the researcher decides what needs to be known and sets out to find people or organizations who can and are willing to provide the information by virtue of knowledge and experience (Bernard, 2002; Lewis & Sheppard, 2006). Within that population only a few of the organisations were willing to provide the information (Bernard, 2002; Lewis & Sheppard, 2006) beyond what was publicly available, due to trade and competitive protectionism. Considering the stringent selection criteria used, the two companies used in this study are considered as critical cases and therefore are arguably able to provide information that could be logically generalised (Patton, 2002).

Eisenhardt (1989) argued that theory building could be performed from theoretical-driven sampling methods due to the confidence in the characteristics of the informants (i.e. knowledgeable experts). Purposive sampling is especially exemplified through the key informant technique (Garcia, 2006; Bernard, 2002; Jarvis et al., 2004), wherein a few individuals are solicited to act as guides to a study. Based on the ensuing arguments, only business executives were used as key informants since they are the ones charged with the crafting of strategy in organisations.

Purposive sampling is considered adequate when resources are limited (Patton, 2002) and is a recommended technique where a single case or a small number of cases are used, because once researcher bias is eliminated, the technique is considered decisive in explaining a phenomenon of interest (Tongco, 2007; Patton, 2002; Eisenhardt, 1989). Considering the stringent criteria used for selection as detailed in Section 2.6, the two companies used in this thesis are considered as critical cases and therefore arguably provided the information that could be logically generalized (Patton, 2002). Another characteristic of critical cases is that they allow maximum application of information to other cases, because according to Patton (2002:243), "if it's true for this one case, it's likely to be true for all other cases". Thus the

findings and outcomes from the two cases are considered typical enough to be applicable to other cases, particularly within the South African business environment.

The major advantage of purposive sampling is that the technique provides for analytical and/or logical justification (Tongco, 2007; Patton, 2002; Eisenhardt, 1989) to make generalisations from the two cases studied. Yin (1984, 1994) defined pattern matching as linking patterns in data to patterns found in theoretical propositions to aid in theoretical or analytical generalization. By employing pattern matching (Yin, 1984; 1994) during analysis and discussion, both theoretical and analytical generalisations were achieved.

2.5 Mixed Method as a Strategy of Inquiry

2.5.1 Why the Mixed Methods Approach Was Chosen

Due to the multi-stakeholder and potentially conflicting multi-objective nature of corporate climate change response, disclosure of information was potentially an issue in this study. Because this could have been an emotionally charged subject with turf wars and protectionism, a single method of data collection can be limiting for the study. In his study of the impact and added value of mixed methods approach in the in the field of management and strategic decision making, Molina-Azorin (2011) found that the mixed method approach was very valuable in the field of strategic management with respect to relevance and the importance of context, taking into account the need for an in-depth understanding of industry- and firm-specific variables (Jonsen *et al.*, 2010). For complex, multi-faceted research topics, such as this thesis, Jonsen (2010) and his colleagues called for scientific mindfulness as a research paradigm where research approaches are holistic, contextual and cross-disciplinary. Given the complexity of this thesis, Jonsen's recommendations were adapted resulting in mixed methods being the preferred strategy of research inquiry. Triangulation of concurrent qualitative and quantitative methods (Eiesenhardt & Graebner, 2007; Driscoll *et al.*, 2007; Creswell & Plano Clark, 2007) was used in the study of the behavioural aspects of decision making and in the trading-off of multi-criteria decisions on climate change response. The hybrid methods were used during the problem identification, data collection, data analysis and research inference (Jehn & Jonsen, 2010; Johnson *et al.*, 2007; Greene, 2008) phases of the thesis.

The ability of a mixed methods approach to accommodate variations, multi-layers and inconsistencies allowed for a practical means to synthesise (Creswell, 2009) the debates and discussion surrounding trade-off analysis and agreement on the criteria and alternatives selected during the AHP modelling process. The rationale for using mixed methods was as Denscombe (2008) observed, to produce a more complete picture by combining information from complementary sources. The overall purpose of employing a mixed method strategy in this study was to develop a better understanding of complex multi-criteria phenomena. The complexity stemmed from the need to balance the requirements of multiple stakeholders and choosing from a spectrum of initiatives against finite company resources. A better understanding was obtained by triangulating results from the one-on-one interview sessions, the intra-group comparisons and the secondary data, which enhanced the validity of inferences (Greene, 2008; Creswell & Plano Clark, 2008). This is in line with Creswell's 2009 conclusions that one of the key advantages of mixed methods research is the synergy found in the use of both qualitative and quantitative research, thereby ensuring a study that is stronger than if either method had been used on its own.

2.5.2 Pragmatism as a Underpinning of the Mixed Methods Approach

One of the major attributes and added value of mixed methods research that qualified it as the most suitable method for this study is its methodological pluralism (Molina-Azorin, 2010; Bryman, 2007), which has afforded the research flexibility and superiority over mono-method research (Creswell, 2009). This pragmatic approach guided and framed (Greene & Caracelli, 1997) the approach to this thesis, including the type of questions and responses sought, the type of data analysis used, the ethical roadmap of the study and total research design (Rocco *et al.*, 2003). The pragmatist position (Jehn & Jensen, 2010; Creswell, 2009; Denscombe 2008), generally regarded as the philosophical underpinning of mixed methods research, calls for a fusion of philosophies and methodologies – a "fit-for-purpose" – that best meets the practical demands and complexities of the problem under study. This position was found to be the most relevant for this thesis given the complexity of the constructs under study.

2.6 The Characteristics of Companies Studied

Although the number of small and medium businesses in South Africa is quite large, their internal structures, corporate cultures and business strategies are inherently different from their larger counterparts, who are more compliance and reputation-driven. Voluntary as well as compelled climate change governance is likely to be too onerous for them and might undermine their competitiveness (Chu & Schroeder, 2011). The profiles of companies that proactively address climate change are those that are multi-national (therefore exposed to international trends), have economies of scale and scope, and have a long-term perspective to business (therefore they can trade-off short-term economic performance over low-carbon investments and business sustainability), have access to material and human resources and are generally good corporate citizens (Chu & Schroeder, 2011). This study purposely excluded small or medium enterprises. The two companies chosen for the study are in different industries but are both classified as high impact businesses as far as climate change impacts are concerned, due to the nature of their activities. Tongaat Hulett is a member of the JSE SRI, while ATNS is still working towards its membership but is still classified as high impact. This classification is further explained under the JSE SRI environmental classification as follows:

JSE SRI Environmental Classification

The JSE SRI Climate change classification is premised on the understanding that all businesses have some kind of impact on the environment, however some have more negative impacts than others by the nature of their economic activities. The SRI Index follows the system developed by EIRIS to classify the sectors, which in turn is closely linked to the Industry Classification Benchmark (ICB). The environmental impact classification, however, groups companies based on similarity of economic activities as opposed to economic ties. The basic principle is that a sector's overall environmental impact should be assessed in relation to the economic contributions of that sector, i.e. the ratio of environmental damage to the economic significance. For each sector, direct environmental impacts such as issues in climate change, water consumption and pollution, waste management, and air pollution are used. Indirect environmental impacts such as upstream and downstream supply chain activities are also incorporated.

A main reason for choosing to study these two entities was based on their willingness to discuss some otherwise non-publicly available information. Evidence that the company had taken significant steps in understanding climate change related challenges to business and is making efforts to address them was another key qualifying criterion. The link to international business was also an important qualifying criterion, because international business interests imply that such companies are more likely to be exposed to the international business practices and global supply chains where effects of climate change have already been creating challenges. Companies with international business interests are also more prone to scrutiny and reputational risk from environmentalists and green consumerists. Long-term investors, asset managers and analysts are also beginning to integrate proactive management of systemic climate induced risks into investment analysis and decision-making. This is likely to affect bigger companies, with international interests, thereby acting as drivers for such companies to put in place long-term measures to address climate change concerns.

Within the two companies, only senior to executive management personnel were targeted because of their closeness and exposure to strategy formulation, implementation and reporting. Strategic management in most companies is the privy of senior management, although some lower ranked employees may be involved in parts of business unit strategy formulation. Middle management personnel were included in the study only where they had clearly demonstrated link to the climate change response process, for example the specialist engineer at Tongaat Hulett who has been tasked with evaluating the climate change response options for the business.

Having laid the groundwork regarding the research problem and the principle research method and the characteristics of eligible companies, the next gives an in-depth look at the two companies selected for the study.

2.7 The Behavioural Constructs Examined

This section summarises the bounded rationality constructs that were explored in the thesis. Two of these have been shown to be specific to climate change response while the rest of the list have been studied and proven in finance, economics and other decision fields.

2.7.1 The 'No Regret' and 'Energy Efficiency Gap' Paradoxes

'No regret' emission reduction potential, as already explained under the literature review chapter is defined as a situation in which the costs of implementing a measure are more than offset by the direct or indirect benefits (not including climate-related benefits) it generates, based on traditional financial criteria (Huntington *et al.*, 1994). The failure to make 'no regret' choices defies market logic, because overcoming 'no regret' failures is argued to be unequivocally efficient and climate-friendly (IPCC, 2001). According to the normative economic and finance paradigm, if such a profitable potential did exist, economic agents (i.e. optimising machines) would eventually undertake the necessary investments to capture it (Sutherland, 2000). Yet, despite considerable efforts and calls to push for climate-friendly investments, even simple 'no regrets' choices on the energy demand-side management (CDP, 2010), such as reduced energy costs as a result of deployment of energy-efficient technologies, fuel-efficient and economic vehicles, and a change in energy use behaviours and habits (WWF, 2011) etc., have failed to penetrate even a fraction of their potential.

From a market perspective, users of such energy equipment defy the simple logic of preference for cost-effective operations, leading to what has been termed the "efficiency gap" (De Caino, 1998). While some market oriented pundits are baffled by this "irrationality", others have attempted to explain it away using the concept of market failures, citing hidden costs (unprized environmental externalities) and market imperfections such as insufficient investible resources, imperfect information, distortionary taxation or misplaced incentives (Sutherland, 2000). However, while such costs do indeed exist, bottom-up studies have shown that they do not quite offset the benefits from identified profitable energy-efficient investments (Brown, 2001). DeCanio (1998) and Shove (2005) showed that there are non-economic barriers that are just as important to bring to the light if decision-makers are to tap into the 'no regret' potential, citing organisational and institutional behaviours as arguments in explaining the efficiency gap in

energy. Schleich and Gruber (2008) concurred that the idea of routinized behaviours is aggregated in groups such as firms and institutions where sources of inertia are multiple. These relate to the irrationality of man commonly referred to as the "bounded rationality" of economic agents (Simon, 1955). In adapting to their limited capabilities, agents adopt decision "routines" to simplify their decision making process and ensure satisfactory results, a phenomenon Simon (1955), termed "satisficing".

2.7.2 Other Irrational Behaviours in Strategic Decision Making

The other irrational behaviours whose influence was examined in the corporate climate change strategy formulation programme are provided in Table 2-1. The researcher looked for predictors or indications of the predictors of each of the irrational behavioural concepts as detailed in the last column of each behavioural concept in the table.

Table 2-1 Behavioural Constructs under Study

Behavioural Concept	Definition and Descriptors	Key Authors	Predictors/ behavioural tendencies
Availability heuristic	Rule of thumb or mental shortcut that allows one to estimate the probability of an outcome based on how prevalent or familiar that outcome is.	Tversky & Kahneman (1973) Gilovich & Griffin (2002)	• Irretrievability – ideas that are retrieved most easily also seem to be the most credible. • Categorisation – categorising or summoning information that matches a certain reference. • Narrow range of experience – when a person possesses a too restrictive frame of reference. • Resonance – extent to which a situation resonates with the individual's personal situation.
Anchoring and adjustment	In numerical prediction, when a relevant value (anchor) is available, people make estimates by starting from an initial value (anchor) that is adjusted to yield final value.	Tversky & Kahneman (1974)	• Undue emphasis on statistically arbitrary, psychologically determined hurdles rates, prices. • Perceiving new information through a warped lens.
Mental accounting	Tendency to code, categorise and evaluate economic outcomes by grouping assets into any number of non-interchangeable mental	Thaler (1985) Thaler (1999) Barberis & Huang (2001)	Placement of investment assets into discrete "buckets" according to asset type without regard for potential correlations connecting investments across

	accounts. Two values are attached to any transaction - acquisition value and transaction value. *Acquisition value* is the money that one is ready to part with for physically acquiring some good. *Transaction value* is the value one attaches to having a good deal. If the price that one is paying is equal to the mental reference price for the good, the transaction value is zero. If the price is lower than the reference price, the transaction utility is positive.		categories. Layered investment portfolios with each tier addressing certain investment goals independent of any additional goals. Increased or reduced risk taking behaviour on investments depending on the capital classification, e.g. Money you can afford to lose (risk money, risk capital); Money you need (safety capital).
Status quo bias	Tendency to want things to stay relatively the same.	Samuelson & Zeckhauser (1988) Kahneman, Kentsch & Thaler (1991) Fernandez & Rodrik (1991)	• Inertia, usually because of an emotional attachment or lack of knowledge of the alternatives. • Finding that an option is more desirable if it is designated as the "status quo" than when it is not • Holding inappropriate assets.
Loss aversion and Myopic loss aversion	Losses and disadvantages have greater impact on preferences than gains and advantages. Approximately risk neutral when stakes are small. Stronger impulse to avoid losses than to acquire gains.	Kahneman, Kentsch & Thaler (1990) Kahneman, Kentsch & Thaler (1991) Kahneman & Tversky (1991) Benartzi & Thaler (1995)	Consistent one-sided deviations of subjects' choices from the predictions of risk neutrality causing decision makers to hold on to a more risky portfolio instead of divesting from some investment, or not taking up certain investment resulting in unbalanced portfolios.
Endowment effect	People often demand much more to give up an object than they would be willing to pay to acquire it. A differential weight is placed on the value of an object.	Kahneman, Kentsch & Thaler (1990) Kahneman, Kentsch & Thaler (1991)	Bargaining habits (willingness to pay WTP, or willingness to accept, WTA). Resistance to offload certain assets in ownership due to fear of unknown assets, or attachments to legacy. Familiarity is treated as having value.
Hyperbolic Discounting (short vs. long horizons)	Tendency for people to have a stronger preference for more immediate payoffs relative to later payoffs, where the tendency increases the closer to the present both payoffs are.	Poterba & Summers (1988) Lee & Swaminathan (2000)	Positive autocorrelation in returns over short horizons and negative autocorrelation over long horizons. From a distant perspective we see the forest, but from a proximal perspective, we see trees.

Herding	Social influences such as "emulation," where some members of a group mimic other members of higher status. Tendency towards mass or copied behaviour (group think), Choosing the socially desirable option. Information aggregation/cascade in market contexts.	Banerjee (1992) Grinblatt, Titman & Wermers (1995) Wermers (1999) Nofsinger & Sias (1999)	Diffusion processes whereby organisations adopt an innovation, not because of their individual assessments of the action's efficiency or returns, but because of a bandwagon pressure caused by the sheer number of organisations that have already participated in this action.
Affect heuristics (anchoring and adjustment)	Deriving both risk and benefit evaluations from a common source. Basing a decision on an emotional reaction rather than a calculation of risks and benefits.	Finuacane *et al*. (2000) Slovic, *et al*. (2002) Gilovich & Griffin (2002)	• Rule of thumb decisions. • Experienced as a feeling state with or without consciousness. • Relying more on experiential systems for decision making.

The behavioural perspectives presented in this section will be applied to the domain of climate change response investments. To this end, a framework that examines the relationship between these behaviours and companies' responses to climate change will be developed.

The next section describes in detail the operationalization of the multi-criterion nature of the climate change challenge for organisations using the analytical hierarchy process (AHP) as the chosen multi-objective decision aid tool.

2.8 Construction of the AHP Framework

In this section, practical formulation - a mathematical model for the climate change response decision problem under conditions of three overarching conflicting objectives (environmental, social and economic) using the analytical hierarchy process (AHP) - is presented. For example, trading off environmental impacts against economic impacts is a challenge for all climate change response strategies for both businesses and governments (Raymond & Brown, 2011). Multi-objective analysis was used in this case to choose among, prioritise and generate the most feasible menu of acceptable strategic choices based on a multiplicity of criteria under each objective (Steuer & Na, 2003). The solution derived was a set of points on a surface, in up to

three dimensions that all fit a predetermined definition of an optimum, commonly referred to as Pareto Optimality (Pareto, 1906).

The Analytical Hierarchy Process (AHP) is a process that helps pick up one of the options of a list of choices. Each choice has a few parameters attached to it and weights can be assigned for each parameter. AHP picks the best choice from the list of choices. One of the greatest strengths of this multi-criteria decision aid method is that it takes into account many different parameters for many alternatives in both qualitative and quantitative forms, and gives the result that best matches the parameters.

The following section gives a step-by-step brief of how to apply this method to mathematically solve a corporate climate change challenge. The challenges are brought about by the need to trade-off among a diverse set of conflicting alternatives, with the understanding that, while it is imperative for a business to respond to climate change (an environmental perspective), for-profit businesses still have to do so within the confines of economic sustainability.

Steps in the AHP methodology

2.8.1 Construction of the Hierarchy

The first step in an AHP problem is to decompose the decision problem (climate change response) into its constituent parts in a hierarchical format (Hwang & Syamsuddin, 2010), progressing from the top layer which is the general, to the lower more specific sub-objective. Thus the progression is from the ultimate objectives, sub-objectives and sub-sub-objectives, down to the discrete bottom level alternatives. Each set of alternatives can be further divided into an appropriate level of detail, bearing in mind that the more depth in the relevance tree, the less discrete the alternative becomes. At the top, the overarching objective is a climate change response strategy.

2.8.2 Pairwise Comparison by Decision Makers

The next step is to assign a relative weight for each objective. A set of questionnaires is formed based on the original Saaty Rating Scale on linguistic variables (Table 2-2).

Table 2-2 Saaty Linguistic Variables

Intensity of Importance	Definition	Explanation
1	Equally important	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgment slightly favour one over the other
5	Much more important	Experience and judgment strongly favours one over the other
7	Very much more importance	Experience and judgment very strongly favours one over the other. Its importance is demonstrated in practice
9	Absolutely more important	The evidence favouring one over the other is of the highest possible validity
2,4,6,8	Intermediate values	When compromise is needed

Source: Saaty (1980)

Using the linguistic variable measurements to demonstrate the effect of each objective on the strategy, decision makers are presented with a series of pairwise comparison questions of the format: How important is criteria E relative to criteria F? The options are based on the five linguistic variables "equally important", "somewhat more important", "much more important", "very much more important", or "absolutely more important". Alternatively the decision makers could subjectively assign their own personal weights between 0 and 100.

Each sub-objective has a local (often called immediate) and a global priority. The sum of all the criteria beneath a given parent criterion in each tier of the model must equal one. Its global priority shows its relative importance within the overall model.

2.8.3 Aggregating the Weights

Because the perception of each decision maker varies depending on knowledge, experience and objective interests, a geometric mean was used to deal with the N numbers of decision makers to integrate their judgment values. This had the effect of shortening the gap effects between very low and very high values, therefore controlling for biases. The geometric means for each leaf of the hierarchy for the lower numbers were calculated as follows:

$$G_u = (g_{l1} * g_{l2} * g_{l3} *\ldots G_{ln})^{1/n} \quad (1)$$

And the weight for the lower fuzzy numbers was:

$$W_l = g_l / \int_1^n gul \quad (2)$$

Similarly we obtain w_u and w_m for upper and medium numbers.

Three weights were obtained for each leaf for lower, medium and upper. These three values describe the pessimistic, normal and optimistic modes (Syamusuddin & Hwang, 2009) for further deliberation and choice by all decision makers. Scores were then synthesised through the model, yielding a composite score for each choice at every tier, as well as an overall score as shown below:

$$W_{fl} = (\sum_1^n wln)/n \quad (3)$$

$$W_{fm} = (\sum_1^n wmn)/n \quad (4)$$

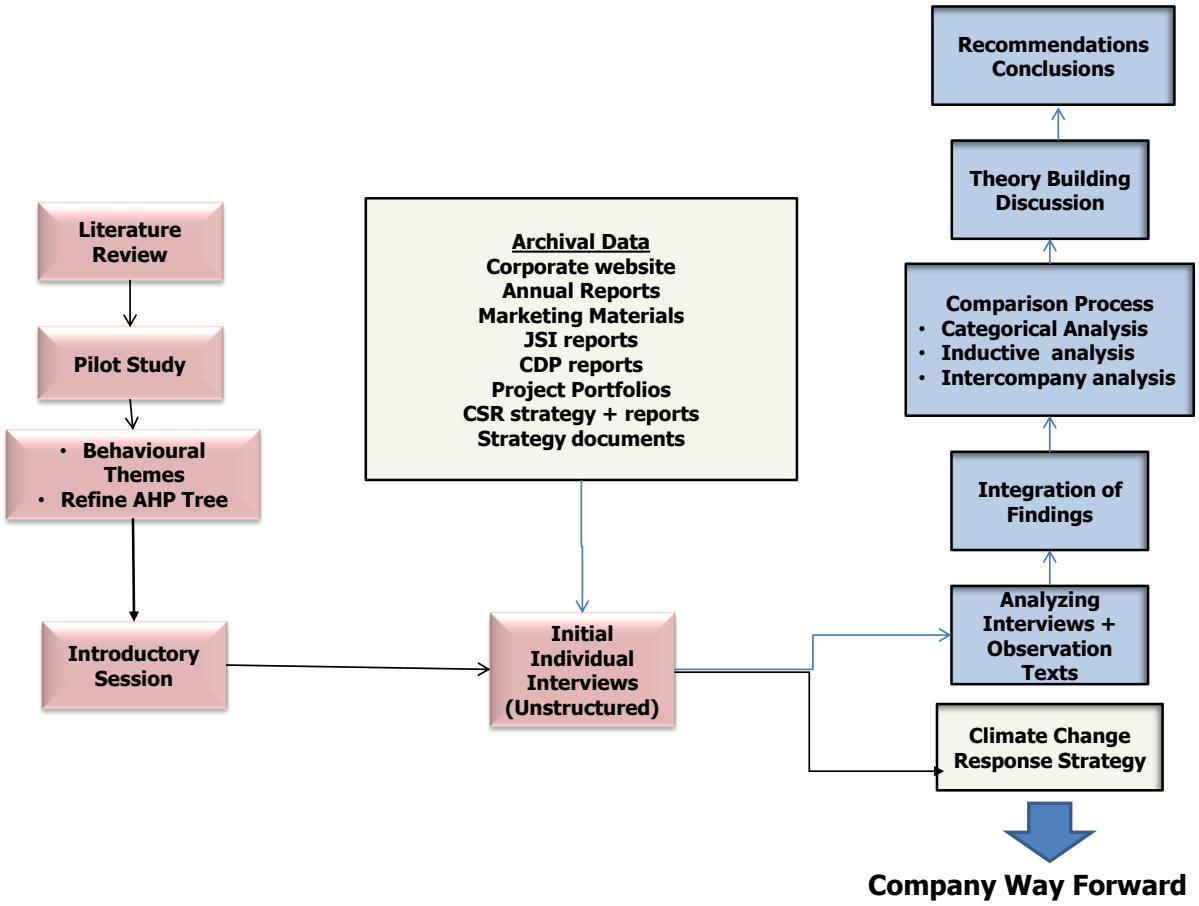
$$W_{fu} = (\sum_1^n wun)/n \quad (5)$$

Problem structuring is one of the key issues that executives confronted by the climate change challenge battle with. AHP allows environmental, economic and social objectives to be coped with simultaneously, whilst also allowing for a careful structuring of the climate change risks and opportunities before committing to a strategic path of action. The framework proposed in this section allowed for the evaluation of both qualitative and quantitative factors, thereby combining sophistication and realism to solve a practical challenge faced by businesses.

2.9 The Research Process

The rest of this section will focus on understanding the flow of the research processes, as shown in Figure 2-1. There are three distinct phases, with the first encompassing research instrument design (based on the literature review) and a pilot study to refine the research instruments. The next phase, which was the longest and most intense part of the process, was the data gathering phase. The methods used for data gathering and the reason for the choices of the methods employed are explained. Integration of findings and analysis form the last phase of this section of the research. Each phase is explored in detail.

Figure 2-1 **Research Process Flow**



2.9.1 Data Collection Procedure

This section describes in detail the primary and secondary data gathering processes used. Prior to recruitment and data collection, the research procedures and participation were approved by the CEOs of both companies used in the case studies. Informed consent was obtained from all participants. All interviews were audiotape recorded and transcribed verbatim. Guiding questions aimed at identifying and explaining the drivers and motivations and responses to climate change in the two companies were used. The interviewees were business executives or subject matter experts in business strategy and/or climate change response, including operations directors, financial managers, marketing managers, human resources managers, sales managers and engineering managers. The interviewees were chosen to cover all functional aspects of business, being operations, finance, sales and marketing, human resources and strategy. A total of 11 executives were interviewed in eight interview sessions lasting between 60 and 100 minutes in the period March to June 2012. In all cases,

interviewees were guaranteed confidentiality and anonymity in any written reports and publications. The interviews were the main data collection tool, as in-depth probing and understanding of the drivers and decision making processes involved in responding to climate change could not be ascertained from secondary and archival data.

2.9.2 Primary Data

Both quantitative and qualitative data was collected. Open-ended questions were used to solicit responses from the interview participants. Quantitative as well as qualitative data was collected during the rounds of in-depth, face-to-face semi-structured interviews with respondents. Responses were recorded electronically using a Sony IC Recorder. The output files were .MP3 audio files which could be played back on any audio player. Transcriber 1.5.1 was used for transcribing. Research assistants were employed to assist with transcribing of more than 15 hours of recorded interview scripts.

Four steps are described in the data collection section. The steps are listed in the order in which they occurred, as shown in Figure 2-2.

Step 1: Introductory session

Introductions and familiarisations were conducted telephonically and via email with the Head of Sustainability for Tongaat Hulett, who then introduced the rest of the respondents. The purpose of the research and the research process overview was discussed and shared in the form of a research guideline (see Annexure A), which was mailed to all participants prior to the interviews. Background information and understanding of the company's stance towards climate change was mostly obtained via publicly available information in both companies' annual reports which were available on their websites, the Johannesburg Stock Exchange Socially Responsible Investment (JSE SRI) and Carbon Disclosure Project (CDP) reports, as well as any Engineering News and other publications.

Step 2: One-on-one semi-structured interviews

Unstructured interviews were conducted with each participant to solicit their judgments on the climate change challenge and their preferences in terms of the courses of action. This was

followed be semi-structured interviews (i.e. interviews conducted with a fairly open framework which allowed for focused, conversational, two-way communication. They were used both to give and receive information). Semi-structured interviews gave the informants more control over the direction of the conversation and allowed them the opportunity to paint a picture of what is important to them. Interviews were conducted in the informants' workplaces to ensure each participant's comfort. A checklist of questions (see Annexure A) was used to preserve consistency across the interviews. The interviews progressed from the more general climate change response mitigation and adaptation agenda in the business, to the more specific climate change response initiatives and plans.

The interviews were aimed at understanding what initiatives the business had embarked on, and more specifically, the process used to arrive at the decisions for a specific initiative (the 'how' of decision making) and why the certain decisions were made. The 'why' questions sought to understand the drivers and motivations to responding to climate change for the specific industry and the particular organisation. The latter parts of the interview sessions were aimed at determining the diffusion of climate change mitigation and adaptation into the business, as well as understanding the successes, frustrations and challenges encountered during the climate change response journey. Interview participants were shown a copy of the AHP tree, and after a walk-through of the concept they were given an opportunity to review by ticking off against some of the initiatives they felt were part of their organisation's consideration or were already work in progress. They also had an opportunity to comment on the concept and ask questions. Individual informant's beliefs, attitudes and values towards climate change and their views on how the business should respond were also sought. The researcher recorded field notes describing the interpretations, observations and general feelings about the interview on the day of the interview to avoid alteration of interpretation by sleep (Werner & Schoepfle, 1987).

2.9.3 Ethical Considerations

This study was conducted in a manner that fulfilled legal and ethical requirements. The interviewees were provided with written information about the study and asked for their consent to record and transcribe the interview sessions. The interviews were handled in the strictest of confidentiality and anonymity in the interviewees' offices. The findings of the study

were shared with some of the members of the executive teams from each of the two companies, as well as the Chief Executive Officer from one of the two companies, before being reported publicly.

2.9.4 Archival Data

Materials from governmental publications, press reports, and online documents were examined. The JSE Socially Responsible Investment (SRI) Index and the Carbon Disclosure Project (CDP) for the years 2008-2010 were reviewed and non-financial reports of the two companies were downloaded from the corporations' websites. One of the companies provided a hard copy of their Sustainability and Climate Change Strategy as well as a copy of their Environmental Sustainability Action Plan. Following on the methodology followed by Ihlen (2009), a keyword/phrase search for "climate change", "global warming", "greenhouse gas", "carbon/ CO_2 emissions", "COP 15/17", "UNFCC", "IPCC", was conducted. The reports were also read in their original context and categories and stances on climate change were synthesised. The five typical environmental stances suggested by Bullis and Ie (2007) were adopted in this study, namely: compliance (reacting to pressure), openness (information sharing), integration (attempting to realise positive gains), collaboration (partnering with external stakeholders) and sustainability (implementing an ethical, ecological, and systems-based approach that does not place the entity's financial interests first). The findings from this exercise were merged (compared and contrasted) with the results from the primary data collection process, thereby completing the data collection and analysis triangulation process.

2.10 Data Analysis

Data analysis was conducted within the quantitative (descriptive and inferential numeric analysis) and the qualitative (descriptive and thematic text and categorical analysis) domains. Qualitative data collected during the interview sessions was analysed both separately and together to create a comprehensive dataset (Creswell, 2009; Driscoll *et al.*, 2007). Computer Assisted Text Analysis (CATA) and the qualitative data analysis (QDA) package Atlas.ti 4.2, was used for coding and retrieving in the qualitative content analysis (Bazeley, 2004).

Primary and secondary data collection and analysis was used in an interactive and sequential manner. Secondary data and the literature review informed the preparation and conduct of the interviews, while findings from the one-on-one interviews led to the refining of the literature and a further literature search. Because the interviewees were business executives charged with the crafting and subsequent implementation of a climate change strategy, their statements were taken to be authoritative. Literature was still used to triangulate the statements however.

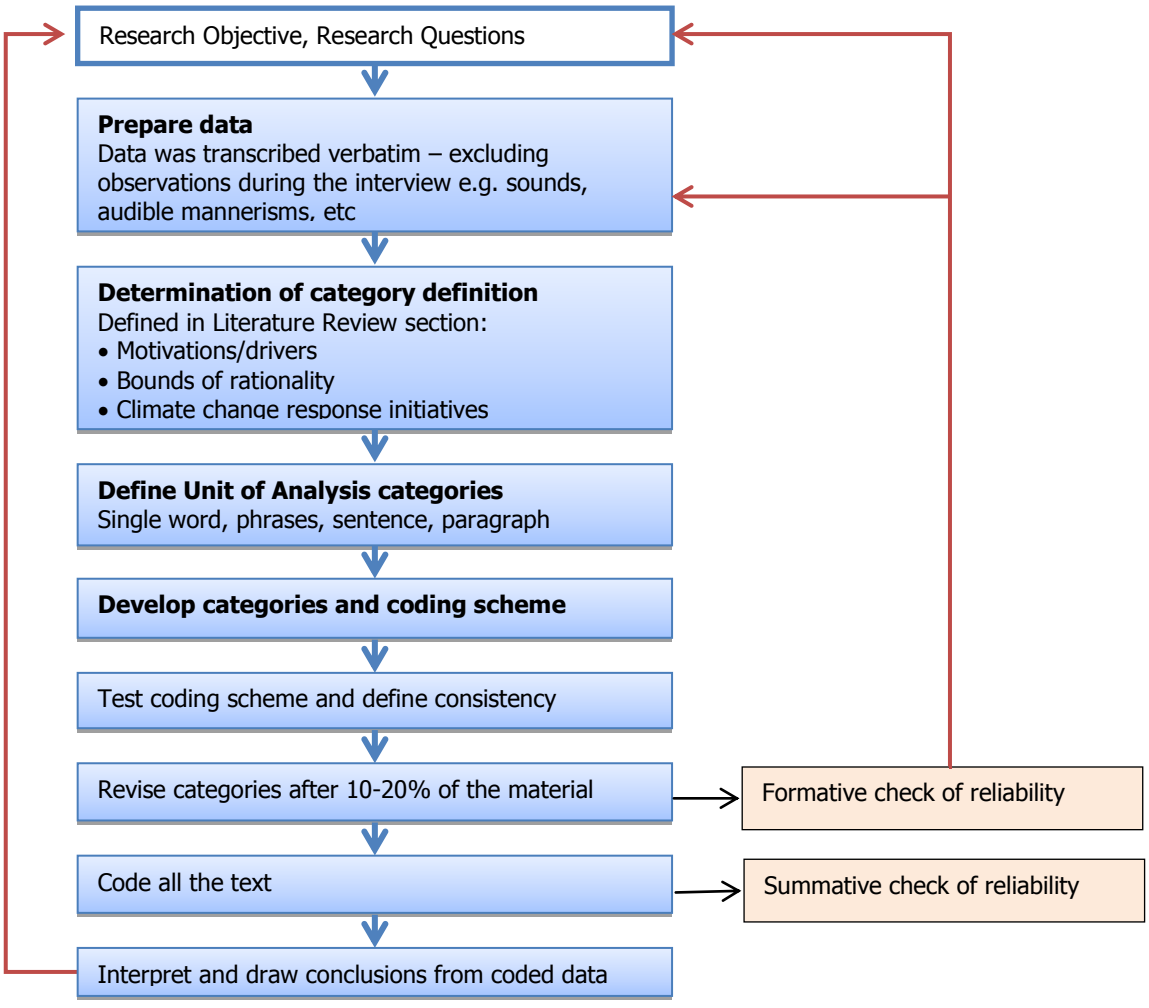
2.10.1 Qualitative Content Analysis

Content analysis is the qualitative research technique used in this thesis. There are three distinct approaches to qualitative content analysis namely: conventional, directed, or summative (Hsieh & Shannon, 2005). All three approaches are used to interpret meaning from the content of text data thus, adhere to the naturalistic paradigm. Qualitative content analysis is an analytical approach of empirical, methodologically-controlled characterisation of language as communication, with attention to its content and context (Krippendorff, 2004) in order to understand meanings, themes and patterns in the particular text (Wheelock *et al*., 2000; Hsieh & Shannon, 2005) and knowledge of the phenomenon under study (Weber, 1990). Holsti (1969:14) offered a broader definition of content analysis as, "any technique for making inferences by objectively and systematically identifying specified characteristics of messages". In this study, Heish and Shannon's (2005: 1278) definition of qualitative content analysis was used, which is, "the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns".

The approaches to coding scheme generation, origins of the codes and threats to trustworthiness differentiate the different approaches (Hsieh & Shannon, 2005; Krippendorff, 2004) to qualitative content analysis. Hsieh and Shannon (2005) advanced three main approaches to interpret meaning from content data, namely: conventional content analysis, where coding categories are derived directly from the text data; directed content analysis, where initial coding is guided by some theory or relevant research findings; and summative content analysis, which involves counting and comparisons of key words followed by the interpretation of the underlying context.

Directed content analysis, also referred to as inductive category content analysis and summative (latent) content analysis, were the primary qualitative content analysis approaches used in this thesis. Simon's bounded rationality concept was the primary theory under study, with the study objective being to practically validate and/or extend this theoretical framework in behavioural strategy applications. The motivations and drivers of climate change response and the categories of initiatives undertaken by businesses are the other two classes of content which were also analysed using qualitative content analysis.

Figure 2-2 Content Analysis Process Flow



Source*: Krippendorff, 2004*

From the process flow diagram shown in Figure 2-2, bounded rationality theory and climate change response strategy theory were used to develop the initial coding schemes. Through the

loopback process shown above, additional codes were developed and the initial coding scheme was revised and refined as data analysis progressed.

2.10.2 Directed (inductive category) Content Analysis

With a directed approach, analysis starts off with a theory as the basis for identifying key themes, concepts and categories and acts as a guide for the generation of initial codes (Boyatzis, 1998). The main idea of the procedure is to formulate a criterion of definitions (derived from theoretical background and research questions). Following a step-by-step work through content material, descriptive labels and tentative labels are given to distinct occurrences of phenomena, gradually moving down to lower-level categories and integrating these into higher-level categories (Hsieh & Shannon, 2005) as necessary. Using an iterative process, the categories are revised, reworked and eventually reduced to main categories which are checked for reliability. The integration of the data allows for insightful categorization of information, promoting the emergence and generation of new theory (Mayring, 2000).

The theory of bounded rationality, technology adoption, the 'no regret paradox' and 'energy-efficiency gap' theories were used to provide variables of interest and the relationships among the variables (Hsieh & Shannon, 2005). Porter and Reinhardt's concepts of corporate climate change response initiatives were also used as a second set of coding categories. Having identified the key concepts and variables, operational definitions for each category were determined using the literature review. Professional colleagues, an industrial psychologist and climate change response specialists agreed to the coding categories that were applied to the data. Revisions to the categories were made, up to the point where exclusivity and exhaustiveness were maximised (Boyatzis, 1998; Weber, 1990).

2.10.3 Summative (latent) Content Analysis

Summative analysis is particularly useful for texts that are complex or cover sensitive topics. It works best with diverse data, snippets of text, or long, meandering tracts and enables data that do not fit a mould to be considered, offering more analysis flexibility (Rapport, 2010). Summative analysis has the potential to generate a range of insights and reflections and can provide a careful approach to sensitive or emotional topics (Sparkes, 2002) by allowing the

researcher to become aware of ambiguous aspects of text. It preserves the quality of the speaker's voice irrespective of the mode of presentation and considers issues beyond a researcher's own knowledge (Rapport, 2010). The analysis technique' greatest strengths are its versatility and inclusivity where everyone's views matter. While end-result of analysis is reduction (Miles & Huberman, 1994), summative analysis minimises the reductive effect by considering the importance of text as a whole and its impact on the speaker and audience (Rapport, 2010).

In order to build the climate change response continuum, a summative approach to content analysis was used, where the starting point was the identification and quantification of certain words and phrases in the text with the purpose of understanding the contextual use of the words. The data analysis started with computer-assisted searches (using NUD*IST) for occurrences of the terms of potential interest such as "water utilisation", "energy efficiency", "waste", "awareness", etc. (Annexure 4) for the coded scripts. This was then followed by a Key Word in Context (KWIC) search to test for the consistency of usage of the words (Weber, 1990). Word frequency counts for each of the climate change actions – related words or phrases were calculated and compared per speaker. Next, alternative terms or expressions used instead of "waste", energy efficiency", "water utilisation", etc., were identified. Occurrences of these terms were also counted as a total number and for each alternative term. This quantification was an attempt to explore usage (manifest content analysis) and prevalence, as well as the extent to which these climate change initiatives were a part of the company's current climate change response agenda or under consideration.

The transcripts were then reviewed carefully, highlighting all text that on first impression appeared to describe bounded rationality in strategic decision making. Data that could not be coded into the identified and agreed coding categories were re-examined to search for new and emerging categories or sub-categories of existing codes. The coded data was analysed to establish the extent to which the research findings offered supporting or discomfiting evidence of strategic decision making biases and bounds on rationality. The extent to which findings that were supportive of bounded rationality theory compared with rational economic utility maximisation theory were examined. Incidences of the codes representing bounds on rationality are presented, with examples from the interview scripts and descriptive evidence, where available, also being provided.

2.10.4 The Use of Categories

Categorisation or coding of data was undertaken to facilitate an understanding, retrieval and comparison of the information within and between case studies. *A priori* categories of analysis were determined based on Table 2-1, but most QDA packages allow for the emergence of new categories based on the analysis. Both options were used in order to allow for comparability as well as to identify outliers requiring further analysis. Descriptive, analytical and interpretative categories were then explored in the study. Coding indicating the frequency (number of counts) of themes and categories of climate change response initiatives, while binary counts (presence or absence) of certain categories were also used in the analysis (Jehn & Jonsen, 2010). The quantitised frequencies indicated particularly prominent initiatives, drivers or irrational behaviours in organisational strategic decision making processes (Onwuegbuzie & Teddlie, 2003). The quantification of qualitative data enabled an inter-company comparison, as well as a comparison with the quantitative data collected within an organisation. Pattern analysis, the method of analysis indicated for multiple case studies, entailed identifying a pattern of categories and variables (Seekamp *et al*., 2010, Dures *et al*., 2010) from the literature and the pilot case, and then assessing patterns observed in each of the two cases against that predicted pattern. The binary form of quantitising determined the presence or absence of each behavioural category for each participant. Individual responses from the one-on-one interviews were converted into a series of coded response categories that were in turn quantified as binary variables 0 or 1 based on the absence or presence of each coded response.

Because quantitising has the effect of reducing everything to a single-dimension, causing considerable loss of context and meaning (Seekamp, *et al*., 2010, Rocco, *et al*., 2003), interpretation of these categories was based on both the quantitisied and the raw transcripts. Where evidence from different sources was inconsistent or contradictory, reasons for the discrepancies were sought.

2.10.5 Interpretive Content Analysis

Text analysis was used for construct development and construct measurement in a variety of organisational contexts (Jehn & Jonsen, 2010; Seekamp *et al*., 2010) to facilitate data

exploration. To identify and measure the irrational behavioural constructs in this study, interpretive content analysis (Seekamp, 2010) was employed to assess the types of constructs and social influences reflected in the statements made by participants in the one-on-one and group deliberative processes, and to develop coding categories for the behavioural constructs. The focus on the interpretive content analysis was on understanding the meaning of data in context to catch salient as well as subtle behaviours under study. A trained psychologist was utilised for the process to reduce researcher biases, such as reactivity, selective information processing and possible misinterpretation.

2.10.6 Examination of Other Data Sources

Transcriptions of field notes and notes taken during observations were analysed for instances of the irrational behavioural constructs.

2.11 Integration of Findings

The concurrent triangulation mixed methods approach allows for the integration of findings where convergence, differences or some combinations can be interrogated for confirmation, disconfirmation, cross-validation and/or corroboration (Molina-Azorin, 2010; Creswell, 2009; Greene *et al.*, 1989). The convergence or similarity of results from different methods and/or measures was analysed to check for transactional triangulation, which, where present, increased the confidence in the validity of the method used (Seale, 2004). Outliers and salient as well as subtle discrepancies were also examined as these have been proven to be sources of great insight (Jehn & Jonsen, 2010; Creswell, 2009, Miles & Huberman, 1984). For example, if the motivations and drivers from two participants provided widely different rationales, then inconsistences were scrutinised. As Jehn and Jonsen (2010:327) put it, the objective is to use a "more contemporary and transformational triangulation mind-set", which allowed the study to answer the 'how' and 'why' of executive decision making regarding climate change response. This in-depth probing created complementarity and increased confidence in the research findings (Creswell, 2009; Scadura & Williams, 2000).

The different comparison techniques that were used in this study included:

2.11.1 Categorical Analysis

As stated earlier, the objective of coding was to identify any of the behavioural constructs as specified in Section 2.7. Individual self-reported behavioural constructs gathered during the unstructured interviews, field and observation notes and transcripts from the interviews were examined, first separately and then together. Therefore, evidence of behavioural constructs were examined to see how the executive team processes the information to make decisions and how the irrational behaviours and other group dynamic forces at play influenced the organisation's choice of climate change response strategy . For example, status quo bias (the tendency to want things to stay the same), can significantly impact the decisions and alternatives selected. This can easily be seen in such phrases as "that is how we have always done things around here", etc. Contingency tables (cross tabulation or matrices) were used to record and analyse the relationship between two or more categorical variables, displaying the (multivariate) frequency distribution of the variables in a matrix format.

2.11.2 Across-Group Analysis

Another method of analysis that was utilised was based on choosing a category on which the two firms' differed and probing to gain an in-depth understanding of the similarities and difference and the possible causes of those. The discriminating factor for this analysis was the quality of the Pareto optimal function (based on the AHP tool outcomes) derived by each organisation as their chosen climate change response strategy. The across group performance was analysed on the irrational behavioural constructs affecting decision making within the two companies, by comparing the one-on-one interviews outputs and the other sources of information and the field and observation notes. This analysis uncovered patterns and insights that have important implication and contributions (Jehn & Johnsen, 2010) to the fields of behavioural and behavioural strategy theory building.

2.11.3 Variable Score Comparison

Variable comparison was used to show the results of each executive's text rating for each variable and the group's score on the same variable. The absolute frequency counts from the text analysis were also included in a variable comparison table. Building of fact-linkages, correlations and other descriptive statistical inferences were performed on those to gain a

deeper understanding of the relationships and the dynamics at play. Factor analysis, which seeks to answer the question: "What are the patterns of relationship among these data?" were explored. These patterns were viewed from the perspective of the pattern of variations and similarities of the two firms' behavioural constructs.

2.12 Validity and Reliability of Research

According to Denzin and Lincoln (2000), researchers within a constructivist paradigm, such as that used in a case study research methodology, attempt to reconstruct participants' understanding of the world, such that traditional criteria of internal and external validity are replaced by concepts like trustworthiness, credibility, authenticity, transferability etc. For this study, dependability and auditability was used in the place of reliability (Guba & Lincoln, 1985), where the question to be answered was whether the research design, purpose, data collection and analysis strategies indicate coherence. Internal validity is replaced by credibility or authenticity, where the aim is to ensure that the findings and outcomes can be depended upon. For the study to be meaningful and for it to contribute to the body of knowledge, the outcomes and conclusions have to be transferable to other contexts, so that external validity is replaced by transferability or fittingness (Patton, 2002; Yin, 1993).

2.12.1 Trustworthiness

According to Folger *et al*. (1984), the development of a good coding scheme is the key to trustworthiness in research employing content analysis. Lincoln and Guba (1985) defined the four criteria central to trustworthiness in content analysis research as: credibility, transferability, dependability and conformability. This section explains how trustworthiness was improved in the study.

2.12.2 Credibility

As evidence of trustworthiness, credibility or internal consistency is a key requirement of summative content analysis. Credibility was defined by Bradley (1993:436) as "the adequate representation of the constructions of the social world". The need to demonstrate that textual

evidence is consistent with interpretation (Weber, 1992; Hsieh & Shannon, 2005) was made easier by the fact that the words under study are technical terms which mean the same thing across businesses and industries. Professional colleagues in the climate change field were used to check reproducibility of the coding categories for the climate change response initiatives. Reliability was calculated by using Cohen's Kappa (Cohen, 1960), which calculates the proportion of units on which raters agree, taking into account chance agreements. A Cohen Kappa of 0.83 was considered good enough for the coding categories to be considered credible.

Only one researcher was involved in the study both from a data collection and coding perspective, so the question of inter-coder reliability is automatically eliminated in this study. Validation of the coding scheme was provided by an industrial psychologist who was the content expert (Hsieh & Shannon, 2005; Krippendorf, 2004) in understanding organisational decision making biases and bounded rationality concepts.

Other actions taken to improve credibility included triangulation of data, where secondary data from the publicly available Corporate Sustainability Reports, JSE SRI and CDP submissions were also used. Negative case analysis (Patton, 2002) was actively pursued in the study where all outliers were carefully analysed. Interpretations were checked consistently against raw data; while peer debriefs (Lincoln & Guba, 1985) using climate change experts and an industrial psychologist were consulted extensively throughout the data collection and data analysis phases of the study. The data collection adequately solicited representation by involving as many functional areas as necessary. Some of the conclusions were drawn directly from the raw data.

2.12.3 Transferability and External Validity

Transferability is the degree to which a researcher's working hypothesis can be applied to another context (Krippendorf, 2004). For this study, data sets and descriptors are provided in the Findings section and Annexure 3, whose transferability to other settings and contexts other researchers can determine. Dense description (Lincoln & Guba, 1985), also called "thick description", was used throughout this research study. To thickly describe social action is to "begin interpreting it by recording the circumstances, meanings, intentions, strategies, motivations, and so on that characterize a particular episode. It is the interpretive characteristic

of description rather than detail per se that makes it thick" (Schwandt 2001: 255). Theoretical and analytical generalisation was employed through "pattern matching" (Yin, 1984), where patterns found in the data were linked to patterns found in climate change response and bounded rationality theories, thus aiding in conceptual generalisations.

2.12.4 Conformability

Conformability is the extent to which the characteristics of the data posited by a researcher can be confirmed by others who read or review the research results (Bradley, 1993).

Both transferability and conformability can only be judged by reviewers of this work. Audits of the research process (including methods, decisions and analytical strategies), findings and checking the internal coherence of the research product by checking the raw data (some of the interview transcripts included in Annexure 3), the findings and the recommendations have all been verified by the academic panel throughout the course of the research.

2.12.5 Validity

Triangulation is the in-built design tool most accepted as a way of increasing the validity of a research process (Lincoln & Guba, 1985; Patton, 2002). Multiple sources of information for data (data triangulation), theory triangulation (multiple theories/perspectives used to interpret the findings of the study) and interpretation were used in this research. "Thick description" (Schwandt, 2001) of design phenomenon and of the findings were closely associated with corporate climate change responses and bounded rationality theoretical underpinnings.

Literature Review

This section is divided into three chapters. Chapter 3 describes the climate change challenge, and it's relevance to business. The risks and opportunities presented by climate change are discussed followed by some of the key drivers that are motivating companies to respond to climate change. Chapters 4 and 5 describe the key theories that are used to construct the climate change response framework. The influence of bounded rationality to industrial organisations and its impact in strategic decision making are emphasised. Multi-criteria decision aid theories and their relevance in solving multi-criteria decision problems are presented in chapter 5.

3. The Climate Change Challenge

The literature surveyed starts with the general challenges of climate change , it's effects and impacts on humanity and how the human race has organised itself to adopt to and mitigate these effects. This is then followed by a closer look at how businesses in different industries and jurisdictions are approaching climate change adaptation and mitigation. The last section of this chapter looks at climate change response within the sugar, starch and aviation industries. These three industries are relevant to the two companies used in the case study.

3.1 Climate Change History

One of the hottest topics in business boardrooms and political round tables of our time is climate change – often loosely referred to as "global warming". It brings together a diverse set of stakeholders from the science communities, researchers, risk and insurance, politics, economics, and the greater public (Raymond & Brown, 2011). Although actions against climate change risks, impacts and challenges for businesses, societies and the whole of humanity have only taken centre-stage in the last twenty years, the debate has been going on for more than two centuries. Interest and studies on climate change date as far back as the 19th century (Corner & Pigeon, 2010). Scientists predict that atmospheric concentrations of carbon dioxide will soon rise above preindustrial levels to 450 parts per million, which may lead to a global average temperature increase of between 1.8 and 4 degrees Celsius (Anderson & Bows, 2008)

by the end of the 21st century relative to 1990 levels. A 4-degree temperature change could cause the collapse of essential regional ecosystems (IPCC, 2007*b*).

A significant amount has been written (Anderson & Bows, 2008; Stern, 2006; Taviv *et al.,* 2007) about how we know that climate change is happening and what risks exist for business. As more evidence about the reality of climate change becomes available and the rift between proponents and critiques narrows, the debates and controversies have shifted to issues surrounding mitigation and adaptation (King & Lessidrenska, 2009; Winkler, 2010). Mitigation presupposes that people can make a concerted effort to reverse or at least arrest the anthropogenic effects of global warming and climate change (IPCC, 1996), while adaptation efforts are aimed assisting humanity, communities and whole countries to survive and thrive amid all the negative consequences brought about by climate change.

3.2 Definition of Climate Change

For the purposes of this thesis, the United Nations Framework Convention on Climate Change (UNFCCC) definition of climate change was used. According to UNFCC, climate change is:

"[. . .] a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (www.unfccc.org).

Dow and Downing (2011) and Stern (2006) defined climate change as related to a set of natural causes such as solar radiation, volcanic activity, continental drifts and the earth's tilt. According to Stern (2006), the natural causes of climate change are complemented by anthropogenic actions such as emissions of greenhouse gases from industry, combustion of fossil fuels, land-use change and deforestation. This combination of natural and human-induced causes in turn leads to greenhouse effect(e.g. global warming, ozone layer depletion, changes in socio-economic conditions) and consequences (e.g. disruptions in agriculture, sea level rise, increases in the frequency of draughts/floods) which disrupt the natural order and flow of life on planet earth.

3.3 Taking Action against Climate Change

In his research, Filho (2009) arrived at the conclusion that "Finding practical, workable and cost-efficient solutions to the problems posed by climate change is now a world priority and one which links government and non-government organisations in a way not seen before". The United Nations has been in the forefront of both researches aimed at understanding more on anthropogenic climate change, as well as efforts to address the challenges it poses. A joint effort of the World Meteorological Organization and the United Nations Environment Programme culminated in the formation of the Intergovernmental Panel on Climate Change (IPCC) in 1998 - a world body that evaluates the risks of climate change. The IPCC has found worldwide acceptance and recognition since its inception (Dow & Downing, 2011; Winkler, 2009; Filho, 2009). This led to the tabling of the UN Framework Convention on Climate Change (UNFCCC), which was adopted on 9 May 1992 by the Intergovernmental Negotiating Committee, an arm of the IPCC. The stated objective of the UNFCCC is to achieve stabilisation of the concentrations of six greenhouse gases (GHG); carbon dioxide, methane, nitrous oxide, ozone, water vapour and halocarbons, which are considered to be the main causes of climate change, in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. In early June 1992, the UNFCCC was opened for signature and entered into force on the 21st of March 1994. The UNFCCC has over 200 parties and observer states, making it one of the most universally supported and most influential multilateral environmental agreements. The South African government ratified the UNFCCC in 1997.

Negotiated under the UNFCCC, the Kyoto Protocol was agreed in Kyoto, Japan, in December 1997. The Protocol established legally binding commitments for reducing greenhouse gas emissions from Annex I countries (industrialised/developed countries) as well as outlining general commitments for all signatories aimed at meeting the ultimate goals of the UNFCCC (http://unfccc.int). The Kyoto Protocol entered into force in February 2005 and set targets for industrialised countries "with a view to reducing their overall emissions of such gases by at least 5% below existing 1990 levels, in the commitment period 2008-2012" (http://unfccc.int). Negotiations on a new agreement to replace the Kyoto Protocol are on-going. Under the Bali Roadmap of 2007, a new global agreement was due to be reached at the end of 2009 in Copenhagen. Instead, the negotiations resulted in the 'Copenhagen Accord', which allowed both

developed and developing countries to make non-legally binding commitments for 2020. Negotiations on an official post-2012 agreement are continuing after the COP 17, Durban 2011 Conference.

Although these climate change responses are national-level commitments, in practice most countries will delegate their emissions targets to individual industrial entities, such as utilities and manufacturing companies. Thus, finding practical, workable and cost-efficient solutions to the problems posed by climate change is now a world priority for business as well. Stern (2006) has reiterated the fact that a sound understanding of the economics of climate change is needed in order to underpin an effective global response to this challenge. Adapting to climate change is important (Tompkins & Adger, 2005) so as to reduce vulnerability (Dow & Downing, 2011) and to understand and map out the opportunities it presents.

3.4 The Complexity of the Climate Change Challenge

Scientific uncertainty about natural climate variability and the consequences of global warming on the natural climatic system (Raymond & Brown, 2011) is creating uncertainty about future impacts and feedbacks of climate change on social and economic structures, which further depend on human adaptation (Dow & Downing, 2011). In a warmer world, people's living conditions will be seriously challenged. Global food security is expected to worsen as a result of climate-related drought and weather-related extremes (IPCC, 2007*b*), compounded by a world population that is estimated to balloon to 9 billion by 2050. For these reasons, climate change poses the greatest problem for people who are already battling with marginal conditions. Land-use change is one of the major challenges that societies will have to grapple with in a warmer world (Raymond & Brown, 2011). The area of degraded or marginal lands is estimated to increase by 17% over coming decades as a result of global warming (World Bank, 2007).

The uncertainty associated with climate change makes it difficult for the public and private sectors to respond optimally (Tompkins & Adger, 2005; Dessai & Hulme, 2007). On a governmental level, uncertainty hampers the design of appropriate mitigation and adaptation

strategies. On the individual and company level, uncertainty creates difficulties in handling possible future costs arising from climate change. Raymond and Brown (2011) contended that uncertainty increases the influence of the institutional environment (i.e. influence of industry fads that come and go over time, competitors, industry associations, consumers, NGOs, regulatory agencies, and the media, etc.) and reduces the impact of economic and competitive factors (the "task environment"). Radically new technologies that are economical, environmentally benign, and virtually carbon neutral coupled with the finances, institutions and leadership is required to address the challenge effectively (Dow and Downing 2011). Given this high level of uncertainty concerning climate science, technological and market developments, and policy responses, businesses cannot easily make rational, objective calculations of their economic interests and appropriate strategic responses. The problem is not that investment decisions are taken under conditions of risk; rather, planning scenarios contain assumptions and predictions about research and development costs, technological developments, consumer behaviour, competitors' reactions, and regulatory responses that are shaped by organisational fields and are not stable over time (Dow & Downing, 2011).

3.5 Market-Based Policy Instruments to Address Climate Change

3.5.1 Cap-and-Trade

Two market-based policy instruments, emissions trading and carbon taxation have been widely accepted and adopted by many governments. Emissions allowances (caps) are tradable commodities entitling the holder to emit certain quantities of CO_2 equivalents (Dubrowski, 2010). To be in compliance, entities must hold quotas greater than or equal to their cap (Bartos, 2009). Supply and demand dynamics determined pricing (Dubrowski, 2010) which has implications for business. Entities that find creative ways to keep their emissions below their limit could potentially earn revenue by selling their excess credits (Millard-Ball, 2009), while those entities emitting above their cap would earn the right to emit by purchasing quotas (Murray et al., 2009) from the cap-and-trade market, such as the European Union Emissions Trading Scheme (EU ETS), which is a grouping of 25 European Union member states or home-grown systems, like Shell's Tradable Emissions Permit System.

Carbon markets also offer project based transactions (Millard-Ball, 2009) where carbon emissions are traded through credits from projects birthed to offset emissions via such channels as renewable energy generation, carbon sequestration, reforestation or energy efficiency – called the Clean Development Mechanism (http://cdm.unfccc.int). Joint Implementation (JI), (http://ji.unfccc.int) on the other hand, allows financing of projects between Annex-1 countries and earns the financier the Emissions Reduction Units (ERUs) type of carbon credits. Trading programmes can be implemented on a mandatory (e.g., EU ETS or Australia's Carbon Pollution Reduction Scheme) or a voluntary basis (e.g., Gold Standard Carbon Emissions Reduction or the Chicago Climate Exchange).

3.5.2 Carbon Taxes

Taxation of greenhouse gas emissions is the second policy instrument which fixes the marginal cost for carbon emissions and allows quantities emitted to adjust accordingly (Litman, 2010). Carbon taxes are based on fossil fuel carbon content. They place a price on emissions by levying a charge on every ton of carbon dioxide or equivalent emitted, thereby creating an incentive for GHG emitters to find creative ways to reduce emissions, which is the ultimate goal of all these interventions. Proponents of carbon tax (Litman, 2010; Tol & Verde, 2009; Lee, 2008) argue that direct levying of taxes on business entities encourages firms to rethink their core business models and seriously consider alternative energy sources. They stress that there are economic benefits, both at corporate and societal level, to be realized by businesses being more efficient and innovative.

Much of the debate around carbon taxation centres around its administration by governments (Gerlagh et al., 2009; Yohe *et al.,* 2007; Yusuf & Resosudarmo, 2007), as well as the effects that further policy actions could have on economic growth and development, particularly for the developing and least developed nations. Economists all over the world have developed sophisticated models (Nordhaus & Bayer, 2000; de Leyva & Lekander, 2003) to model the costs, benefits and impacts of different policies on businesses, industries, whole economies and/or regions.

3.5.3 Other Instruments and Measures

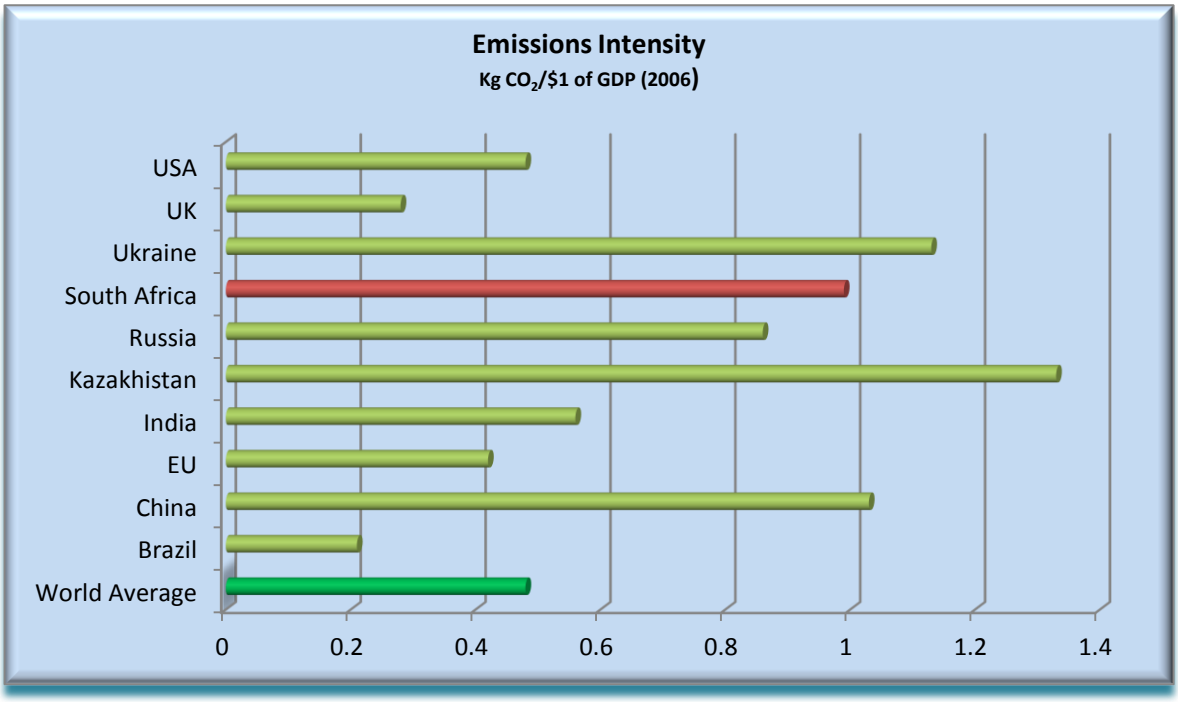
A carbon tax or a cap-and-trade system by itself will not solve this very complex challenge. Governments the world over are adopting a mix of instruments (Dow & Downings, 2011; Devarajan *et al.*, 2009) in addition to other measures and standards that are not based on the actual amount of emissions, such as standards and regulations to increase energy efficiency, other economic instruments such as incentives and duties on energy-efficient equipment, encouraging the development and use of renewable energy. Adaptation strategies aimed at water availability and human settlements and food security (Dow & Downing, 2011; Taviv *et al.*, 2007) are being brought into the climate change adaptation and mitigation stream.

3.6 The Relevance of Climate Change to South African Businesses

South Africa has been included with such developing economies as India, China and Russia as participants who, although not classified as developed economies, are contributing as much to climate change (Winkler, 2009; King & Lessidrenska, 2009) and could have the resources required to mitigate further increases in greenhouse gas emissions. South Africa is a relatively heavy GHG emitter, contributing 65% of Africa's and 1.5% of the world's carbon dioxide emissions (http://cdiac.orni.gov). It is ranked as the 12th heaviest emitter of GHG in the world due to energy-intensive sectors in the economy e.g. smelting, deep mining, coal-to-liquids fuel generation and a heavy reliance on coal to produce electricity (www.climate.org). The carbon dioxide emissions distribution in South Africa is due to the energy supply mix which is heavily skewed towards coal (King & Lessidrenska, 2009). Of the country's total consumption, about 75% is coal and 20% oil, with the balance being made up of natural gas, nuclear, hydroelectricity and other renewables (www.bni.org).

As an active participant in the Kyoto Protocol, South Africa demonstrated its commitment by developing a Long-term Mitigation Scenario (Winkler, 2008). The conditional pledge by President Jacob Zuma to reduce national GHG emissions by 42% by 2025 (www.environment.gov.za) during the 2009 Copenhagen Conference on Climate Change and the hosting of Conference of Parties (COP) 17 in November 2011 is further incentive for South African companies to seriously consider climate change impacts.

Figure 3-1 South Africa's Carbon Emissions Intensity



Source – Carbon Dioxide Information Analysis Center (http://cdiac.ornl.gov)

These undertakings, together with the recent introduction of climate change measures such as the SA Climate Change Response Strategy and the introduction of a vehicle carbon tax in September 2010, is indicative of the seriousness with which businesses should addressing the climate change challenge response. Climate policy in South Africa is gaining momentum and frameworks for greenhouse gas emissions reduction and trading are emerging (www.environment.gov.za). In the words of John Varley, the Group Chief Executive of Barclays, "Climate Change is a business issue. It has joined the list of top risks and opportunities." (http://www.independent.co.uk). The proactive engagement of business in climate change, Varley said, is in businesses' own interest. He also made the point that in today's integrated economy, businesses are more globalized than governments and are thus indispensable in this endeavour.

The Department of Environmental Affairs Deputy Director, Joanne Yawitch, noted that, "Operating in a 'carbon-constrained world' has brought up issues of innovation and competitiveness that businesses in South Africa need to recognise and deal with (www.environment.gov.za). Speaking at the University of South Africa's press Trialogue panel

discussion in February 2010, Webber Wentzel Attorneys' partner Johan Scholtz emphasised that companies that take climate action early will be best placed to take advantage of the opportunities and protect themselves from the negative aspects of climate change. He highlighted the myriad of climate-related risks facing corporations, including: operational delay risks; regulatory; tax; reputational; insurance; and litigation risks.

According to Claude Fussler, Programme Director for the Caring for Climate (C4C) section of the United Nations Global Compact (www.caring4climate.org), businesses from all regions and sectors have already started their journeys towards energy efficiency, innovation and GHG emission reductions. Fuelled by opportunities to reduce energy costs, secure energy supply, protect business from climate change risk and damaged reputations, generate new revenues or enter into new industries; carbon management has become a strategic imperative for many organisations (www.pewclimate.org). In fact, this drive towards food and water conservation, energy efficiency and carbon reductions, combined with a proactive management of systemic climate risks, is defining a new level of environmental stewardship (Dow & Downings, 2011). Long-term investors, asset managers and analysts such as Bloomberg and Google Finance are beginning to integrate these considerations into investment analysis and decision-making such as the FTSE CDP Carbon Strategy Index (www.ftse.com) and the Markit Carbon Disclosure Leadership Index (www.markit.com). Venture capitalists and corporate R & D divisions are investing in different "clean technologies".

3.7 Business Impacts of Climate Change

Exposure to climate change can be positive, negative or a combination of both, depending on the industry and the company-specific variables (Schultz & Williamson, 2005). Climate change presents both risks and opportunities for business. The impacts of these risks and opportunities vary significantly among businesses, depending on the source and exposure to greenhouse gas emissions (Reyers *et al.*, 2011), i.e. direct emissions as a result of a company's own operational activities, or indirect emissions such as those along a business' value or supply chain, e.g. purchased electricity, resource availability, resource costs and security of supply, changes in customer needs as a result of changes in economies, or weather induced requirements (Schultz & Williamson, 2005).

Business risks from climate change include physical impacts resulting from volatile weather conditions which are resulting in extreme weather patterns (droughts, wildfires, hurricanes, monsoons, typhoons), rising sea levels, melting ice glaciers, and the resultant effects on animal and human health and well-being (Dow & Downings, 2011). A key risk for business is access to resources and risks to capital stock, such as infrastructural damage due to sea level rise. As a consequence of the above, there are negative impacts on business resources, personnel, insurance markets and corporate business models (www.pewclimate.org). Mounting legal and regulatory pressures and litigation is being augmented by country level or industry level investment risks and increasing public and stakeholder activism affecting business reputation and brand equity (Schultz & Williamson, 2005).

Opportunities and Risks

For the agile firm, climate change is also presenting numerous opportunities including revision of business models to allow for greater efficiencies in terms of materials and energy, waste, water, etc.; development of new and cleaner technologies, products and services, industries and participation in whole new industries which were non-existent a decade ago; participation in carbon markets and emissions trading giving rise to new revenues; strengthening of reputation and the brand by managing stakeholder requirements, advocating climate change response and making contributions to solving climate change issues (Raymond & Brown, 2011).

Climate change risks cut across almost every industry, whether directly or indirectly. The greatest liability in carbon exposure is in carbon-intensive sectors such as oil and gas, basic resources, utilities; heavy manufacturing where carbon costs could be direct or be due to purchased electricity or passed down through the supply chain in the form of higher prices (www.irrcinstitute.org). Some of the major risks are explained below.

3.7.1 Legal and Regulatory Risks

As emission reduction requirements become more well-defined and stringent, non-compliance risks and consequent litigation risks rise. Regulatory risks are on the increase the world over as governments take heed of the calls to action through treaties such as the Kyoto Protocol; regulations; national resolutions or local government and federal regulations. These national and international commitments are creating environments where the need for dialogue

(Griffiths, *et al.*, 2007) between governments and the private sector are becoming increasingly unavoidable, resulting in policy positions that are forcing corporations to seriously consider the impacts of climate change on their businesses.

The lack of climate change legislation or the slow enacting thereof in some jurisdictions is creating discomfort within the corporate community (www.nbi.org). This has been a subject of much debate in South Africa. A key question has been posed: "Supposing a proactive company takes action to reduce GHG ahead of legislation. Will the authorities take cognisance of the new baseline when they calculate an entity's emission levels and the required limits?"

3.7.2 Competitiveness Risks and Opportunities

With adverse weather conditions (Khandekar *et al.*, 2005; Stern, 2006), changes in climate may cause damages to buildings, interruptions to infrastructure and supply chains. It may also change travel and migration patterns, affecting such business decisions as location decisions and geographic markets to pursue. For example, the European Union Directive on Aviation (http://ec.europa.eu) is causing viability challenges for airlines. The introduction of climate change specifications on goods imported into the EU and the imposition of taxation on imports through Border Tax Adjustments (BTAs) poses serious trade barriers (http://ec.europa.eu). Businesses also face the obvious risks of changes in the prices of oil, gas, electricity and, where required, carbon. To mitigate these risks, companies can either reduce their exposure or hedge the risk (Mills, 2005). Such attempts to pass through carbon costs will add onto the prices of goods and services, making products uncompetitive on global supply chains.

Product and Market Diversification

The pursuit of diversification as a business strategy - the need to enter into new businesses; shift away from low margin, low growth or mature industries, distribute risk, utilise excess productive capacity, compensate for technological obsolescence, reinvest earnings into high growth industries (Carbon Trust, 2006), are key drivers for businesses to respond to climate change. By investing in efficient technologies and developing sufficient skills to support value addition e.g. significantly reducing energy costs, streamlining the supply chain and meeting stakeholder expectations, benefits will trickle to the bottom-line. Several companies are investing in research and development to come up with environmentally-friendly products with

new revenue streams (e.g. SunChips by Frito-Lay: www.sunchips.com) and services which open up new markets and industries. Companies are seeking market opportunities in developing new technologies, often backed by venture capitalists and "green capital". Some of those companies have grown into publicly traded, large organisations, e.g. SolarWorld (www.solarworld.de). Other investors seek specific opportunities in renewable energy assets, such as solar, wind farms, tidal waves, biomass or co-generation promising more stable growth.

3.7.3 Investment Relations – Risks and Opportunities

Financial markets are calling for more robust corporate disclosure of carbon intensity so as to factor the carbon profiles into capital allocation and investment decisions (www.caring4climate.org). There is also increasing pressure on businesses to report non-financial issues related to climate change, through mechanisms such as The Carbon Disclosure Project (CDP). The cost of capital will likely be influenced by a company's ability to mitigate exposure to liabilities posed by a carbon-constrained world (CDP, 2012). Bank-lending criteria that take cognisance of climate change mitigation have already been incorporated by leading multi-national financing institutions (www.worldbank.org). Investment decisions in assets such as power stations, industrial plants and buildings are already being driven by carbon intensity considerations. The cost of capital associated with carbon-intensive investments is an additional risk that can become more prominent in the future. Discounting of share prices for companies poorly placed to compete in a carbon-constrained world is already taking place in most of the Annex I countries (www.pewclimate.org). Thus, financial exposure from climate change affects business' ability to raise capital and impacts on credit ratings.

3.7.4 Brand Equity

Public perceptions of corporate behaviour have the potential to impact the bottom line of businesses (Reyers *et al.*, 2011) and the very existence of certain businesses. A 2002 study of European and American businesses showed that the value-at-risk because of climate change varied between companies by a factor of 60 times (Innovest Strategic Value Advisors, 2002). A 2008 study by Point Carbon showed that the market capitalisation of American business was impacted by between 10 and 35% due to climate change–related risks. Several organisations have stepped up educational and awareness building programmes on climate change (CDP,

2010). Organisations that are seen to be taking steps towards carbon-neutrality are reaping benefits (Schultz & Williamson, 2005), while those choosing to ignore the calls oppose climate change action outright, may have to bear the brunt of the repercussions, including increased scrutiny of business activities, reduced ability to attract talent and investments, consumer boycotts, media coverage and potential litigation (www.pewclimate.org). Those companies that will succeed in portraying a positive image of their efforts to mitigate climate change stand to gain market share at the expense of the laggards (Deutsche Bank Research, 2007).

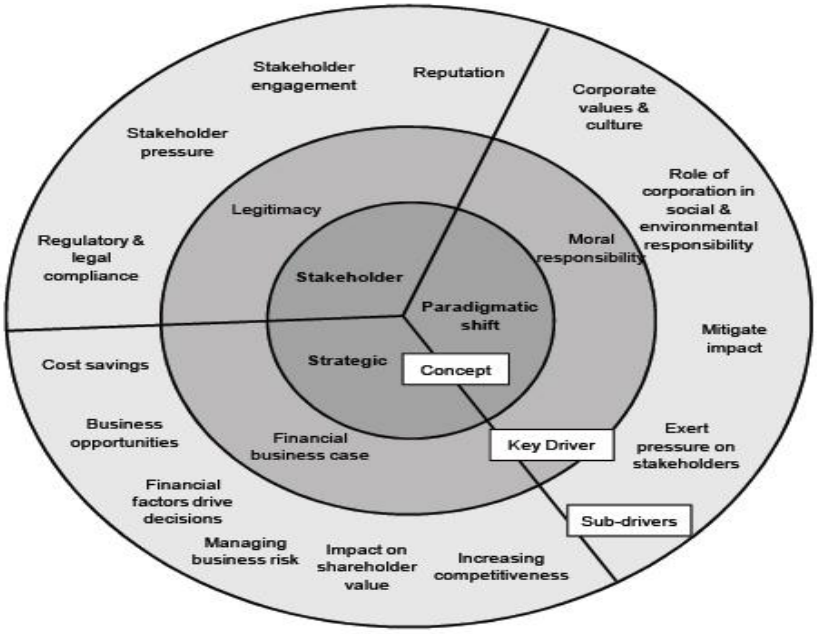
3.7.5 Supply Chain and Operational Risks and Opportunities

Achieving sustainable environmental management along a whole supply chain is complex due to global business management trends (Welford & Frost, 2006) like global sourcing and off-shoring. In their study of multinational supply chain partnerships, Cheung et al., (2009) found that companies are adopting a top-down approach to green supply chain management by imposing higher "green" standard on their suppliers. As a result, business-to-business relationships are increasingly incorporating environmental sustainability standards (Welford & Frost, 2006). On the other hand, accounting for emissions along a supply chain can help identify lucrative emissions and cost reductions (Stoffberg & Prinsloo, 2009) and other value-creating opportunities.

3.8 Drivers of Corporate Climate Change Response

Banerjee (2002) and Bansal and Roth (2000) identified the key drivers for corporate action as being competitiveness, also called the financial business case, organizational legitimacy (Bansal & Clelland, 2004) primarily geared towards managing stakeholder expectations, and ecological responsibility, which is a paradigm shift towards responsible earth citizenship where values and morality become the dominant drivers for corporate climate change response. From a South African perspective, Reyers, *et al*. (2011) extended Banerjee and Bansal and Roth's frameworks and came up with subcategories for the three over-arching drivers as shown in Figure 3-2. The addition of another layer of sub-drivers provides necessary information which allows distinctions to be drawn between the motivations of different companies and enables one to answer with precision the question "Why respond to climate change?"

Figure 3-2 Corporate Climate Change Response Drivers



Source: Reyers, *et al.* (2011)

Other studies that have provided vital information concerning motivations and drivers for corporate climate change action including the Pew Center's 2006 study, 'Getting Ahead of the Curve: Corporate Strategies That Address Climate Change', which was undertaken by Andrew Hoffman of the University of Michigan, as well as the Climate Change Connection Report entitled, 'The Bottom Line on Climate Change: A Manitoba Business Guide'. These studies identified several drivers for corporate action including; profitability and access to new sources of capital, customer demands for 'greener' products; shareholders demanding accountability and transparency; pressure from NGOs and activists; desire for increased operational efficiency in order to remain competitive; consistency with existing corporate cultures; protecting the global environment; social responsibility; improving company reputation; remaining competitive with industry peers; rising energy or feedstock prices; intra-industry energy or climate change initiatives; compliance with existing or pending national, state or local legislation or international agreements; new strategic direction for company

In their study of the drivers for corporate activity of the Carbon Disclosure Project 500, Kolk and Pinkse (2004:307) found that companies "emphasise the business opportunities related to

climate change rather than the risks". The expected increase in competitiveness was largely spurred by realising cost reductions, changes in demand for goods and services due to increasing consumer awareness and demand for environmental friendlier products and services, and the precipitation of innovation resulting in the development of new technologies. Other motivations for action include the lobbying and influencing of governments and policy outcomes (Griffiths *et al.*, 2007) such as minimum standards, access to resources (natural, energy, water), waste management, energy efficiency, carbon emissions standards, carbon pricing, and feed-in-tariffs (www.busa.org.za).

3.9 Corporate Climate Change Response Strategies

In their study of companies' responses to climate change, Kolk and Pinkse (2004) identified several types of responses for corporations, ranging from active resistance on one end of the spectrum to proactive engagement at the other. Lying somewhere in the middle are fence-sitters, termed opportunistic/hesitant responses, where companies prepare themselves for eventualities arising from climate change drivers such as risks and threats or opportunities (Kolk & Levy, 2001). Other classifications include dodgers, emergent planners, internal explorers and champions (Kolk & Pinkse, 2005). While such classifications have merit, Kolk and Pinkse (2004) argued that such responses were generally addressing companies' responses towards public policy rather than competitive activities in the marketplace. In their 2008 study of multi-national companies (MNCs), Kolk and Pinkse concluded that climate change is opening up new opportunities for MNCs to develop "green" propelled firm competitive advantages that are enabling them to thrive and grow. In their study of Australian institutions' responses to climate change, Griffiths *et al.*, (2007) proposed that there is a direct relationship between the governance systems in a country or industry and an organisation's speed of adaptation or innovative capabilities developed in response to climate change

In their study on the implications of environmental choices on corporate strategy, Reinhardt (1998, 1999) argued that the topic of environmental sustainability investments should be explored from the perspective of the timing and appropriateness of such investments, rather than the perspective of whether or not such investments should be made. He argued that environmental investments should be treated like any other policy-driven or ethically-driven investments where the industry structure, competitive environment, economic sustainability of

the business, and the business' competencies are key determinants of the "what", "how" and "when" of climate change response.

In an attempt to answer the question, "When does it pay to be green?", Orsato (2006) identified four generic types of competitive environmental strategies, the first of which he labelled eco-efficiency", modelled around Porter's 1980 cost leadership strategy, where companies should be promoting resource efficiency in the form of reduction of material used, reusing material, recycling and exploring by-products from the waste. Thus firms pursuing low-cost leadership coupled with climate change impact should follow the eco-efficiency strategy. The second option is what Orsato (2006) termed "Beyond Compliance Leadership", where reputational and organisational legitimacy are key drivers to climate change response. Beyond Compliance practices, such as environmental and climate change certifications, can give some businesses a "license to operate", get businesses into good books with key customers, the general public and other influential stakeholders. The third option is what Orsato termed "Eco-Branding", which can be attractive to companies seeking a differentiated or niche strategy (Porter, 1996). Marketing differentiation based on some products' green characteristics is being explored, particularly by business-to-consumer (B2C) companies. The fourth option is termed "Environmental Cost Leadership", where businesses can command a price premium for green-oriented products. Green product innovation, fuelled by dematerialisation, material substitution and other green technologies, is a viable option for companies in mature industries or in commodity industries where room for differentiation is limited. It is also an innovative way to move into new and emerging industries, thereby diversifying the business.

3.10 The Starch Industry and Climate Change Response

3.10.1 Worldwide Starch Industry

The worldwide starch production figures keep growing due to increasing demand in food and non-food areas. 54% of starch is used in food applications, and 46% in non-food applications (International Starch Institute, 2012). Over the last 20 years there has been a three-fold increase worldwide in starch production. Maize is the most important raw material for industrial starch production, with the global share of maize starch accounting for more than 80%. Due to the warmer climate, maize is widely grown in Southern Africa and is readily available because it

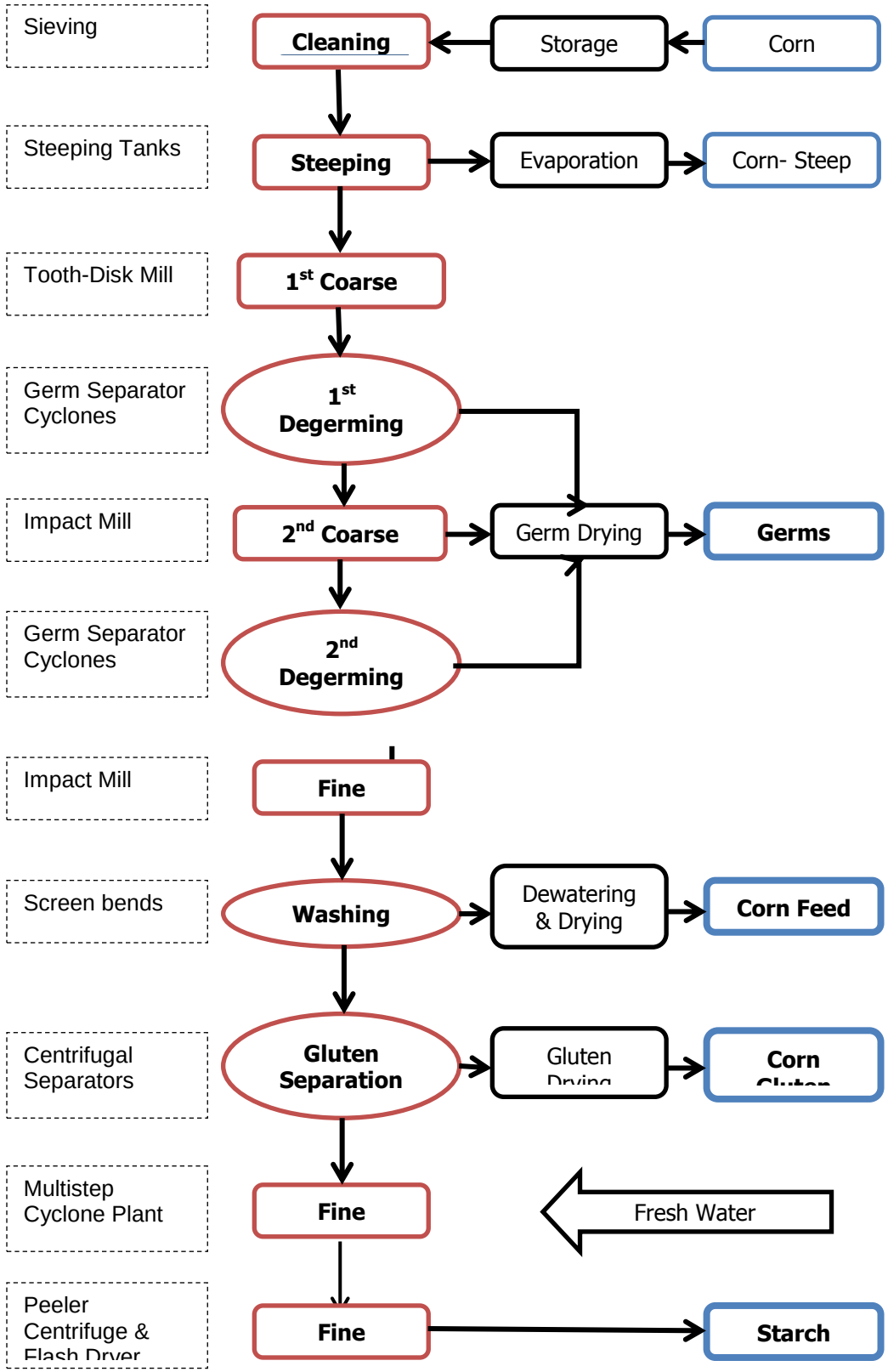
is a sample food for the majority of African countries (Colin *et al*., 2007). A problem facing the industry in recent years has been sagging prices, largely due to expansion in production (International Starch Institute, 2012). The continued sustained growth in corn wet milling, despite the drop in prices, has resulted from the industry's continuous development of new products and expansion into new markets (Galitsky *et al*., 2003). Advances in food chemistry have developed ways to transform corn into a variety of products (Colin *et al*., 2007). According to the International Starch Institute (2012), another key driver for competitiveness in the industry has been the use of more efficient production technologies to bring down the cost of production.

Traditional food uses of starch have been supplemented by widespread developments in the use of starch as a raw material for a variety of non-food industrial products. Increasingly, starch is being viewed as a more environmental friendly, renewable raw material that is replacing non-renewable fossil fuel derived feedstock for a wide range of carbon-based products, including plastics (Colin *et al*., 2007). Another trend is the development of specialty starch products for niche markets/uses, either through modification or cultivation of crop varieties containing starch with specific biological characteristics (e.g. non-genetic modified maize). Starch can be broken down into its saccharide components, which are used as glucose and fructose syrup sweeteners for the food and soft drinks industries and as substrates for the production of a wide range of fermentation products such as citric acid, monosodium glutamate or lysine for animal feed (Galitsky *et al*., 2003). Starch can also be physically or chemically modified for use in the paper and corrugated industries.

3.10.2 Corn Starch Production Process

Corn wet milling plants require a large capital investment and are bound by large economies of scale. The process of starch extraction requires large volumes of water. This water is subsequently removed and discharged as, effluent with high amounts of carbonaceous matter which pose serious threats to the environment. Tongaat Hulett in this study uses a wet milling process (Figure 3-3).

Figure 3-3 Corn Starch Wet Milling Process



The goal of corn wet milling is to optimise the value from each constituent of the corn kernel by separating corn into its four main components, which are further processed to produce starch and various by-products such as edible oil and feed industry products (Colin *et al.*, 2007). Wet-milling produces four major co-products for the feed industry from the isolated steep water, bran, germ meal and gluten (International Starch Institute, 2012). Together, these co-products represent about 25 – 30% of the corn processed. The two main products, ethanol and sweeteners, are made by further processing starch. Corn starch is another main product, along with corn oil, made from the germ component. The fibre contains proteins and they, along with other by-products, are generally used in animal feed.

Agro-processing industries generate high organic content wastewater (Rajasimman & Karthikeyan, 2006), requiring biological processes to treat before discharging. Decomposition of the organic matters emits methane, a greenhouse gas and a biogas that could be used in heat and energy generation. The production process consumes large volumes of water and energy and also generates organic-loaded solid and water waste. The resulting wastewater is susceptible to anaerobic degradation (Colin *et al.*, 2007). The drying and dewatering steps are the main energy consumers in the milling process (Galitsky *et al.*, 2003).

3.10.3 Energy Efficiency of Wet Milling Processes

Corn wet milling is the most energy-intensive industry within the food and kindred products group (Galitsky *et al.*, 2003), using 15% of the energy in the entire food industry. After corn, energy is the second largest operating cost for corn wet millers in the United States and South Africa, making energy efficiency improvement an important way to reduce costs and increase predictable earnings, especially in times of high energy price volatility (International Starch Institute, 2012). Corn wet milling is an energy-intensive industry because it is a wet process that produces dry products (Drescher, 1997). Corn is soaked in water to loosen the corn's component materials, i.e. protein, gluten and fibre, and throughout the process water is used as a medium for separating these components. For most of the products, dewatering, evaporating and drying are required, which often entail the use of large amounts of energy (Galitsky *et al.*, 2003). Significant amounts of energy are also required to power the large

motors for grinding after degermination, compressors, blowers and pumps for effluent treatment.

Electricity is used for pumping, grinding, separating and drying the corn products. Fuel is used either to make steam or for direct drying (Weigel et al., 1999). Steam is used for evaporation, drying, fermentation, extraction, ethanol recover, jetting or jet conversion in starch refineries and for maintaining process temperatures. Flue gas is used for drying and stillage processing (Shapouri *et al.*, 1995; Drescher, 1997). The relative importance of electricity, in addition to the high steam demand in the industry, prompted investment into combined heat and power (co-generation) of onsite electricity and steam. Most corn milling plants generate both electrical and thermal energy burning coal in boilers using steam turbines (Galitsky *et al.*, 2003).

3.11 Sugar Industry

According to The Sugar Association (2012), around 170 million tons of sugar was produced by the more than 100 sugar-producing countries in the 2011/12 international sugar season. 81% of this is made from sugar cane grown primarily in the tropical and subtropical zones of the southern hemisphere, and the balance from sugar beet which is grown mainly in the temperate zones of the northern hemisphere. Africa, with its favourable agronomic conditions, has significant potential to contribute towards the production needed to meet the growing demand (SASA, 2012).

The South African sugar industry is one of the world's leading cost competitive producers of high quality sugar (DME, 2007). The industry produces an estimated 2.2 million tons of sugar per season (SASA, 2012). About 60% of this sugar is marketed in the Southern African Customs Union (SACU), with the balance being exported to Asia, the Middle East and other African countries. The industry is diverse, combining agricultural activities of sugarcane cultivation and the manufacture of raw and refined sugar, syrups and a range of other by-products. There are several "white end" millers producing refined sugar for direct consumption and export (SASA, 2012).

A fundamental shift has been taking place in the global sugar industry as increasing quantities of cane are directed at producing ethanol as an effective carbon dioxide (CO_2) mitigation

strategy (Hertel *et al*., 2010). The fibre in sugar cane is increasingly being used for renewable electricity generation (Zuuibier & van de Vooren, 2008; Yevich & Logan, 2002). Sub-Saharan Africa, with ample unutilised arable land and using less than 10% of its available fresh water, is well positioned to benefit from these developments (DME, 2007). The adoption of a phased-in 60% ethanol replacement of petrol within SADC over the next 15 years would result in the construction of over 100 sugar milling/ethanol facilities (SASA, 2012). The development of an ethanol industry on the scale described above within the SADC region would require the use of 3 to 6% of available land based on a combination of irrigated and rain-fed sugar cane farming (DME, 2007).

A second thrust in terms of renewable energy is the production of electricity from the burning of sugar cane fibre (Hertel *et al*., 2012). While this has been carried out by the sugar industry for many years, it has not been exploited from a South African perspective on a commercial scale (Illovo 2011). The adoption of high efficiency boiler and electricity generating technology will allow sugar mills to produce substantially more electricity from the same quantity of fibre, allowing for meaningful quantities of renewable electricity to be made available to the national grid (Yevich & Logan, 2002). If this thrust is developed in parallel with a bio-fuel regime, then the 100 plus sugar mills discussed above with regards to ethanol production could potentially create 8,000 MW to 10,000 MW of renewable electricity-generating capacity (DME, 2010).

3.12 The Aviation Industry

Global aviation has gained importance rapidly with the revenue passenger-ton-miles increasing from 3.2 billion to 84.1 billion in the period 1954-2007 (Gossling & Upham, 2009). In 2009, over 2.2 billion passengers were carried by the world's airlines and the global aviation industry produced 628 million tonnes of carbon dioxide, which is equivalent to 2% of total global emissions (IATA Economics, 2012). Approximately 80% of aviation CO_2 is emitted from long-haul flights of over 1,500km, for which there is no practical alternative mode of transport (IATA, 2012). Air transport carries approximately 5% of the world's trade volume which equates to approximately 35% by value. The industry currently contributes $425 billion of the world's Gross Domestic Product (GDP) per year, and is forecast to contribute $1 trillion by 2026 (IATA Economics, 2012).

Aviation is a global activity as it provides an interconnected network of air services spanning the whole globe, with aircraft and the associated emissions continuously crossing national jurisdictions and continents (Forster *et al.*, 2007). Domestic flights have implications for international aviation as they often serve as feeders for the international network (Gossling & Upham, 2009). Realising this web of interconnectivity, governments at the 37th ICAO Assembly in October 2010, reached a global agreement on a sectoral framework for addressing international aviation emissions (ICAO, 2011). The agreement formulated global targets for the aviation industry. The aviation industry, through the guidance of ICAO, has committed to improve its fuel efficiency by 1.5% per year to year 2020, cap its net carbon emissions from 2020 through carbon neutral growth, and halve its net carbon emissions by 2050 with 2005 as the base year (ICAO, 2012). The entire aviation sector signed a declaration in 2008 that committed it to what is known as the Four Pillar Strategy for reducing emissions.

The industry has detailed four steps involved in the cutting of emissions, namely:

1. **Improved technology** – technological advances in aircraft designs, composite lightweight materials and radical engine advances, which has resulted in each new generation of aircraft being 20% more fuel efficient, with airlines expected to invest $1.3 trillion in 12,000 new planes (ICAO, 2011), offering high prospects for reducing aviation emissions. Aircraft are required to meet certain engine certification standards related to fuel burn, noise and emissions of oxides of nitrogen (NO_x, carbon monoxide, unburned hydrocarbons) with reference to landing and take-off cycles, as prescribed by ICAO (IATA, 2012). Sustainable biofuels are already in use in commercial flights, with more research and development being channeled into aviation biofuels (Lee *et al.*, 2009; Arnold *et al.*, 2000), as evidenced by the signing of a cooperation agreement between the Air Transport Action Group (ATAG), a global industry body that brings together all aviation industry action plans for promoting aviation's sustainable growth, and Canada's Green Aviation Research and Development Network (GARDN), a business-led Network of Centres of Excellence, whose mission it is to promote aerospace technologies for the protection of the environment (ICAO, 2011). The agreement is to foster and promote environmental research in aviation, particularly in the areas of sustainable aviation biofuels, sustainable development, industry collaboration and climate change. Other opportunities for improved technologies are in the communications, navigation, surveillance and air traffic management systems (Gossling & Upham, 2009).

2. **More efficient operations –** 'operations' in aviation terminology describes a range of activities including the flying of the aircraft, the control and monitoring of the aircraft by the air traffic management system and the conduct of various airport activities (Gossling & Upham, 2009). Emissions reductions in operations are being achieved through operational redesign initiatives such as reduced auxiliary power unit usage, more efficient flight procedures, baggage loading strategies, weight reduction measures (ICAO, 2012) and other measures geared towards reducing the amount of fuel used in servicing and operating each flight, which also results in significant cost savings for airlines (Lee *et al.*, 2009). Operational measures to reduce emissions do not necessarily require the deployment of new or expensive technologies, but call for different ways of operating the equipment already in place (Lee *et al.*, 2009). For example, landing using a continuous descent approach (CDA) is said to save at least 150kg of CO_2 per flight (www.enviro.aero).

3. **Better use of new infrastructure** - reducing flight time has a positive impact on the amount of emissions (Lee *et al.*, 2009). Infrastructure presents a major opportunity for short-term emissions reductions. Full implementation of air traffic management and airport infrastructure is expected to provide substantial emissions reductions through implementations of measures such as the Single European Sky ATM Research (SESAR) and similar regional collaborative arrangements, as well as the implementation of Next Generation air traffic management (NextGen) systems (ICAO, 2012). SESAR aims to triple European airspace capacity by 2020, halve the cost of providing air navigation services and reduce the environmental impact per flight by 10% from the 2005 base-year levels (ICAO, 2012). NextGen is expected to deliver improved access, fuel savings and reduced CO_2 emissions, as well as reduce delays by 35-40% by 2018.

4. **Positive economic measures** – these are short-term initiatives which are designed to close the gap until technology and more efficient operations can provide the means to meet the aviation's industry targets (ICAO, 2012). Governments are working at agreeing on a global framework that accounts for emissions only once, to ensure that airline users are not taxed more than once for carbon emissions (ICAO, 2012; Forster *et al.*, 2007).

Flight Navigation

More than 100 000 flights take off at airports across the world daily, some on short hops and others across the oceans but in the same sky (IATA, 2012). It is estimated that 8% of aviation fuel is wasted as a result of inefficient aircraft routing (ICAO, 2012). Evolutions in the industry are having profound effects on the way aircraft are being safely handled and in more environmentally friendly ways than in the past (Lee *et al.*, 2009). Until recently, aircraft routing was based on pre-determined routes (highways in the sky), which were designed around the location of ground-based navigational aids (ICAO, 2012). The accelerated growth in the number of in-service aircraft has demanded a shift in this type of air traffic management (Gossling & Upham, 2009). Technology advances based on automated communication data-links are making it possible to move towards the management of optimal airspace use rather than management of each flight (Lee *et al.*, 2009; Gossling & Upham, 2009). Communication, navigation and surveillance can be managed within a global or regional framework of information systems, rather than relying on voice communications between a controller and a pilot (IATA, 2012).

In this dispensation, air traffic management will be treated as a global rather than a national operation, with common automated technologies and procedures based on satellite data-links (IATA, 2012). This will allow aircraft to dynamically change altitude or direction to exploit prevailing traffic and weather conditions. These developments have already been tested and proven in the airspace of 41 European countries (ICAO, 2012), where reduced vertical separation minimum (RVSM) increased the en-route airspace capacity above Europe by 14%. This has resulted in reduced flight delays, increased fuel economies, greater flexibility for air traffic controllers and has consequently improved environmental performance due to reduced fuel burn (ICAO, 2012).

ANSPs are exploring new designs in take-off, routing, cruising and landing procedures, which are resulting in improved efficiencies (Lee *et al.*, 2009). Commonly referred to as "green departures", airlines in collaboration with ANSPs are experimenting with procedures where pilots can take-off and climb to the optimal cruising altitude in one smooth, continuous ascent. This is a big departure from the traditional procedure of ascending to the cruising altitude in several steps. These "green departure" procedures saved 10 000 tonnes of fuel and 32 000

tonnes of CO_2 emissions in one airport in a year in Europe (ICAO, 2012), with fuel savings estimated at $34 million in 2008. Fuel savings of up to 40% (equivalent to 50 – 150kg of fuel) during the approach phase have been demonstrated through the use of continuous descent operations (CDO) (ICAO, 2012). It is estimated that up to 150,000 tonnes of fuel and 500 000 tonnes of CO_2 per year could be saved in Europe alone if CDO procedures are widely adopted (IATA, 2012).

ANSPs are working collaboratively with aircraft manufacturers, airlines and airports to ensure that aircraft are taking-off, cruising and landing in the most efficient way (Lee *et al.*, 2009). ATNS is a member of an aviation group working on an Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) project, started in September 2008. By early 2010, the Atlantic Interoperability Initiative to Reduce Emissions (AIRE) project had a 1 152 flight trial, with a demonstrated 400 000 tonnes saving in CO_2 as a result of greener ATM procedures. The most wasted fuel is in delays as aircraft queue up for a runaway take-off slot, or a wait until a terminal gate is free (ICAO, 2012). The utilisation of airport collaborative decision making (A-CDM) directly linking airport operators, ground handlers and service providers to air traffic management networks, and giving users access to operational data, ensures that flight schedules are planned in alignment with available runway and airspace capacity (ICAO, 2012). In one European airport, the introduction of A-CDM reduced taxing times by 10%, with a fuel savings of $3.6 million in a year (ICAO, 2011). In the United States, the cost of burning fuel on the ground due to delays was estimated at $5 billion for 2008 (IATA Economics, 2010). Technological evolutions are looking at advanced collaborative decision making where information such as passenger flows and baggage information will be shared to improve on-the-ground service efficiencies (ICAO, 2012).

In order to be effective, efforts to reduce greenhouse gases are addressing the total aviation value chain, requiring close collaboration between different parties to these value chains including airlines, aircraft manufacturers, fuel suppliers, air navigation service providers and airports, as well as ancillary suppliers of services (ICAO, 2012). By mandating the development of common functional airspace blocs such as the Single European Sky (SESAR) programme, the aviation industry has taken major steps towards national and regional collaboration (ICAO, 2012). This collaboration is extending to all airspace users, including the military, business and

general aviation flyers, giving users access to previously restricted airspace, e.g. restricted military zones (IATA, 2012). In the past, avoiding restricted airspace meant lengthy and inefficient detours which increased the amount of emissions per trip.

Due to the global, interconnected nature of air transport, governments around the world are encouraged to equally apply the parameters of a global framework to both domestic and international aviation emissions reduction efforts (ICAO, 2012). They were tasked with the responsibility of establishing appropriate legal and fiscal frameworks to facilitate CO_2 emissions reduction efforts within their jurisdictions.

4. Bounded Rationality in Strategic Decision Making

4.1 Rational Economic Man Theory

Rational economic man theory says that a decision maker is always fully informed and therefore maximises his utility by determining his "complete, reflexive, transitive and continuous preferences over alternative bundles of consumption goods" (Butler, 1991:43). Theoretically, it is possible to make a perfect, rational decision by means of very complex calculations, taking a lot of time and effort. This theory was formalised in rational choice theory (Bakka & Fivesdal, 1986), expected utility theory (Mongin, 1997; Schoemaker, 1982) and is the foundation of probability theory (Wald, 1939) requiring choice so as to measure expected utility that reflects a complete and consistent preference order over possible alternatives.

Research into decision making has traditionally focused on how people, as individuals, choose among alternatives and specifically about how they go about finding the best alternative or making the "right" decisions. This is most clearly expressed in the normative, neoclassical economic model assumptions that characterise the rational decision maker, the *homo economicus* (Lee et al., 2009). According to these models, people are rational "wealth maximizers" who seek to increase their own well-being, thus emotions and other extraneous factors do not influence people when it comes to making economic or strategic choices (Botzen & van den Bergh, 2009). The first assumption is that a rational decision maker is completely informed which means that s(he) knows what all the possible alternatives are and what the outcome of any action will be. This presumably includes both short-term and long-term outcomes. The second assumption is that a rational decision maker is infinitely sensitive (Alm, 2010); hence is able to notice even the slightest difference between alternatives and uses this to discriminate amongst them (Cook *et al.,* 2007). One consequence of this assumption is that two alternatives can never be identical, as they will always differ in some way.

The third assumption is that the decision maker is rational, which implies that alternatives can be put into a weak ordering and that choices are made so as to maximise something. The weak ordering means that if for three alternatives A, B, and C, the decision maker prefers A over B, and B over C, then the decision maker must also prefer A over C. This in turn requires that there is a common dimension, which can either be simple or composite, by which all

alternatives are rated. This common dimension also enables the decision maker to identify the alternative that has the highest value, in order to maximise his or her decision outcome. According to conventional strategic theory, executives and other decision makers are treated in the most part as rational value maximisers.

Rational decision making is about making decisive steps (means – known as procedural rationality) to achieving a certain goal (end - goal rationality). Generally one end becomes the start of another end, leading to a hierarchical chain of decision choices (Simon, 1976). Rationality then, according to Simon (1976), is that process of constructing means-end relationships. What is rational at any given time depends on the performance measure that defines the goal, the perceptual history of the decision maker, the percept sequence, the decision environment, the knowledge, expertise and experience of the decision maker and the constraint in the type of actions and amount of time available in which to act.

Simon (1976, 1991) described decision making as involving four distinct steps namely:

1. Identifying and listing the alternatives involved in all the choice decisions;
2. Describing and determining the consequences of the choice of each of the alternatives;
3. Evaluating and comparing the sets of consequences resulting in a preference order of the alternatives; and
4. Selecting the option with a corresponding highest evaluation on the list of alternatives (known as maximisation).

The choice problem is about describing the consequences, evaluating them and associating each of them with the alternatives, ranking them into some preference order in order to select the best performing alternative (Simon, 1976). Rational economic man theory says that a decision maker always acts rationally in following these four steps, i.e. the decision maker is always fully informed and therefore maximises his utility by determining his "complete, reflexive, transitive and continuous preferences over alternative bundles of consumption goods." (Keynes, 1936: 43). The theory also advances that a rational decision maker will always make the same choice when the same decision situation occurs again at some time in the future (Bakka & Fivesdal, 1986).

4.2 Bounded Rationality Explained

Conformance to the rational economic man's standard of optimising behaviour has been found to not always work in practice, even when decision makers are intendedly rational. Evidence from everyday observations, laboratory experiments and research studies have shown that rationality often fails in important situations, resulting in mismatches between the decision situation and decision choices (Jones, 1999). The rational economic model of decision making has been criticised (Simon, 1955) for disregarding the inner conflicts (cognitive dissonance) that have been shown to be prevalent particularly in complex decision making situations. Human behaviour was found to deviate from rationality in a number of ways including (Simon, 1976):

- Complete knowledge about the consequences of a possible course of action is not always feasible.
- Attaching value to a future event is not always practical, especially in new and novel situations where experiential learning is not available to gain knowledge from.
- In most situations, not all of the possible alternatives are available for evaluation at the time.

In an attempt to reduce cognitive load (Marsh, 2002) as called for by the rational economic man model, decision makers generally attempt to reduce the pain, uncertainty, tension and discomfort associated with decision making by employing a variety of fast and frugal simplification strategies (called heuristics) and rules of thumb, which quickly and economically return satisfactory choices that would satisfice (be optimal or good enough), rather than maximise utility over the long run (Todd & Gigerenzer, 2000; Simon, 1955). These heuristics have been accepted as critical to problem solving (Newell & Simon, 1990; Groner, *et al.*, 1983), even though they give rise to severe and systematic errors called biases (Kahneman, *et al.*, 1982).

This culminates in less comprehensive and often irrational decision choices, particularly in complex, uncertain and risky decision problems (Tversky & Kahneman, 1974). The deviation in judgment that occurs in particular situations leads to replicable patterns of perceptual distortion, inaccurate judgment and illogical interpretation, commonly called irrationality.

Rationality, Simon (1955), found is bounded by time, information, cognitive and other internal constraints. The systematic experimental study of reproducible errors of human reasoning, and what these errors and the underlying revelations about mental processes say, are known as heuristics and biases. These biases make up the filter between what actually exists, and what is perceived to be true.

Theoretically, it is possible to make a perfect, rational decision by means of very complex calculations taking a lot of time and effort. Simon (1955) postulated that humans made decisions using *fast and frugal* heuristics, rules of thumb (Kahneman & Tversky, 1974), that would *satisfice* (be optimal) rather than maximize utility over the long run. Several researchers have proposed the incorporation of bounds on rationality as and when they are important or necessary (Gilovich *et al.*, 2002; Simon, 1996; Conlisk, 1996; Thaler, 1999).

4.3 The Case for Bounded Rationality in Industrial Organisations

Interest in the study of bounded rationality in industrial organisations has increased, largely spurred on by the premise that an organisation is a group of actors sharing a common objective, and that the behaviour of organisations mimics the behaviour of the organisational actors (March, 1994, 1991). Irrationalities have been studied in organisations through game-theoretic approaches, encompassing such issues as limited attention spans, organisational identification (Jones, 1999), organisational routine and agency theory, the deviation from profit maximisation propelled by a desire to secure profits, to a desire for maximum profits (Cyert & March, 1956; Rothschild, 1947).

In their study of satisficing in organisations, Cyert and March (1956) found that organisations in the face of competitive pressures deviate from profit maximisation by expanding sales in order to secure profits. Jones and Bachelor (1994) concluded that solutions did not automatically follow problems, such that organisations sometimes had solutions waiting for problems, such as a technological innovation that is yet to find commercial use. Organisations were also found to have limited attention spans (Simon, 1991, 1979), particularly for phenomenon and events that take a long time to unfold. This was found to be due to limited corporate memory and an inability to plan over long time horizons.

4.3.1 Deliberation Costs

Bounded rationality is premised on psychological principles that satisfy the constraints of limited knowledge, limited time, uncertainty and cognitive limitations, so that decisions are designed to be fast and frugal (heuristics). Bounded rationality employs heuristics which have been criticised as a source of bias, but which are also viewed as critical to pragmatic decision making (Simon, 1969, Kahneman *et al.*, 1991; 1990). This is because there are costs to decision making, including, the search for all the information necessary to assembly the alternatives (Conlisk, 1996), the survey for the role and effects of all the risks and uncertainties associated with each alternative (Vernon & Walker, 1993), the time and computational effort required to estimate all the probabilities and utilities for the possible outcomes associated with each alternative (Pingle, 1992), the calculation of each expected utility function (Pitz & Sachs, 1984), the scoring of the alternatives and the choice of the highest scoring alternative (Simon, 1956). These are called deliberation costs (Conlisk, 1996; Smith & Walker, 1993, Day & Pingle, 1996). The more complex and the higher the stakes in a decision problem, the higher the deliberation costs; there is a trade-off between judgmental accuracy and deliberation costs (Day & Pingle, 1996).

In his study of political organisations, Jones (1999) argued that deliberation costs are not sufficient to explain bounded rationality, proposing instead that people have been known to cast votes based on organisational loyalty (identification) rather than some calculated policy goal utility function. Additionally, there are experiments and observed organisational behaviours where people have been shown to be impulsive and myopic (Thaler & Sustein, 2008; Hong *et al.*, 2000), to view and evaluate losses differently from gains (known as loss aversion), to keep track of earning and spending separately (known as mental accounting), the winners' curse in auctions (Thaler, 1992), to misunderstand statistical independence, and several other examples mentioned elsewhere in this thesis.

4.3.2 Experience, Learning and Adjustment

According to Jones (1999), as people interact with each other in their teams, their businesses or social networks, they have an opportunity to adjust their goals and decisions in light of new information and learning (March, 1991) so that decisions are generally flexible and adaptive to changing environments. This has been advanced as a reason for de-biasing and moving closer

to rationality, arguing that actors will be less biased when they have better opportunities to learn, practice or are more experienced (Grether, 1992; Battalio, *et al.,* 1990). Smith and Walker (1993) argued that market forces such as competition are a significant incentive for rational decision choices. Several researchers have agreed to this, pointing out that although learning attenuates bias, the degree of attenuation is not sufficient to remove bias.

In fact, in the process of adjusting from the initial perception (known as the anchor), decision makers tend to invoke other biases such as confirmations, availability (Gilovich & Griffin, 2002) or representativeness (Pompian, 2006). During the process of adjustment the probability of conjunctive events is overestimated, while that of disjunctive events is underestimated (Kahneman & Tversky, 1979; 1974). This anchor may be evoked by the problem formulation, the partial computation of available information (Tversky & Kahneman, 1974) or as a result of other biases such as the availability or representativeness biases. This starting point (the anchor) can result in confirmation or disconfirmation biases, where the search for additional information is leaning towards information that lines up with (confirms) the anchor (Chapman & Johnson, 2002; Slovic *et al*., 2002). Perceptions of risk are influenced by the anchor so that supplementary information and further processing results in few or no revisions to the initial perceptions (Stewart, 2004).

March and Simon (1968) found that rather than maximising on learning, experience and expertise, organisations tended to settle to some routinized behaviour, resulting in slow adaptation to learning (March, 1978), as opposed to the swift adjustment processes which rational economic man theory propose. Organisations were found to be sticky when it came to pricing of goods and services or major strategic decisions (Cyert & March, 1963). Asset and resource allocation was one such area where routine behaviour was found to trump learning and changes in the operating environment. For example most corporate and federal budgets are based on an incremental budgeting model which is based on a base year and adjustment from that base for the preceding financial planning period. Most of the adjustments in the planning cycles are step changes that do not take cognisance of the changes in the competitive environment or strategic thrust of the business (Mckinsey, 2012).

Several researchers have explored debiasing, arguing that after sufficient practice and learning (Slonim, 1994), or expertise and experience (Jones, 1999), decision makers will tend to reason more accurately (Battalio, *et al*., 1990), and that by providing enough incentives that punish errors most errors in judgment disappear. Competition and market discipline (Smith & Walker, 1991; Osberg & Shrauger, 1986) have also been shown to have debiasing effects. A systematic relationship has been found between the nature and magnitude of errors and economic costs, such as market incentives, deliberation costs and knowledge and experience (Flyvbjerg, 2005; Conlisk, 1996).

Other areas relevant for this thesis where bounded rationality has been uncovered in organisations are detailed below:

4.3.3 Investment Decisions

In his study of the net present value (NPV) model as a decision model, Magni (2009) concluded that in real life, decision makers use a subjectively determined hurdle rate as opposed to the computed opportunity cost of capital to make investment choices, in order to cater for context-specific and project-specific aspirations. Jagannathan and Meier (2002) and McDonald (2000) reached a similar conclusion that by using hurdle rates, companies take into account key aspects of the behavioural and organizational contexts in which investment decisions occur. Magni (2009) postulated that actual strategic choice behaviours use the hurdle-rate heuristic as a satisficing strategy (Simon, 1955), allowing decision makers not to be confined to equivalent-risk alternatives. Instead, the behaviourally based models of decision making allow executives to have adequate regard for constraints in time, knowledge, computational capacities that humans face (Gigerenzer, 2006), or strategic and expiring investment decisions where first mover advantages or compliance and/or regulatory and social justifications might have commitment, reputational or other value rather than monetary.

4.3.4 Technology Adoption

At a personal level, Loewestein and Thaler (1989) showed that consumers purchase electrical and other appliances with high energy consumption but low purchase pricing without taking

into account the total cost of ownership of the appliance, where the initial purchase savings do not compensate for the cost of energy during the useful economic life of the appliance.

In corporate organisations, the slow pace of technology adoption has been explained from both rational and boundedly rational perspectives. Rational economic theory proponents have offered the long economic life of machinery as a plausible explanation for the delayed up-take of new technologies in a field. Moore and Benhast's (1991) Perceived Characteristics of Innovating Belief has several characteristics as antecedents of any technology adoption decision: relative advantage, compatibility, trialability, visibility, image, result demonstrability and voluntariness. Relative advantage is defined as the degree to which a specific technology is perceived to be better than comparable current technologies. A direct correlation has been proposed between positive relative advantage and the rate of new technology adoption (Agarwal & Prasad, 1997).

Compatibility is the extent to which a new technology is congruous with existing technology, i.e. it is capable of being used in an organisation without the need for special modifications or conversions. Trialability is the degree to which the new technology can be experimented with on a limited basis before being adopted. It reduces a potential adopter's perceived risk of acquiring the new technology. Visibility is the degree to which a technology is visible to a user community during its diffusion phase (Plouffe, *et al.*, 2001). The extent to which a potential technology adopter can see the positive effects and utility of a technology is the result demonstrability. The more the positive effects are perceived, the higher the rate of adoption. Image is defined as the degree to which a potential adopter believes that the technology will earn them some status or good standing within the user community. Voluntariness is the degree to which a technology is not forced upon a potential adopter.

A number of market characteristics (including the regulatory environment), coupled with the size, role and position of the firm in the industry, are also key determinants in the pace and timing of technology adoption. The possibility of differences in managerial attitudes and the differences in relative risk exposures for firms of different sizes are plausible explanations for the different rates and speed of technology adoption (Hannan & McDowell, 1984). Information availability or the lack of information on new technologies has been advanced as a possible explanation by bounded rationality proponents. Consumers, technical buyers and other users of

technology do not generally have all the information required to make fully informed decisions on new inventions, with the result that some fast and frugal methodologies can be employed in the assessment of these new technologies. Kislev and Shchori-Bachrach (1973), proposed that herding behaviour (a phenomenon where individual or group decision making is influenced by what others around them are doing, rather than using their own information to evaluate and decide), is a key factor that influences the adoption of new technologies. Banerjee (1992: 798) concurred, adding that "the very act of trying to use the information contained in the decisions made by others makes each person's decision less responsive to her own information and hence less informative to others", which may result in negative externalities to the rest of the technology adopters.

Ellison and Fudenberg (1995), proposed a model by which organisational decision makers come to have information about new and competing technology (called social learning) in order to make decisions. The two mechanisms proposed are firstly, decision makers paying attention to the popularity of particular technologies, while the second is via decision makers observing the technology choices and associated payoffs in their specific geographic confines. Depending on the size of the sample of firms, herding behaviour can occur in small samples resulting in unpopular technologies dying out, or diversity can occur in which case polarisation of some criteria can be the result.

4.3.5 Technology Assessment in Organisations

Smallwood and Conlisk (1979) stated that decision makers continue to use the same product/technology until a breakdown is experienced. In the case of climate change response technology, a breakdown can be as a result of a technology reaching the end of its economic life, or a certain driver in the form of a risk or threat of vulnerability exceeding a certain threshold, necessitating the replacement of a certain technology or considering a new technology. The question is, do decision makers go for any one of a number of new technologies never tried before, or do they stick to familiar tried and trusted technology options? Organisations are assumed to be more rational in that they will compute optimality because failure to do so will penalise them in the form of market competitive dynamics (Ellison, 2006). In order to make rational choices, *a prior* knowledge of the value of the unknown technologies is required, in terms of the quality, efficiency, cost and effectiveness, etc.

Other information required would be the uptake of the technology by other businesses, the popularity of the technology and the technology maturity levels. Decision makers will have to understand the market dynamics by which maturity or popularity has been achieved and the buying processes followed, such as market research, supplier comparisons, product walk-throughs and reference sites, as well as understand how the information from these information searches were used (Banerjee & Fudenberg, 2004).

4.4 Behavioural Finance and Behavioural Strategy

Increased interest in the behavioural-based approaches to finance, economics and more recently, strategy, has been stimulated by accumulating evidence that people have cognitive limitations, causing them to make seemingly irrational decisions in certain critical areas (Brekke & Johansson-Stenman, 2008). According to research (Evensky, 2005; Ashraf *et al.*, 2005; Kahneman & Tversky, 1979), humans are bounded in many dimensions, particularly in their rationality, self-control and self-interest. Bounded rationality manifests in complex decision making as a result of a limit in the amount of information available, the cognitive limitations of the minds and the amount of time available in which to make a decision (Kahneman & Tversky 1979). In a boundedly rational model some information is missing totally, some information is not quite what it should be, and there could even be a surplus of certain types of information, i.e. the information is not perfect for the purposes for which it is meant (Gigerenzer, 2006). Added to that, only bits and pieces of information available are actually used in decision-making.

Problems of self-control have also been shown to be linked to sub-optimal social behaviour, through the tendency of economic agents to make decisions that are in conflict with their long-term interests (Berg & Gigerenzer, 2007). In an experimental research, Shiv and Fedorikhin (1999) confirmed that long-term considerations are given less weight in cognitively-loaded situations. The problems of limited self-control were found to be partial causes of addictive behaviour (Gruber & Koszegi, 2001), under saving, or procrastination (Thaler & Sustein, 2003; Thaler & Bernartzi, 2004). Much evidence suggests that people do not necessarily pick the options that are best for themselves (decision utility), but instead gravitate towards their experienced utility and well-being (Kahneman *et al.*, 1997; Kahneman & Thaler, 2006).

Several researchers (Alm, 2010; Lovallo *et al.,* 2009; Thaler & Sunstein, 2008; Camerer *et al*., 2005; Camerer *et al*., 2003) defined behavioural economics/finance/strategy as the use and application of social cognitive and emotional factors, methods and evidence from such social science disciplines such as psychology to economics/finance/strategy, in order to inform the analysis of individual and group decision making (including borrowers, investors, consumers, gamblers, politicians and businesses) and its effects on market prices, returns, resource allocation, political and strategic choices. The primary facet of concern is the bounds of rationality (selfishness, self-control, etc.) of economic agents.

Behavioural strategy departs from the approach of rational value maximisation by borrowing from the psychology of decision making to offer a more realistic depiction of the behaviour of real people. Advances in cognitive psychology, behavioural finance and behavioural economics have shown that there are many instances where emotion, bias and other extraneous influences affect decisions and strategic choices (Thaler, 1999), thereby explaining some of the irrationality and irregularities that conventional strategic theories have failed to explain. According to Alm (2010) and other researchers (Thaler, 1999, 1992, 1991; Lovallo, 2009), there is growing acceptance that:

- Human beings are affected by the ways in which options are "framed" (e.g., anchoring, loss aversion).
- Human beings' computing ability is not limitless (e.g. framing effects, George Ainslie's hyperbolic discounting, mental accounting, etc.).
- Human beings systematically miscalculate the true value of their actions (e.g. The Winner's Curse by Richard Thaler, 1992).
- Human beings are not always self-serving (e.g. communalism, morality, justice, etc.).
- Human beings have limited willpower, and
- Human beings are influenced by the process, the environment and the context in which decisions are made.

These advances offer insights into business – people are not always rational and because people carry with themselves their biases, beliefs, values and rationality into their work

environments, business executives, and consequently businesses, will not always be rational when making strategic decisions (Botzen & van den Bergh, 2009). Left unchecked, subconscious biases will undermine strategic decision making. The abilities and skills that determine the quality of strategic decisions and the creation and solution of problems and opportunities are stored in the minds and hearts of real people, as well as organisational memories and cultures.

Behavioural economics, behavioural strategy and behavioural finance have been proven in a number of studies, based mostly on laboratory experiments (Thaler, 1999; Alm, 2010, Lovallo & Sibony, 2006). A number of studies have also investigated the phenomena in single project settings, where decision makers had to select among competing project alternatives (Flyvbjerg *et al.,* 2009; Lovallo *et al.,* 2009), or select specific attributes and parameters within a project. Yet a number of research studies have concentrated on explaining and arguing for the acceptance and application of behavioural concepts (Lovallo & Sibony 2006; Finkelstein *et al.,* 2008; Foss, 2003, Teece *et al*., 2002; Hite, 2003; Bromiley & Flemming, 2002, Barberis, *et al*., 2001, Barberis & Huang, 2001). Application of bounded rationality principles in real life settings is still limited (Magni, 2009).

In their study of the tracking error of financial market equilibrium, Berg and Gigerenzer (2007) and Todd and Gigerenzer (2000) concluded that behavioural economics and psychology are engendering better decisions, but whether such violations of rationality are beneficial and in which contexts, remains debatable. In his article entitled, 'The End of Behavioral Finance', Thaler (1999:15) came to the conclusion that "we can enrich our understanding of financial markets by adding the human element". Magni's (2009) recommendation for further studies hoped for more views on the interrelationship between bounded rationality and standard economics and finance, stating that the two should not be treated as "rivals". Gigerenzer and Regier (1996) argued for the non-distinction of the two systems, arguing that the separation is artificial and only useful as a metaphor. Thus a study of a real life situation on the cooperation of bounded and unbounded rationality is long overdue.

In their paper, 'The Case for Behavioral Strategy', Lovallo and Sibony (2006) argued that business executives are aware of cognitive biases in decision making, yet choose to ignore them. These two, with several other researchers in the field (Flyvbjerg *et al.,* 2009; Finkelstein

et al., 2008; Foss, 2003), have argued how bounded rationality in decision making is an integral part of strategic management. These theories have emphasised the uniqueness in firms (organisations and organisational actors differ), in terms of their aspirations, their knowledge, and their decisions. According to Lovallo *et al.* (2009), the most basic contribution of the behavioural theory of the firm to strategy is the recognition of the fundamental importance of firm heterogeneity, with firm heterogeneity leading to performance heterogeneity within an industry. The idea that firms are fundamentally heterogeneous, in terms of their internal knowledge, skills, and resources, is at the heart of the field of strategic management (Porter, 1980).

These findings suggest that there is merit in merging the normative and the behavioural-based models of decision making. This is an important concept to understand when dealing with a problem such as climate change, as it involves multiple stakeholders, a multitude of diverse information from diverse backgrounds (climatology, science, economics, sociology, etc.) and seeks to address multiple objectives. All of these actors address problems and their solutions based on their own biases, their world-views and/or organisational structures.

4.5 Why Bounded Rationality is Relevant in Climate Change Response

Climate change provides fertile ground in which to test bounded rationality theories. Firstly, the field is still relatively new, there is fragmented knowledge and expertise to base decisions on. Secondly, companies have limited time in which to act if they are to harvest climate change-induced competitive advantages. Lastly, the subject of climate change response is still very emotive, appealing more to human and social justification than the economic sustainability of organisations. Studies have shown that such emotions sometimes cloud economic and corporate decision making (Camerer et al. 2005; Muramatsu & Hanoch, 2005).

"No regret" paradox and "energy efficiency" gap are two irrational behaviours that have been found to be specific to climate change response and environmental management in for-profit organisations.

4.5.1 The "no-regret" Paradox in Climate Change Response

Efforts to address the economic, societal and environmental impacts of carbon fall into two broad categories, generally called top-down and bottom-up approaches. Top-down approaches use macro-economic models, thus predicting economy-wide impacts based on price elasticity, resource intensity, growth parameters and fuel prices (Cook *et al.,* 2007). Bottom-up or engineering-economic models use data on technological costs to construct economic estimates on a technology-by-technology basis (De Canio, 1998; Brown, 2001; Marechal, 2007). The outcomes of bottom-up models are generally presented in terms of the incremental costs of specific measures or interventions. Jackson (2007) reported that despite the large variability of results across top-down and bottom-up approaches, the main difference between the two approaches has been that:

"Macroeconomic models have predicted considerable economic costs associated with reducing emissions of greenhouse gases, whereas microeconomic models have identified considerable potential for the introduction of technological measures, which are cost-effective even now and would lead to substantial economic benefits for the implementing party".

Marechal (2007) showed that there is a plethora of inefficient technologies on the market, particularly in the developing world. Contrary to standard economic theory, there have been numerous cases where it was possible to reduce GHG emissions and reap economic benefits at the same time, e.g. US steel firms (Worell *et al*., 2003). Research found that even in situations where it would be beneficial and profitable for an entity to adopt climate-friendly, energy efficient technologies, the uptake of such investments has been less than satisfactory (Masini & Menichetti, 2010; Marechal, 2007). This was termed the 'no regret' emission reduction potential, which is defined as a situation in which the costs of implementing a measure are more than offset by the direct or indirect benefits (not including climate-related benefits) it generates based on traditional financial criteria (Huntington *et al*., 1994). The failure to make 'no regret' choices defies market logic, because overcoming 'no regret' failures is argued to be unequivocally efficient and climate-friendly (IPCC, 2007a). According to the normative economic and finance paradigm, if such a profitable potential did exist, economic agents (i.e. optimising machines) would eventually undertake the necessary investments to capture it (Sutherland, 2000). Yet, despite considerable efforts and calls to push for climate-friendly investments, even simple 'no regret' choices on energy demand-side management (CDP, 2010), such as reduced

energy costs as a result of deployment of energy-efficient technologies, fuel-efficient and economic vehicles, change in energy use behaviours and habits have failed to penetrate even a fraction of their potential.

From a market perspective, users of such energy equipment defy the simple logic of preference for cost-effective operations, leading to what has been termed the "efficiency gap" (De Caino, 1998). While some market oriented pundits are baffled by this "irrationality', others have attempted to explain it away using the concept of market failures, citing hidden costs (unprized environmental externalities) and market imperfections such as insufficient investible resources, imperfect information, distortionary taxation or misplaced incentives, as a strong rationale for inaction (Sutherland, 2000). However, while such costs do indeed exist, bottom-up studies have shown that they do not quite offset the benefits from identified profitable energy-efficient investments (Brown, 2001). These rational economic man theory explanations have been unsatisfactory and not compelling.

DeCanio (1998) and Shove (2005) showed that there are non-economic barriers that are just as important to bring to light if decision-makers are to tap into the 'no regret' potential, citing organisational and institutional behaviours as arguments in explaining the efficiency gap in energy. Schleich and Gruber (2008) concurred that the idea of routinized behaviours is aggregated in groups such as firms and institutions where sources of inertia are multiple. These relate to the irrationality of man, commonly referred to as the "bounded rationality" of economic agents (Simon, 1955). In adapting to their limited capabilities, agents adopt decision "routines" or "heuristics" to simplify their decision making process and ensure satisfactory results, a phenomenon Simon (1955) termed "satisficing".

4.6 Procedural Rationality and Strategic Decision Making Process

Simon (1976) clearly distinguished between goal rationality (the result of the decision) and procedural rationality (the process by which the result is obtained), arguing that decision makers' behaviours are shaped by the complexity of the environment and their computational capabilities. These result in a tendency for decision makers to set aspirational as opposed to optimal goals, and set sequential rather than simultaneous goals due to limitations of cognitive

abilities to acquire, process, draw inferences or retain information and plan long-term (Simon, 1996). Procedural rationality views uncertainty as impacting not only the outcome of a decision but also the specifications of that outcome.

Simon (1976) defined strategy as a series of decisions carried out to determine alternatives for a specific moment's behaviour, but over a length of time. Strategic management then, can be proposed as the art of dealing effectively with the challenges of bounded rationality in a changing and uncertain environment (Simon, 1955). Researchers have recognised that effective strategic decision making is important for the evolution of organisations and for the capture and creation of value (Teece *et al.,* 2002; Brouthers *et al*., 1998) through the creation and solving of problems and possibilities. The strategic decision making process involves problem definition, information search, analysis, evaluation and selection of choices. Studies (Brouthers, *et al.*, 1998; Daft *et al*., 1988) have found that firms with more intense information search methodologies are more likely to be more rational in their strategic decisions.

The ability to distinguish between relevant and irrelevant information and the art and discipline of using the information from the previous phases in the actual choice process are two key areas where bounded rationality can easily manifest. Studies (Lovallo *et al.*, 2009; Flyvbjerg *et al*., 2009; Brouthers *et al*., 1998, Simon, 1956) have shown that even after extensive information gathering, analysis and discussion, managers still tend to use intuition in selecting the right alternatives. This, they found, is dependent on the aspirational goals and objectives of the particular organisation at the time of the strategic activity. Decision making was found to be affected by the problem/opportunity under consideration, the existing written and unwritten rules in the organisation (a reflection of the prior learning of the organisation), the location of decision making responsibility in the organisation and the vision and goals of the organisation (Thaler, 2005; Lovallo *et al*., 2009; Raymond & Brown, 2011).

Strategic decision-making often involves a great deal of complexity, uncertainty and ambiguity. Because managers are subject to 'bounded rationality', their cognitive processes may result in systematic decision biases as a result of limited information, cognitive limitations on their minds, conflicting preferences for certain organisational goals and the finite amount of time they have in which to make decisions (Kahneman & Tversky, 1979; Russell & Thaler, 1985). Because decision makers lack the ability and resources to arrive at the optimal solution, they instead

apply their rationality only after having greatly simplified the choices available. Thus the decision maker is a satisficer; one seeking a satisfactory solution rather than an optimal one.

4.7 Strategy as Decision Making

Winter (2000) advanced the notion of strategy as being the study of decision making about external, internal and historical issues. External decisions are about the environment - the context in which a business is set - including industry, global setting, competitive conditions and the interaction amongst the many variables. Because of the imperfect match between a firm and its environment, Simon (1976) argued that businesses also need to pay attention to the decision processes within an organisation. Thus, according to Simon, "correct decisions about a firm's product and markets must necessarily take into account the characteristics of the firm – in terms of its human, organizational, physical, and financial resources – that constitute its comparative advantage" (p. 131). Lovallo and colleagues (2009) agreed that a firm's strategy is built on its history (the successes, failures, adaptation to competitor activities, etc.).

These arguments suggest that strategic management is business development within an evolutionary context, i.e. firm strategy is a combination of the processes of environmental selection and rational adaptation. As a result, even with intended rationality, while processes of improvement and learning can lead to progress (Zacharakis & Shepherd, 2007), they cannot guarantee optimal outcomes. This is because we cannot predict with certainty, given the initial conditions, where the firm is going. The subtlety of this argument lies in the fact that tomorrow's decisions about strategy depend not only on today's decisions about strategy, but also on how today's decisions were arrived at (Lovallo *et al.,* 2009). A more detailed investigation of how such decisions are made, coupled with an application of the same in the climate change arena, has the potential to enhance and deepen the understanding of strategic management.

Thus, Simon (1956) saw survival and success in strategic management as requiring the expansion and development of three skills sets, namely skills in anticipating the shape of the uncertain future (what can be more uncertain than the climate change space in terms of alternatives available and the probability distribution of those alternatives?); skills in generating new alternatives for strategic decisions (being a new space, it is not clear what the climate

change response alternatives are and there are still very few opportunities to learn from others and the past); and skills, competencies and experiences required to implement the new strategic initiatives (Raymond & Brown, 2011). Change and adjustment is both at the individual and organisational level because of what March and Simon (1968:151) referred to as, "a complex interweaving of affective and cognitive processes": What a person wants and likes influences what he sees; what he sees influences what he wants and likes.

4.8 The Behavioural Theory of Organisations

Research (Thaler, 2005; Lovallo & Sibony, 2006; Flyvbjerg *et al.,* 2005; Baghai *et al*., 2009) has shown that strategy is embedded in a larger set of behavioural ideas about politics and rationality in decision making and behaviors in organisations. Whereas corporate objectives and strategies in rational theory paradigm are pictured as given alternatives each with a set of consequences attached, and the problem of choice consisting in the selection of the best alternative; objectives and strategies within the behavioural theory paradigm of the firm were found to mirror the demands of a political coalition (Teece *et al.,* 2002), changing as the composition of that coalition changes. In the behavioural view, agents have only limited rationality, meaning that behaviour in organizations is intendedly rational (Thaler, 2005), i.e. it is neither emotive nor aimless. Decision making and consequently strategic management in the behavioural theory is assumed to take place in response to a problem or opportunity, through the search for an alternative that is acceptable from the point of view of the current aspiration levels (Teece *et al.,* 2002) of the organisation. Decision making is affected, therefore, by the definition of the problem or opportunity, by existing rules (which reflect past learning by the organisation), by the order in which alternatives are considered (which reflect the location of decision making in the organisation and past experience), and by anything that affects aspirations and attention (Lovallo & Sibony, 2006).

Teece *et al.* (2002) argued that when these foundational elements are in place, the behavioural perspective on strategy can be seamlessly integrated into a complete picture at the individual, organisational, and industrial levels of analysis. Strategic management is then about behavioural theories where decision making is at its heart (Lovallo *et al*., 2009). In this it will be a theory of know-how rather than know-what. While rational theories of strategic

management try to directly relate the "what" (resources and capabilities) with outcome measures (Flyvbjerg *et al.,* 2009; Baghai *et al*., 2009), behavioural strategy theory focuses on "how" organisations can craft and implement strategies both with regard to the acquisition and utilisation of changing resources and capabilities within the firm, as well as adapting to and negotiating with the external environment (Baghai *et al.,* 2009). Moving to a more dynamic view highlights the nature and role of knowledge and human capital (Teece *et al*., 2002; Eisenhardt & Martin, 2000). However it is only when we get into the skin of the firm and observe human level processes driven by the behaviour of individuals and groups that we begin to get a near-complete and useful picture of strategic management from a behavioural perspective.

4.9 Criticism and the Co-evolution of Normative and Behavioural Theories

There is a protracted debate between proponents of behavioural and neoclassical theories, particularly between proponents of the efficient market hypothesis or capital asset pricing model and the behavioural finance model. Anomalies in financial markets such as excessive volatility, overvaluation or undervaluation have been interpreted by both the efficient market and the behavioural finance arguments (Konte, 2010).

Behavioural theory has been criticised as lacking integrity due to the absence of a unified concept of the individual behaviour that applies across the various individual behaviours. Ross (2005) argued that behavioural finance was being defined by what neoclassical finance does not offer rather than by what behavioural finance does. Alm (2010) agreed with this critique, noting that models of behavioural economics typically identify a particular market anomaly and address it by describing decision makers as using heuristics and as subject to framing effects. Perhaps the most notable critic of the behavioural finance concept is Fama (1998), who contended that behavioural finance is more a collection of anomalies than a true branch of finance, and that these abnormalities are either quickly priced out of the market or are explained by appealing to market microstructure arguments like the market efficiency theory.

Such an approach, the researchers believe, lacks the academic rigour often associated with theories and concepts. They claim that a concept can explain a phenomenon but fail to explain another related phenomenon, can arrive at different inferences from different angles and

explain a partial problem, but fail to expound the universal theoretical framework. Ross (2005) criticised the doom and death prophesies on standard finance models by proponents of the behavioural approach.

Another criticism of the behavioural approach is the focus on individual rather than group, aggregate or market behaviour. The argument put forward was that individual cognitive biases are distinct from social biases (Fama, 1998; Glaeser, 2003), where the former can be averaged out and its effects short-lived since they are short-term chance events. They also argued that the effect of individual choices is crowded out by aggregate behaviour, which is most relevant for finance and economics in particular. Alm (2010) countered this argument by proposing that the whole is made up of the sum of its parts, so it is prudent for researchers to understand the constituent parts (the individuals) before understanding the whole (the group, aggregate or market).

Another point of contention is around soft paternalism as a recommendation implied out of behavioural economic studies. Also referred to as asymmetrical paternalism or libertarian paternalism, soft paternalism as implied by behavioural concepts suggests that governments and other authorities should enact policies designed to assist irrational people (since they are not advancing their own interests in any case rather than allowing them to continue choosing), while not interfering with and/or infringing on the autonomy of those who make rational, deliberate decisions (Thaler & Sunstein, 2008). The economist, Klein (2004), criticised libertarian paternalism as oxymoronic, arguing against what he perceived as an oversimplification of the definition of libertarianism on the grounds that Thaler and Sunstein (2008) made no meaningful distinction between liberty and coercion. He also argues that aggregate behaviour cancels out individual irrationality over time.

Critics of behavioural economics typically stress the rationality of economic agents (Fama, 1998). They contend that experimentally observed behaviour has limited applications to market situations, as learning opportunities and competition ensure at least a close approximation of rational behaviour. Others note that cognitive theories, such as prospect theory, are models of decision making, not generalised economic behaviour, and are only applicable to the sort of

once-off decision problems presented to experiment participants or survey respondents (Thaler, 2005; Lovallo & Sibony, 2006)

Traditional economists are also sceptical of the experimental and survey-based techniques which behavioural economics have used extensively until recently. Economists typically stress revealed preferences over stated preferences from surveys in the determination of economic value. Experiments and surveys, they argue, are at risk of systemic biases and lack real-life incentive compatibility (Glaeser, 2003).

Some studies have offered explanations of the diversion, proposing that the two schools of thought came from different eras and from different theoretic backgrounds (psychology and philosophy vs. economics and mathematics), so the notion has largely been two mutually exclusive approaches (Alm, 2010; Shiller, 2006). Shiller (2006) suggested that the best way to differentiate between normative and behavioural finance is that, "…behavioural finance is more eclectic, more willing to learn from other social sciences and less concerned about elegance of models and more with the evidence that they describe actual human behaviour".

Several researchers (Shiller, 2006; Konte, 2010; Alm, 2010) noted that by holding on tenaciously to one school of thought and model, researchers run the risk of making themselves irrelevant when they lose sight of the appropriate context and timing for the use of their models. Conlisk (1996) argued that while bounds of rationality are not always important, their frequency occurs often enough to render them important for inclusion in economic analysis. These researchers instead proposed an interweaving of the two theories as a way to reconcile the arguments from both sides of the divide in the form of dynamic evolutionary or genetic algorithms. Lo (2005) proposed the adaptive market hypothesis to reconcile the two theories, by using evolutionary systems which argued that behavioural finance draws on a wide expanse of knowledge from all the social sciences that offer real and tangible alternatives which should not be lost. Other literature uses agent based models (adaptive or evolutionary systems) based on heterogeneity and bounded rationality.

5. Multi-criteria Decision Aid (MCDA)

5.1 Introduction to Decision Support Methodology

This section describes the basic concepts of multi-criteria decision aid and how it is applied in this study to aid strategic decision making in order to deal with the complexity of climate change response. Belton and Stewart (2002) defined multiple objective decision analysis as a methodology that considers multiple objectives or criteria in decision making environments, by providing insight to decision makers who are faced with making decisions with multiple, and often conflicting, objectives or criteria. The methodologies provide frameworks for structuring (collecting, storing and processing) complex problems well and considering multiple criteria explicitly, leading to more informed and better decisions (De Brucker *et al.*, 2004; Steuer, 1989). A multi-criteria decision problem can be represented in the criterion space, the decision space or the weight space, provided the different criteria are combined by a weighted linear function (Junior & Lins, 2009). The main advantage of multi-criteria modelling is that it makes it possible to consider a variety of data, relations and objectives which are generally present in a specific climate change response problem (Tudela *et al.*, 2006; Funtowicz, 1999), making it possible to analyse and evaluate the trade-offs from different points of view.

Due to the presence of more than one criterion, preference information has to be incorporated into a multi-criteria decision problem in order to obtain a set of optimal solutions. The process of solving multi-criteria decision problems consists of finding a set of non-dominated solutions, that is, feasible solutions where it is not possible to vary or improve one objective function without sacrificing at least one other objective function (Junior & Lins, 2009). Methods with *a priori* preference aggregation do exist, but they require the knowledge of the Decision Maker's (DM) value function, which is generally not the case. One alternative is *a posteriori* preference aggregation (Karasakal, 2009), which requires the DM to compare non-dominated solutions, but often the set of non-dominated solutions is so large that arriving at a single final choice becomes an onerous task. Another intermediate flexible alternative is to allow further interaction between the analyst and the DM in the search for the most preferred non-dominated solution. This implies the need to assist decision makers with tools that help them deal with the trade-offs among different non-dominated solutions, since any possible gain in one criterion shall be compensated by losses in other criteria (De Brucker *et al.*, 2004). This is the classical

situation the multi-criteria decision making deals with, particularly in situations where substitution of different types of capital is very difficult, as in climate change problems.

5.2 Multi-criteria Decision Aid Methods

There are three broad categories of multi-criteria decision analysis methodologies.

Utility-based models are based on the construction of some numerical value which is used to represent the degree to which one decision choice is preferred over another on the accessed criteria. The algorithms enable decision makers to define an index which they evaluate using decision weights (Belton & Stewart, 2002). Common methods are multiple attribute utility theory, MAUT (Keeney & Raiffa, 1976); multi- attribute value theory (MAVT) (Keeney & Raiffa, 1976), simple multi attribute rating technique (SMART), Compromise and composite programming. By their classification, these methods are premised on rational decision making and utility theory making them subject to the same criticism as the theories underpinning them (Stagl, 2004).

Outranking multi-criteria methods are based on weaker assumptions about the existence of utility functions and additivity, where alternatives are compared pairwise in order to assert the preference of one alternative over another (Brans *et al.*, 1986). They allow for incomparability of options and allow for the interaction between the model and decision maker. The aim is to facilitate the identification of compromise solutions in a transparent and fair way (de Montis, *et al.*, 2005; Stagl, 2004). Common methods include: *Elimination et Choix Tranduisanrt la Realite* (ELECTRE) I, IS, II, II, TRI (Roy, 1996); preference ranking Organisation method for enrichment evaluation (PROMETHE) I, II (Brans *et al.*, 1986), NAIADE and Regime.

The third category is the reference level or goal methods, where a certain aspirational, desirable goal or target value of achievement is established *a priori* for each criterion. Programming methods generate alternatives during the solution process on the basis of some mathematical formulation (de Montis *et al.*, 2005). Goal programming is one popular method in this category, in which unwanted deviations from this set of target values are minimised in an achievement function which can be a vector or a weighted sum. As satisfaction of the target is deemed to satisfy the decision maker(s), an underlying satisficing (Simon, 1955) philosophy is assumed.

Another example is multi-objective programming (MOP). Analytical hierarchy process (AHP) and Evaluation Matrix (Evamix) are examples of single criterion methods which convert impacts concerning different criteria into one criterion or attribute.

Table 5-1 shows a characterisation and comparison of the popular attribute aggregation multi-criteria decision aid methods that were considered in this study.

Table 5-1 Characterisation and Comparison of MCDA Methods

MADM Method	Input	Output	Decision Types	DM Interaction	Assumptions	MCDM Software
Scoring	Attribute scores, weights	Ordinal ranking	Individual DM, deterministic	Moderate	Non-restrictive	Spread sheets
MAVT	Value function weights	Cardinal ranking	Individual & group DM, deterministic, fuzzy	High	Very restrictive	Logical decisions, MATS, spread sheets
MAUT	Utility function weights	Cardinal ranking	Individual & group DM, probabilistic, fuzzy	High	Very restrictive	Logical decisions, HIPRE3+, spread sheets
AHP	Attribute scores, pairwise comparisons	Ratio scale	Individual & group DM, deterministic, probabilistic, fuzzy	High	Moderately restrictive	Expert choice, HIPRE3+, Which & Why, Spread sheets
Ideal Point	Attribute scores, weights, ideal point	Cardinal ranking	Individual & group DM, deterministic, probabilistic, fuzzy	Moderate	Non-restrictive	AIM, spread sheets
Concordance	Attribute scores, pairwise comparisons	Ordinal ranking	Individual & group DM, deterministic, probabilistic, fuzzy	Moderate	Non-restrictive	ELECTRE III & IV, spread sheets

Source: Malczewski (1999)

5.3 Mathematical modelling of a MCDM Problem

A typical multi-criteria problem with a discrete number of alternatives can be described as being a finite set *A* of *n* feasible actions a_j(j= 1, 2, …., n), with *m* different evaluation criteria f_i *(i=1,2,3….m)* considered relevant in the decision problem, where alternative a_1 is evaluated as being better than alternative a_2 (both belonging to set *A*) according to the i^{th} evaluation criteria if $f_i(a_1) > f_i(a_2)$.

Given such a scenario, the decision problem can be represented in a matrix P of the form *n x m,* called impact or evaluation matrix, whose typical elements p_{ij} *(i= 1, 2, …,m; j= 1, 2, …,n)* represent the evaluation of the j^{th} alternative by means of the i^{th} criterion (Funtowitz *et al.*, 1999; Janssen & Munda, 1999)

As already stated elsewhere in this thesis, decision making in climate change response is complex because of several factors, namely:

1. Multiplicity of response objectives and options (Beinat & Nijkamp, 1998; Janssen & Munda, 1999), which can sometimes be conflicting, have to be considered. Climate change response decisions cannot be made in isolation, but are closely associated with the societal, ecological and economic objectives of an organisation. In such a case, trade-offs in one objective have to be made against another (Forman & Gass, 2001; Clemen, 1996).
2. Multiplicity and heterogeneity of stakeholder interests (Lahdema *et al.*, 2000). There are several stakeholder groups who affect or are affected by the activities and climate change response choices. Their interests and expectations have to be factored into the decision choices. Since different stakeholders represent different interest groups, these interests generally conflict, thus calling for compromise solutions.
3. The long planning-implementation-outcome cycles, the uncertainty of the outcomes (Clemen, 1996) and the potentially far-reaching consequences of wrong decisions, call for well-calculated and well thought through choices. The central aim is the efficient allocation of scarce capital and resources over alternative uses (Hallerbach & Spronk, 2002), in order to obtain the maximum benefit for the environment, the people and the business.
4. Climate change response decisions involve balancing objectives and criteria that are incommensurable. Often these objectives cannot be represented or measured in monetary units alone, as these might be motivated by compliance, social justifications, moral commitment, reputational or values other than monetary. Executives in organisations are faced with judgments that cannot be reduced to indubitable financial numbers. The incommensurability is not confined to monetary reductionism alone, but

to any other physical reductionism, such as eco-energetic valuation (Tudela *et al.*, 2006; Martinez-Alier *et al.*, 1998).

The traditional neo-classical view of the firm has been the uni-dimensional maximisation of wealth for the shareholder. Thus the criterion for strategic decision making had been the myopic view of a unitary set of stakeholders whose interests were to maximise market value and financial return (Jensen, 2004). The advert of the socialist view, advocating socially responsible entrepreneurship (Stauer & Na, 2003) has introduced other stakeholders whose objectives are at loggerheads with the single wealth maximisation view. Traditional opportunity appraisal techniques of net present value or cost-benefit analysis (Stagl, 2004) are falling short given the complexity outlined above. Critiques have questioned the theoretical foundation, the validity of the numbers produced and the tools employed in environmental cost-benefit analysis decisions (Spash *et al.*, 2004).

This necessitates the need for decision making methods that incorporate the complexity outlined above (Hallerbach & Spronk, 2002); such that the strategic and other decisions made produce balanced, optimal choices for all concerned. Multi-objective decision support methodologies are potentially helpful to aid decision making in such complex situations. The methodologies' capability to consider multiple dimensions without the requirements for full monetisation of all criteria or outcomes (de Brucker *et al.*, 2004; Stagl, 2004) and impacts, make them indispensable in climate change response decision making situations. Another key advantage of multi-objective decision making methodologies is the potential for a participatory process, which is necessary when dealing with powerful and influential stakeholders such as governments or activists. Without such rigorous methodological support, decision makers gravitate towards the "fast and frugal" methods of decision making (Simon, 1976b). Multi-criteria decision making methods are proposed as a way to approximate the rational economic man model in climate change response.

5.4 Limitations of Cost-Benefit Analysis Models in Climate Change Response

Cost-benefit analysis (CBA) is a tool that employs neo-classical calculus and is rooted in the utilitarian concepts of quantifying the overall benefits of one party compared to another

(Joubert *et al*., 1997) in decision making. It is used extensively in business for highlighting the potential costs and benefits (in monetary terms) of a proposed decision and its alternatives. In this case it would assess the benefits and costs of ratifying, complying with, and responding to, climate change. CBA can be used in deciding what forms of response or initiatives are most cost-effective. Although this evaluative method is relatively easy, straightforward, and versatile, there are a number of arguments against using cost-benefit analysis as a decision-making tool, including:

1. CBA modelling is an inexact science. The framework requires a single unit, usually monetary terms, for valuation of cost and benefit, raising questions on the valuation of nonmonetary factors such as human lives and geological and environmental damages, reputation among others. It is very difficult to reduce the impacts or benefits of a climate change response initiative to some financial numbers (Tudela *et al*., 2006; Joubert *et al*., 1997). The amount of subjectivity involved when identifying, quantifying, and estimating different costs and benefits of a non-monetary nature for purposes of weighing the total costs compared to overall financial benefits of a particular endeavour, can be very subjective (Lovallo, 2009). This estimation and forecasting is often based on past experiences and expectations, which can often be biased (Tudela *et al*., 2006).

2. Haimes (1998) raises the issue of trade-off analysis in CBA modelling, postulating that the CBA framework involves trade-offs between two conflicting objectives — minimise costs and maximise benefits (or minimise risk/damage). However, cost-benefit analysis converts these multiple objectives into a single dimension objective problem, transfiguring objectives with multiple dimensions into a single monetary value. Trading off risk with other objectives, usually with cost, inherently involves judging levels of acceptable risk through sensitivity analysis. Haimes (1998) suggested assessing risk within a multi-objective framework, where the trade-offs between different criteria is the focus of the modelling.
3. Human error often results in common cost-benefit analysis errors, such as accidentally omitting certain costs and benefits due to the inability to forecast indirect causal relationships (Botzen & van den Berg, 2009). This leads to inaccurate analyses, which can lead to increased risk and inefficient decision-making.

4. Benefits can often be more difficult to quantify than costs. Costs often relate to those incurred by businesses. These costs can be in the form of added capital investment, added transaction costs (e.g. carbon sequestration, rather flaring), decreased market share, or other impacts that readily lend themselves to economic quantification. In contrast, many of the benefits of responding to climate change are non-economic, and economic analysis seeks to translate these benefits into financial terms.

5. Shared benefits can be underestimated. While it may be relatively straightforward to assess the immediate costs of regulation, shared benefits can be difficult to estimate. For example, how would a business estimate the benefits from participating in the Ozone Multilateral Agreements (www.unep.org)? The benefits are shared by all in the world, yet when weighed against the direct costs to the domestic industry, the benefits to the nation and humankind may at first glance seem to be greatly outweighed by the costs.

6. Limited capacity - According to the UNEP (2009), environmental economics is a new discipline in most developing countries. Accordingly, most developing countries have few economists who can accurately assess the potential environmental and public health benefits of climate change or environmental legislation (Dow & Downing, 2011; Pierce, 2007). Similarly, many economists would have difficulties accurately assessing the impacts of regulatory measures on one domestic industry, let alone single entities.

7. Since this evaluation method estimates the costs and benefits of an initiative over a period of time, it is necessary to calculate the present value. How can one accurately represent the present value of future benefits that will be enjoyed in the year 2100? Climate change effects are very long-term, which unfortunately poses a significant disadvantage, because even if one can accurately calculate the present value, there is no guarantee that the discount rate used in the calculation is realistic.

From the analysis above it is clear that cost-benefit analysis is grounded in the normative, rational economic man approach, therefore not appropriate for climate change response decision making. Analytical hierarchy process (AHP) is proposed as the multi-criteria decision

analysis method to solve the corporate climate change challenge. Since response to climate change could have unwanted social and economic repercussions, a best-balanced choice option is necessary for the continued survival and well-being of an organisation. Thus trade-off analysis clarifies the advantages of one option over another, both in the short and long-term planning horizon for the respective entity.

5.5 Analytical Hierarchy Process (AHP) as a MCDA Method

First developed by Saaty (1980), AHP is a multi-criteria decision-aid methodology based on a carefully structured mathematical set of matrices and their associated eigenvectors to compare criteria or alternatives in a pairwise mode against some predetermined objective (Saaty, 1980; Saaty, 2008*b*). AHP is based on the principles of decomposition, comparative judgement and synthesis of priorities. Decomposition requires that a decision problem be decomposed into a hierarchy that captures the essential elements of the problem. Comparative judgement calls for the assessment of pairwise comparisons of the elements within each level/cluster (local maxima) of the hierarchical structure in relation to a parent in the higher level cluster (Malczewski, 1999). In the synthesis phase, each derived ratio scale local maximum is combined with other local maxima of each level, to construct a composite set of priorities for the elements at the lowest level of the hierarchy. This is followed by the aggregation of the scores of the previous levels to produce the composite score at the highest level of each hierarchy, known as the global maxima.

The ability of AHP to decompose a complex problem into a hierarchical structure of homogeneous clusters, coupled with its ability to capture, measure and synthesise individual preferences of qualitative and quantitative attributes into ratio scale weights, make the method appropriate in establishing climate change response priorities and subsequently allocating resources to chosen priorities (Hwang & Syamsuddin, 2010).

The flexibility and simplicity of the method has been proven in practice and validated by physical and decision experiments (Vaidya & Kumar, 2006; Forman & Gass, 2001; Saaty, 2008*b*), making it useful in the private and public sectors at strategic and operational levels in broad areas of choice decisions. Examples include hiring decisions or student admissions, prioritisation and evaluation (Hwang & Syamsuddin, 2010; Syamsuddin & Hwang, 2009; Chiu,

et al., 2004), resource allocation e.g. investment decisions and plant location decisions, benchmarking (Vaidya & Kumar, 2006), public policy (Satty, 2008*a*), health care and strategic planning (Meziani & Rezvani 1990; Ossadnik, 1996; Kurttila *et al.*,2000), quality control programmes and even political decisions, where the Institute of Strategic Studies used AHP to vote on the removal of Apartheid in South Africa and the release of Nelson Mandela from prison (Satty, 2008*a*).

It is against this backdrop of a diversity of applications that AHP is proposed as the suitable multi-criteria approach to quantify and rank the possible set of initiatives and activities that a business could employ to mitigate and adapt to climate change risks, and capitalise on available opportunities. The next section describes in detail the merits for using AHP in this study.

5.5.1 Structuring complexity

Decision theory postulates that the human mind functions better in an ordered experience, where complex systems are hierarchically classified and subdivided into homogeneous clusters of factors (Simon, 1996; Saaty, 1980). AHP simplifies decision making by breaking down a complex problem into its constituent parts, and then aggregating the solutions to all these sub-problems into one solution. The decision problem is structured as a hierarchy of constituent parts, where the main objective of the decision problem is the top constituent of the hierarchy tree and the alternatives are at the very bottom of the hierarchy tree (Satty, 2008*a*), with sub-objectives or criteria in between. The underlying philosophy is based on the ability of human beings to make better judgments on smaller, simpler, common-sense kind of problems (Satty, 2008*b*; Saaty, 1980). The tree structure used to formulate an AHP problem provides a clear, organised and logical view of the climate change response problem, making it easy for decision makers to visualise the problem and analyse it systematically at each level from the more general higher level constituents to the more specific lower level constituents (Satty, 2008*a*). The AHP tree structure is constructed by decomposing a decision problem into its constituent elements (Vaidya & Kumar, 2006) in a top-down approach.

Hayek (1956) stated that models of a complex system should consider two closely interrelated dimensions - the number of variables within the system and their interconnectedness. The implication is that the importance of any element of the AHP structure can only be understood

in terms of its relationships to other elements of the structure, and where the said structure can only emerge if the said elements have particular sorts of relationships. The climate change challenge is a network of such connectedness, as described in earlier chapters.

5.5.2 Interaction of Decision Makers with Model

In their study of information sharing within the USA intelligence network's on terrorism, Cook *et al.* (2007) came to the conclusion that decision making is not the rational processes that some might suggest, because they are compromised by factors outside the events that people seek to control and manipulate. This is equally true for decisions in commercial operations such as nuclear power plants, chemical process industries, oil and gas production, transport operations, air traffic control and in almost every other sphere of complex decision making, where economic factors impinge on the decision making process and risks are high (Teece *et al.*, 2002).

In South Africa, stakeholders such as communities have a vested interest largely driven by broad based black economic empowerment (BBBEE), an initiative seeking to redress the economic imbalances brought on by Apartheid. Other stakeholders such as environmental activists, customers, suppliers, employees, shareholders, regulatory and statutory bodies also have their value systems that influence the types of decisions taken. Therefore particular attention has to be paid to reflect their interests and viewpoints in the climate change response decisions. Consultation and engagement with these stakeholders through a participatory process ensures that their values and interests are incorporated into the response decisions, thereby increasing the legitimacy of an organisation (Reyers *et al.*, 2011).

5.6 Why the Analytical Hierarchy Process Was Chosen

AHP provides a simplistic means to deal with complex decision making and can assist with identifying and weighting climate change response initiatives selection criteria, analysing the data collected for the criteria and expediting the decision-making process (Hwang & Syamsuddin 2010). Other MCDA methods such as Multi-Attribute Utility Theory (MAUT) limit procedural rationality. MAUT is a theoretically sound approach based on the assumption of rationality underlying the classic paradigm of expected utility created by Von Neumann and

Morgenstern (1944). By its very definition this methodology was not suitable for this bounded rational study.

6 Findings

Using a mixed methods approach, this study sought to explain how particular behaviours, cultures, structures and drivers for climate change corporate action individually or collectively promote or hinder response. Bounded rationality and multi-criteria decision aid were drawn upon to help explain the differences in climate change response options, and how bounded rationality concepts impact strategic decision making and consequently explained the similarities and differences in the type of climate change initiatives chosen.

6.1 The Cases

This section introduces the two companies used in the comparative case study. Climate change dynamics within their respective industries are also introduced in order to give a contextual understanding of each company's climate change drivers and motivations from an industry perspective. The climate change dynamics within the respective industries help to understand why the two companies are good cases to analyse comparatively. The industry overview reveals the broad climate change response areas of interest. This is especially relevant for the discussion and analysis section of the report, and in particular the analysis of bounded rationality and strategy decision making. The two cases are introduced below.

6.1.1 Tongaat Hulett

Tongaat Hulett is an agricultural and agro-processing business which includes integrated components of land management and property development (Tongaat, 2012). Through its sugar and starch operations, Tongaat Hulett produces a range of refined carbohydrate products from sugar cane and maize (Tongaat, 2012). Renewable energy, in the form of biofuel production and electricity generation and the water-food-energy nexus are important to the business (www.tongaat.com). Tongaat Hulett employs more than 42,000 employees during its peak milling season. The company's operational land footprint within the Southern African Development Community (SADC) region amounts to approximately 550,000 hectares, with 274,000 hectares of this land owned or controlled by Tongaat Hulett (Tongaat, 2012).

Sugar Operations

Tongaat Hulett has low cost sugar operations in six SADC countries, South Africa, Zimbabwe, Swaziland, Mozambique, Namibia and Botswana- under the Huletts® sugar brand. Tongaat Hulett's South African sugar milling, refining and agricultural operations are located on the north coast of KwaZulu-Natal, with sugar mills at Maidstone, Darnall, Amatikulu and Felixton, and a central refinery in Durban (Tongaat, 2012). The South African sugar product range offers a total sweetener solution including a range of high intensity sweeteners. An animal feeds operation, Voermol Feeds, is located at the Maidstone mill and this operation manufactures and markets a range of energy and supplementary feeds to the livestock farming community through the Voermol® brand (Tongaat, 2012).

Starch Operations

Established in 1919, Tongaat Hulett's wet-milling operation is Africa's largest producer and supplier of maize-based starch and glucose to a diverse range of South African and African industries. It also operates a dedicated Sorbitol facility which is located in Chloorkop in Gauteng, and has distribution networks and facilities in Zimbabwe, Australasia and the Far East (Tongaat, 2012). Using the wet milling process, Tongaat Hulett Starch manufactures a wide range of products, from unmodified maize starch to highly refined glucose products, which are key ingredients for local manufacturers of foodstuffs, beverages and a variety of industrial products. Its products include modified and unmodified starches, glucose, maltose and dextrose syrups, glucose powders, caramel colour, sorbitol, maize germ, high protein gluten meal, gluten feed and corn steep liquor (Tongaat, 2012). Toothpaste, soups, tomato sauce, mayonnaise, sweets, paper, board, braai briquettes, textiles, beer, spices, beverages, glue, intravenous drips and sweeteners are only a few of the industries currently making use of the products and co-products produced by Tongaat Hulett Starch.

Property Development

Durban/eThekwini, South Africa's third largest city, continues to expand into Tongaat Hulett's land holdings to the north and west. Over the past 12 years, Tongaat Hulett's development operation has converted some 2 600 gross hectares to development (Tongaat, 2012). The company is a proactive partner with governments and communities in this conversion process.

6.1.2 Air Traffic and Navigation Services (ATNS)

Based in South Africa, ATNS is an Air Navigation Service Provider (ANSP) responsible for the air traffic control of approximately 10% of the world's airspace with the primary purpose being to permit airspace use and facilitate the efficient and safe use of airspace by separating aircraft to prevent collisions, organising and expediting the flow of air traffic and providing information and other support for pilots (www.atns.co.za). ATNS' controllers keep the aircraft they handle safely separated using internationally agreed standards. This is achieved by allocating different heights to aircraft or by arranging certain minimum horizontal distances between them. ATNS also provides aeronautical information used for all flight planning purposes, as well as alert, search and rescue coordination activities, implementation of terrestrial-based navigation structures, technical maintenance of navigation infrastructure and aerodrome services, training of licensed air-traffic controllers and other technical staff, and support for special events such as test and demonstration flights.

The air transport industry includes 1 715 airlines, with 23 000 aircraft serving 3 750 airports through a route network of millions of kilometres, managed by 160 ANSPs. Over 33 million people are employed in aviation and related activities, with more than 5.5 million people working directly in the aviation industry (IATA, 2009).

ATNS is in the airports and air traffic business, which places it in the high impact climate change category according to the JSE SRI's classification. It is a member of the Civil Air Navigation Service Organisations (CANSO), which is the global voice for companies providing air traffic control services worldwide. As an air navigation service provider, ATNS is regulated by the International Civil Aviation Organisation (ICAO), and is therefore expected to follow the climate change response guidelines as set out by ICAO and the International Air Transport Association (IATA). For ATNS, therefore, climate change response is a key matter from an end-to-end aviation industry point of view, because greenhouse gas emissions and noise not only affects airlines, whose main pre-occupation is the amount of fuel their aircrafts burn, but also the quality of life for people living near airports and beneath flight paths which are geographically dispersed.

The key issue facing ATNS and the aviation industry is the need to meet their customers' and regulators' demands to reduce global greenhouse gas emissions by reducing fuel-burn per seat

through how they control aircraft on a daily basis, which includes improving the efficiency of airspaces, route networks and the investment decisions made regarding new air traffic management technology. Flight planning and flight management tools that allow pilots to exploit prevailing wind conditions, calculate precise fuel loads, set different flight levels and speeds for an aircraft to achieve the most economic performance and determine the exact centre of gravity of an aircraft as it becomes lighter in flight, are some of the key activities which ATNS assists with in optimising the flights of aircraft, thereby increasing the fuel-burn efficiency and consequently reducing the amount of CO_2 emissions per flight.

6.2 General Findings

Using Tongaat Hulett and Air Traffic and Navigation Services (ATNS) as the cases, this section examines the two companies' responses to climate change, Information is based on the analysis of publicly available information, company documentation and the information disclosed during the interview sessions. Topics discussed include the business executives' perceptions on climate change in general and their perceptions on the motivations and drivers for their organisations' response to climate change, and the initiatives and climate change response actions being considered or currently underway.

The study compares how two different corporations, are responding to climate change challenges. Tongaat Hulett and ATNS constitute interesting comparative cases, because both companies are headquartered in South Africa and therefore are subjective to similar macro-economic fundamentals and climate change related legislation. Both companies have operations and business interests outside of South Africa and have customers in Europe, the Middle East and other parts of the world. Climate change response initiatives are underway, but the types of initiatives and the emphasis on each of those differ in very interesting ways between the two entities. Both firms are seeking a balance between climate change response and economic and social sustainability. The differences in industry sectors, management styles, drivers and motivations for action, resources and capabilities seem to have major bearings on the differences in the types, emphasis and values of initiatives currently underway. Both companies face legislative pressures from the different industry governing bodies, with ATNS facing pressure to comply with the International Civil Aviation Organisation (ICAO) directives, while Tongaat Hulett faces environmental legislative pressures from the National Environmental

Waste Management Act 59 of 2008. Climate change legislation is applicable to both entities and according to the JSE SRI; both companies are classified as high impact when it comes to climate change criteria.

Tongaat Hulett Sustainability Strategic Intent

Climate change response is being driven as part of the corporate strategy. Environmental performance is one of the pillars in their performance management system – the Balanced Scorecard for all employees. This statement by one of the executives explains this:

> **"**And there are environmental initiatives as part of our Balanced Scorecard/Strategy**....**ultimately it hits our pockets as well so at the end of the year when we check our Balanced Scorecard, your target, your bonus will be determined on that. That sustainability lag is very much a core part of what we are going to be measured on. So it is part of the strategy."

An introduction to Tongaat Hulett's Sustainability Strategy as posted on the company website (www.tongaat.co.za) reads:

> "As a key player in agriculture and agro-processing, Tongaat Hulett has a responsibility to operate with a long-term view that takes into account how decisions and actions impact its on-going performance and affect the people, habitat, planet and resources associated with company operations. Sustainability is integrated within all facets of the business and is aligned to the organisation's overall objectives. This has direct benefit to the company and its stakeholders as there is an improvement in management's performance and operational efficiency that enables it to reduce the risk that could affect the realisation of strategic goals.

The company's participation in various voluntary sustainability reporting initiatives, including the Carbon Disclosure Project (CDP), the CDP Water Disclosure Project and its listing on the JSE's Social Responsibility Investment index for the seventh consecutive year, is evidence that Tongaat Hulett is actively involved in environmental sustainability of which climate change is a part. The energy-food-water nexus is an evolving dynamic within Tongaat Hulett. The company balances the operational requirement for cane supplies to its sugar cane processing operations with the transition of agricultural land to other uses at the appropriate times (Tongaat, 2012).

ATNS Sustainability and Climate Change Strategic Intent

For ATNS, climate change response was identified as a strategic priority during one of their corporate strategy formulation sessions. One of the executives said:

> "Interestingly, on the 11th May 2011 when we went out for our strategy session at Birchwood, one of the objectives which came out of the strategy was to have this climate change and sustainability. So it was actually birthed through the ATNS strategy and it came on into ATNS and currently it's sitting in the CEO's office. So it is the CEO's project…So it came from the strategy though the CEO and now it's cascading down the entire organisation."

Its stance on climate change as detailed in its Sustainability and Climate Change Strategy document (ATNS, 2012*a*) reads:

> "ATNS' commitment to safety and promoting the wellbeing of stakeholders in the air traffic realm includes an on-going focus on environmental wellbeing. ATNS subscribes to the International Civil Aviation Organisation's Global Air Traffic Management Operational Concept. Amongst others "environmental sustainability" is an expectation of the concept. ATNS is actively involved in a variety of activities and initiatives in support of this expectation."

The company's Environment Management Plan details the approach taken to further develop the initiatives identified in the Sustainability and Climate Change Strategy so as to develop a company-wide response to sustainability and climate change.

> "The Department of Transport (Shareholder), ATNS Board and Executive fully endorses the approach taken by ATNS in recognising the strategic importance of climate change throughout the whole organisation and how the financial impacts of climate change are intrinsically linked to the physical, environmental, social and political relationships that surround ATNS."

ATNS has identified several environmental sustainability initiatives for the short-, medium- and long-term. Some of the key initiatives include noise abatement, where flight procedures are being designed to support compliance in noise abatement. Studies on noise profiling and noise contours are underway. Other procedures supporting the reduction of noise which are under consideration include the application of climb gradient restrictions, design of clean speed procedures, and continuous descent approaches (ATNS, 2012*b*). As an air navigation service provider, ATNS sees opportunities for carbon emissions reduction through fuel use reduction procedures such as optimised routings and flight level allocation; performance based navigation (PBN) with associated required navigation performance (RNP); flexible use of airspace (FUA); reduced vertical separation minima (RVSM); gate-to-gate 4D trajectory management in continental airspace; dynamic information availability supporting tactical route decision making; and other operational initiatives such as paperless ATM, electronic filing, centralised aeronautical database (CAD), paper recycling, etc.

The next section goes into more detail in explaining the similarities and differences in the drivers for climate change response, as well as the initiatives which each of the two companies are embarking on in response to the climate change risks and opportunities.

6.3 Similarities in Climate Change Response Drivers and Motivations

In the following sections, the corporate drivers for responding to climate change are compared and contrasted, and the current practices for each level of activity in each company are reported. The key drivers are divided into three categories, namely financial business case, moral responsibility and organisational legitimacy.

Description and Explanations

6.3.1 Financial Business Case

There are very few similarities in terms of the financial business case drivers for responding to climate change. Both businesses see opportunities to gain competitive advantage by being more streamlined and efficient, but the pathways to achieving that are different for the two companies.

6.3.2 Moral Responsibility

One of the striking similarities between the two companies is the shared understanding and drive to use climate change response as an opportunity to not only develop South Africa, but the whole of the African continent. The patriotism shown in the statements below are a clear reflection of that motivation.

One of the ATN executives stated:

> "…and also coming from the old school of Thabo Mbeki's African Renaissance, where it's said, 'African solutions, for African problems by African people - this is also applicable to sustainability…so what we are saying is let us Africans – we know the environment, we understand it and we know all the catches. Let's come up with our own initiatives which we will be able to sustain."

These patriotic sentiments were also expressed by Tongaat executives as expressed in the following quotations:

> ”We are a country that has tons and tons of unskilled human capacity and we have learnt that it is not being properly utilised. So if we really want to build the capacity and reduce the unemployment in the country; increasing employment in the agricultural sector would have an impact in terms of the economy, people earning X Rands being able to contribute Y into the economy.”

Commenting on the electricity from bagasse generating capacity, a Tongaat executive expressed a similar need to contribute to the growth of Africa:

> “This project has a potential not only focused on SA but also Southern Africa, the so-called SADC. That would have a massive impact in terms of reducing our carbon footprint. We would also be able to influence the economic growth in the country as Tongaat.”

There is also evidence of sharp awareness and motivation to be good corporate citizens, and in climate change terminology, “earth citizenship.” The understanding that resources are finite and that corporations have a moral responsibility to safeguard and protect those resources for future generations was expressed by executives in both companies. Some of the statements included:

> “...also, ATNS being a global citizen, not just a company, but a responsible citizen - we also want to get involved because of these reasons.”

The Tongaat executives had this to say:

> “We cannot continue to be where we were 40 years ago. That we have abandoned – to live as if we have infinite resources. If as an organisation, we don’t purchase a single watt of electricity from Eskom, we will have achieved something.”

Another statement by another executive with similar sentiments was:

> “The drive is about water treatment for Tongaat to save water. The second part is that, if ever we are to be a much more sustainable organisation and a responsible corporate citizen, we have to save water because we are in a water-stressed country. We have to do our part and make a contribution towards that.”

6.3.3 Organisational Legitimacy

Legitimacy is important because of the reputational and other organisational benefits that can accrue from some degree of shared agreement among climate change societal constituencies that an organisation is aligned with accepted notions of purpose, endeavour and outcomes.

Customer Pressures

An important driver for both companies is increasing consumer awareness and pressures. The concept of green consumerism - whereby customers and consumers prefer environmentally friendly products and services is a phenomenon which both companies have started experiencing, albeit to varying degrees.

Tongaat had this to say concerning the need to respond as a result to customer demands:

> "…we have had customers asking what the carbon footprint of our product is….. Yes! How much CO_2 do we produce per tonne of starch? Luckily we have been able to answer that question quite easily because of CDP."

Another executive said:

> "SA Breweries want to stick to non-GMO products … We give SA Breweries what they want because they take 35%+ of our volumes and we don't want to lose market share."

Value chain emissions profiling is becoming a concern as evidenced by this statement from yet another of the Tongaat executives:

> "…I think customers will come to us and say, are your processes running as efficiently as possible, with the lowest consumption of electricity per unit of product, lowest consumption of water per unit of product, lowest emissions and lowest effluent generation per unit of product? So as TH we have to be able to show customers that we have been very efficient on that front…"

Customer pressures are also being felt by ATNS. This push is expressed in this statement:

> "What I'm trying to say is our customers are already aware. They are actually asking that question (Is there a better way you can do your operations now given these environmental issues that are coming up?). They may be asking that question indirectly in order for them to save fuel or to save money, but it's an environmental issue."

The need for both entities to enhance their corporate reputations by paying more attention to the changing societal expectations and other stakeholders is also a key motivator for action.

Legal and Regulatory Pressures

National and international policy frameworks as well as legal and regulatory pressures for emissions reduction are providing an incentive to reduce operational emissions. There were mentions of the Carbon Tax, National Climate Change Response Strategy as well as the Waste Act. The COP 17 held in Durban, South Africa, in December 2011, of which both companies actively participated was still fresh in the executives' minds and so received a substantial number of mentions as an event that has heightened the need for response.

ATNS is being driven by international legislation and requirements as propagated by the International Civil Aviation Organisation (ICAO).

> "So ICAO is like the mother body of all civil aviation organisations in the world and they have come up with a request that every civil aviation organisation, not only air navigation providers, but also airlines, civil aviation authorities etc., all should respond to this issue of climate change ….. ICAO has come up with a Civil Aviation Environmental Protection (CAEP) document detailing how each of the civil aviation members should respond to the issues of climate change."

Tongaat seems to be driven largely by the National Environmental Management Waste Act 59 of 2008 and its predecessors. The following statement bears testimony,

> "…most of the things are around effluent treatment. Primarily those are driven by the environmental legislation. From an environmental perspective, there are certain standards that have been set in terms of what effluent you can release and in what state it should be… so there is a big focus on compliance."

Another statement confirming the motivation to comply is captured in this statement:

> "…so when The Green Scorpions come they must not find that we are releasing effluent that does not meet the standards."

The Green Scorpions are an environmental legislation enforcement arm of the government. Their primary areas of enforcement include biodiversity, protected areas, pollution and waste, as well as coastal, marine and environmental impact assessments.

Another key driver which may be peculiar to South Africa is the need to conserve electricity, due to constrained supplies from the only electricity utility in the country, Eskom:

> "There was a directive from Eskom for us as part of the Intensive Energy Users Group (IEUG) to cut electricity usage by 10% after the 2008 power cuts…. We were actually ready post-2008 to start generating part of our own electricity using Sasol gas…"

6.4 Similarities in Climate Change Response Initiatives

Carbon Trust (2011) recognised and recommended a hierarchy of actions to combat climate change. Both individuals and organisations can follow the steps in the hierarchy as follows: The first step is to be aware of one's actions, behaviours, contribution to the climate change challenge and ultimately, one's carbon footprint. Once a business and individuals in a business have a good understanding of the challenge, avoidance is the next step. Comprehensive initiatives can be instituted to avoid emissions, such as turning off equipment when not in use and avoiding unnecessary travel. The next step in the reduction of carbon emissions is reducing them through efficiency measures. For those emissions that can neither be avoided nor reduced, offsetting is the next step in the hierarchy. Carbon credits can be traded and bought to fund reductions in emissions elsewhere in the world.

This section reports on the similarities in climate change response initiatives which the two companies have embarked on. The initiatives are divided into four categories, namely: activities directed towards raising awareness; initiatives geared towards adapting to climate change and operational efficiency; initiatives that result in new products, services and new revenue streams and initiatives where climate change is seamlessly integrated into corporate strategy.

Descriptions and Explanations

6.4.1 Raising Awareness

Raising climate change consciousness among the companies' stakeholders, both internal and external, is being approached in a way to garner the support, buy-in and commitment needed to take the organisations on the desired climate change response paths. Providing information and creating awareness about an issue does not however automatically lead to behavioural change, but is a key aspect in educating and motivating desired behavioural changes. There are

not many similarities regarding the types of initiatives directed towards raising awareness in the two businesses, except participation in and publicity from COP 17.

Tongaat Hulett benefited by securing some business from the event:

> "We had a stall at COP 17 and what we heard is that some companies visited our stall and when they heard what we as a company are doing they changed the placing of orders away from our opposition to us… And we didn't talk only of initiatives; we also spoke of the projects that had been done and the reduction of carbon emissions… some of them visited the display and asked questions. We didn't know they were CEOs and major guys but afterwards communication came through because we were significantly ahead in some areas. There was some competitive advantage."

ATNS had this to say:

> "We had a major event during the COP 17… where we are driving what we call INSPIRE... it was to review the results of the Green Demonstration Flights".

6.4.2 Adaptation and Operational Efficiencies

Green-inspired operational efficiencies (known as green productivity) is introducing new business models and practices where resource productivity and cost-consciousness are key drivers. By practicing the tenet of "reduce, reuse, recycle, dispose", companies are realising cost savings in areas such as materials and energy, thereby increasing the efficiency and productivity of their organisations (Orsato, 2006) while reducing their climate change impact. Porter and van der Linde (2007) found that green-driven operational efficiencies have a greater impact on both the reduction of greenhouse gas emissions and increasing cost-competitiveness, and have better chances of success for companies in industrial markets with high levels of processing, waste generation and/or by-products, such as the food and beverage industries. Green productivity integrates productivity improvement with climate change mitigation and is applicable across businesses and industries (Dow & Downings, 2011).

Being 'lean and mean' is playing an important role in business today, but requires a combination of new thinking and the capitalisation of new technologies (Porter & Kramer, 2006). Optimising and streamlining operations is crucial in reducing operational expenditure and improving customer satisfaction. By following a well-structured asset/equipment replacement strategy, companies are ceasing opportunities to increase integration and efficiencies and enable greater

automation (Carbon Trust, 2010). Businesses are finding opportunities to replace out-dated equipment and technologies with "climate-friendly" technologies. Applying efficiency measures in energy, materials and water is improving the use of natural resources and fossil fuels, thus reducing emissions and easing the pressure on such resources.

Energy Efficiency

Both companies are looking at green-inspired operational efficiencies; however the scope of activities and the value of the initiatives are vastly different. Both companies have instituted low-cost energy efficient initiatives such as energy-efficient lighting in their buildings. There is also conscious effort among the employees to practice energy efficiency in such actions as switching off lights, paperless offices etc. For example, two ATNS executives said that:

> "Even on a smaller scale I think we are doing quite a lot of things. If you had met us when we were in Isando, each office had a little kettle to boil water for coffee, but now everything has been centralised."

> "I have stopped. Like I said, you have to live it. I wanted to buy another car but then I had to drop and squash that idea fast. It was a fuel guzzler."

On the operational side, ATNS is taking steps to improve energy consumption through fuel consumption, fuel-efficient vehicles, heating, lighting and air-conditioning systems specifically those used in their Control Centre:

> "The fleet has always been maintained with very fuel-efficient vehicles… but being technically minded as engineers, we understand fuel consumption, we understand usage and we always looked at the figures and the specifications of these vehicles… and it always turned out that we bought the most fuel efficient vehicles."

> "For the buildings generally, the bigger buildings, the Operational Centres, the Control Towers, the Control Centres – it's all about electricity usage; it's about heater usage, it's about air-conditioning usage….. A lot of the electronic equipment that the controllers use has to be maintained at a specific temperature. So there, all we can look at is more efficient air conditioning systems. They are quite old; they have been installed quite a few years ago so perhaps another initiative is to review them to see how they are impacting our carbon footprint, how they are creating consumption and perhaps adjust it accordingly, getting more modern systems."

And one of the Tongaat Hulett executives said:

> "My sense is that whatever we do; there are some efforts and initiatives which are on purpose taken to address the climate change issue, for example, the motion sensors and lighting that was purely for us to be green. So there are a few that are done specifically to tackle climate change and to be more environmentally sustainable."

Business Travel and Transportation

Whilst the motivation for carbon reduction in employee travel and transportation are different for the two companies, both entities are consciously reducing the amount of business travel. ATNS is consciously embarking on an initiative to reduce business travel due to the understanding that travelling constitutes a big aspect of their carbon footprint. They are also approaching the same issue from business efficiency and cost reduction perspectives:

> "Interestingly there is an initiative which I and some guys from Marketing and Communications have actually embarked on regarding business travel and transportation… Regarding conferences, meetings, workshops overseas, what we are trying to do is that in a year we want to, not limit per se. We want to choose and prioritise the conferences and workshops that we really need to attend as part of the global community."

The other executive agreed and added:

> "Instead of having a 100 where people are just going… whether they are bringing back business intelligence into the company or it's just for their own benefit… Things like that. That's number one. Number two, we also have a Carbon Emissions Calculator. You put your flight miles, then you are able to say in total to reduce this, this is what we used to have, also for your income statement, obviously you know how much you spent on travel. You work that in tandem with the Calculator and say now you are working towards targets and say we are going to reduce it by this much and obviously you are going to see a cost saving as well."

On the transport for service and maintenance, one of the executives said:

> "What the guys do now is they will typically have sites all over the countryside and they will go to specific sites for preventative maintenance, for corrective maintenance and there are certain routes that one can take and you can do maybe two or three different maintenance activities on the same trip. Instead of driving back a different person another time, we have got initiatives of cross-training some of the people so they understand each other's sites and they will then go to the different sites on the same trip and we are saving them two or three trips over a month."

6.4.3 New Products and Revenue Streams

Eco-design in the form of increasing the productivity of natural resources, shifting to ecology-inspired products and services, or harvesting from waste that becomes an input to another process in a cradle-to-cradle supply chain concept, is ushering tremendous value for marketing differentiation (Ottman *et al.*, 2006). By adopting an outward focus, companies are moving beyond their physical borders and creating collaborative partnerships which can be optimised in terms of waste, by-products and even energy among different supply- and value-chain partners (Kumar & Putman, 2008).

Companies with aggressive green product strategies are "creatively destructing" their own product lines to develop innovative new green products that allow them to tap into new products, market segments and geographic territories (Braungart et al., 2007), thereby creating significant competitive advantage. Other companies are focusing on providing bundled services and end-use value while ensuring cradle-to-cradle product stewardship for products such as leasing as opposed to selling outright (Braungart et al., 2007. The steady flow of monthly lease payments stabilises cash flows and leasing also reduces the need to maintain manufacturing capacity to meet peak demand (Kumar & Putman, 2008) - a source of waste and risk. Leasing also reverses "throw-away" societal behaviour. Instead of using planned obsolescence to boost sales, manufacturers are motivated to produce more durable and easily upgradeable products that lower the amount of materials used and avoid waste and overflowing landfill sites.

Green Products

Tongaat Hulett has researched and tested some green-inspired new product concepts. These are still in the pipeline as seen in the statements below.

Agriculture:

> "One opportunity that we as a company identified is: there is a product, a starch which was developed in the US…The process converts the starch into a product which absorbs water and it can be used in agriculture. When put into the soil it retains moisture in the soil so water does not run away as ground water or evaporation. We have done some studies here in South Africa where crop yields have been increased in trials, for instance, tomatoes with this product on the

ground, and adjacent to it, tomatoes without the product. There were dramatic differences between the two."

"And it is being used extensively in the forestry industry, so we are busy with the Journey … but we have spent some money on the pre-engineering to get ready to build a plant for this…"

Tires and biodegradable plastics:

"The other one, of which we are still miles and miles away from, we don't want to start things from scratch but in the US and Europe, companies have been able to design tires that use our products… For example Goodyear… it's still a bit early, but it has been done. It's a matter of getting into the technology, and not only for tires but also biodegradable plastics..."

Green Services

The whole of the aviation industry is testing new operational procedures designed to lower fuel consumption on flights. As an ANSP, ATNS is doing its part in these new operational procedures.

Performance based navigation (PBN):

"But from a fuel saving point of view, they have got procedures in place; performance based navigation (PBN); they are buying aircrafts that are fuel efficient as well. So we are helping them with those procedures and re-routing procedures are underway...."

Continuous Ascent and Continuous Decent Operations (CDO):

"…the objectives of INSPIRE, which I can mention now: which is to promote recommended procedures, practices and services that have the potential to provide efficiencies in fuel and emission reduction across all faces of light…Now with this project, it's continuous ascending and continuous descent."

ATNS is actively collaborating with value-chain partners such as suppliers, customers, and regulators to offer greener air traffic control, navigation and communication services:

"Coming from the engineering side you will find that the old technology which we used to use was more national. For instance I would go out and buy what is called an Instrument Landing System. I will put it at a particular airport to help the aircraft to land at the centre or to navigate at the centre of the runway. But now the new technology is more regional or even continental. For example, instead of putting that instrument at the airport we have got what is known as the satellite system, GNSS (Global Navigation Satellite System). Once that is put say in this region, it will cover all the 15, 16 SADC countries. So even the technology itself is forcing us to work

> together in the region and that's why most of our efforts like the GNSS, the UASCC, and the AFICAD as well, everything now we are trying to put it in more regional focus than independent countries."

ATNS is taking an integrated (cradle-to-cradle) approach in its equipment and technology purchases and asset replacement strategy. They are taking an active role in influencing their equipment and technology suppliers:

> "We are looking at all the company assets that use energy to see how much each asset is using. And in planning for the future using the ATNS Road Map, how can we put efficient assets that are going to drive us to saving while still delivering on the mandate."

> "Most of the assets have a 15-year life cycle. We are looking at this plan and what we are going to get out of this measurement is we have an R & D Department. Now we are going back to the R& D guys who can look at our requirements, look at the environmental impact and the start putting intelligence into their buying or sourcing - looking at the environmental impact, our footprint as ATNS, nationally and globally as well."

> "And also because we are Africa's leading ANSP we now also work to influence suppliers and the makers of the assets to think environmental-friendly because probably they are not right now. But as the buyer, you go back to them and you start drawing the specifications that you want and you are able to influence future developments of those assets…We need even to impact the design, to say, 'instead of this using electricity why can't you use solar?".

Both companies are in the exploratory phases of new product and service offerings in line with their different industrial sector opportunities.

6.4.4 Fully Integrated into Corporate Strategy

The pursuit of diversification as a business strategy, the need to enter into new business, or the need to shift away from low margin, low growth or mature industries, is a key driver in the pursuit of integrating climate change as a core aspect of a business' corporate strategy. Diversification decisions present unique challenges, particularly the requirement for a business to break away from past traditions, norms and cultures and enter into new, unchartered territories. Because of these changes in mind-sets and *modus operandi*, not enough businesses have jumped onto the bandwagon to a position where climate change response could be considered a new growth sector.

A proactive management of systemic climate risks is defining a new level of environmental stewardship and business competitiveness. New industries that were non-existent a decade ago have been born and are thriving. Sub-sectors in financial markets such as carbon asset trading, brokerage services, clean energy venture capitalism, climate exchanges and carbon trading markets are a new phenomenon. Long-term investors, asset managers and analysts are also beginning to integrate climate change considerations into investment analysis and decision-making. New technologies in energy generation, such as wind turbines, concentrated solar panels, combined heat and energy technologies, as well as host of other low-carbon technologies like electric and hybrid vehicles, carbon capture and storage, to name a few, are being proven and successfully progressing through commercialisation stages.

Climate-smart companies are adapting quickly to operating within networks of collaborative relationships, linking local capacities with the most advanced thinking from around the world and participating in global conversations about the responsibilities of sustainable business in the 21st century. Venture capitalists and corporate R & D divisions are investing in "clean technology" of all types. The amount of capital needed is immense, signalling vast opportunities for business.

Both Tongaat Hulett and ATNS are seeing opportunities to leverage technologically advances to offer green products and services. Tongaat Hulett, for example, is planning to produce electricity from bagasse and ethanol from sugarcane as a substitute for petroleum-based fuels:

> "From a TH perspective we have the capability and we have the raw materials. But if we ever get to a point where prices and other nuances are agreed, there is massive potential of creating lots of green jobs. Very green jobs, because we would be allocated land and we can plant tonnes and tonnes of sugar cane. The bagasse coming from that would be utilised to generate electricity and if ever there is excess sugar it can be converted to ethanol which can be blended for fuels which would replace certain parts of fuel oils"

However, a lack of policy direction and clarity from the National Energy Regulator of South Africa (NERSA) has stalled progress in electricity generation:

> "One of the initiatives as an organisation is for us to generate electricity. For us to be able to generate electricity we need streamlined policies coming from NERSA. If we are going to generate electricity, what are the policies in terms of agreements, how do we sell and deploy it? ... I think we have made some progress, but those PPAs and policies must be very clear..."

Raw material supplies are also hampering progress in the generation of electricity:

> "We were actually ready post-2008 to start generating part of our own electricity using Sasol gas and we put a bid in to Eskom … When we negotiated with Sasol they were really keen to let us utilise some of the allocation of their gas… But overtime I think their priorities also changed. They want all the gas to themselves now… The limitation is just the amount of gas that we have in the country."

Tongaat is also looking at waste and water treatment technologies:

> "For us, it is it would be one thing if we can put up the effluent plant because we would end up getting potable water… But when you look at it and really look at it, it is not cost-effective for now. Putting up an effluent treatment plant for one to do potable water and perhaps methane recovery is big. Those plants are not small… The negative or the challenging part is that those plants utilise lots and lots of electricity. So for the technologies we looked at; 'you can go through and treat the effluent but for you to go to the next phase to extract potable water you need reverse osmosis processes which utilises tons of electricity."

ATNS is working collaboratively with suppliers, customers and competitors and is collaborating across industries into the telecommunications sector. One of the collaboration efforts is:

> "We are working with SADC. I will give you an example of one big initiative which is known as the UASCC, the Upper Air Space Control Centre, where in Southern Africa we have one Control Centre and with that the message we are trying to send is that let's work together as a region. Not ATNS or not Namibia Civil Aviation but working together as a team. So in the near future you will see that aviation will be done at a more regional level… Yes championing this climate change response at a regional level."

> "V-SAT is a satellite communication system which initially we thought would help only us because geographically speaking, South Africa is right at the bottom. But later on it has become the best communication system in the continent. Almost everybody is using our V-SAT to communicate information from one airport to the other airport. It's actually a success story to me."

ATNS has also discussed possibilities of solar panels for some of their facilities:

> "…there has been discussions about looking into solar stuff, solar panelling for the smaller sites…Some of the technicians have mentioned about putting some solar panels in lower consumption sites. Solar panels are expensive, the capital outlay and everything. So it's a process to get that going, but the talks are on-going."

Advocacy and Industry Leadership

Monitoring pending regulations and understanding how climate change regulations could impact business objectives are the goals forward-thinking organisations are pursing. Botzen and van den Bergh (2009) concurred that any company that foresees business opportunities in influencing carbon-emissions regulation is practicing what is expected of business – capitalism. Climate-smart companies are seizing the opportunities to influence the direction of the regulation to their advantage, by asking the right questions such as: What are the regulatory issues at stake? What new requirements will businesses face in creating low-carbon business models and corporate strategies? What new rules and practices are emerging which are changing the way business is conducted? Who is setting or influencing those rules and practices? What are the emerging institutions and technologies that are shaping the low-carbon business of the future?

Both companies in this study see opportunities to drive the green agenda in their respective companies and industries. These are largely driven by the structure of their respective industries:

> "… You look at it as an industry-wide initiative, but it's global. Other companies within the industry, within industries, whether they are manufacturing, aviation, are directly linked. Directly linked because our carbon footprint, for us at the end of the day we will be talking about the environment in legal terms. We fall under the Department of Transport so now we have got ACSA, we have got ATNS, and we have got Civil Aviation. Now ATNS will be concentrating on efficiencies in the airspace, ACSA which is the Airport's Company of South Africa will be looking at better runways, baggage handling, and no delay taxing to the runway and so on. And Civil Aviation will be talking about regulation, imposing of fines; managing the airspace regulations. We are managing the airspace operations as an ASNP…"I think we cannot ignore collaboration. Whoever tries to go their way, will come back to the same spot."

ATNS is looking to influence and play the "Big Brother" role for aviation climate change response in Africa by providing infrastructure, skills and expertise. Two statements worth quoting are:

> "Besides positioning the brand ATNS just as an ANSP we want to infuse the element because we want to be the leader in this issue in South Africa and be the champions of it throughout the continent."

> "… So even in issues of climate change and sustainability, we want ATNS to take that leading role, not in a boastful way, but in a win-win kind of situation. We don't want Africa to be lagging when we are seeing the rest of other continents far ahead. This is why ATNS felt that we want to embrace climate change and drive the rest of our brothers and sisters in the ANSP."

Tongaat Hulett has also embarked on initiatives that are driving towards greater adoption of climate-friendly organisational practices with cross industry collaborations and joint ventures. One example is:

> "The Municipal JVs … it's about advocacy trying to push for this green thing, it is industry leadership."

> "I think in terms of the things that we could have done better, I think having proper partnerships with our municipalities. During Apartheid days; as business people we knew who to speak to in the Council. In terms of moving from that time to the current, we don't have any relationships with people who are in the position of power. For us to be able to have quite a positive impact in terms of issues around climate change, those relationships must start, for example, people knowing each other, and proper networking. Because we can only be able to influence politicians when we are able to really have proper relationships."

> "… What Dr Khosa says is that 'they don't understand the needs of the 21st century'. We have bureaucrats that do not really understand and are not exposed to business needs. At the same time we have a responsibility in terms of influencing and also for us to be able to understand what their strategy is. What are their drivers? What are they are trying to achieve? So that we can be able to influence them."

There are more opportunities to work with different government departments so as to bring down the barriers to their planned projects:

> "…So we need to form better relationships with government agencies. The partnerships are very crucial. As an organisation as we partner with government agencies, for instance when we speak of generation of electricity using bagasse**,** creating employment, producing ethanol, those things can only be done when we have a government that is very streamlined in its thinking in terms of what must be achieved from a strategic point of view. But when we are dealing with the Department of Agriculture on this issue, then you discuss with the Department of Trade and Industry, then you go to the Energy Department separately, it becomes a big issue."

6.5 Differences in Climate Change Response Drivers and Motivations

6.5.1 Financial Business Case

Cost Savings and Operational Efficiency

Being in a commodity business, Tongaat Hulett is highly driven by the need to be more operationally efficient and reduce costs at every opportunity available. This sentiment was echoed by all the executives interviewed. Some of the statements that show this stance are:

> "We have got the market share, so we are looking to decrease costs. That's the only way we can increase margin."

> "But to a large extent most of the things that have been done so far are done to achieve other objectives like cost saving, efficiencies, and the positive spin off is that it also happens to have a positive climate change impact. So I said even though the motivation or the underlying reason why are doing something may not be to tackle climate change but the fact that it has an impact there we should even have almost like a repository of climate change initiatives…"

> "Secondly, what we are aware of after a lot of research was that gas boilers are much more cost effective and efficient in terms of producing steam. So the drive was around efficiency. But when you look at it in terms of running a coal boiler, you have maintenance in terms of all the mechanical issues and secondly in terms of the costs. When we did all the numbers, comparing what we had using gas, also the uptime of gas is far better…. also reliability, ease of response and the ease of starting the boilers."

And yet another perspective which shows a holistic approach to operational efficiency as a key driver to responding to climate change:

> "Part of what we are doing now from a strategy perspective is, we are saying, we want to become more world class and we want to be become operationally excellent, so it's in line with that that we have asked XX to come in and help us with doing some benchmarks so that as we say we want to be operationally excellent, what is the baseline that we are on now, what are the world class matrices, what is the gap between ….. And the focus then is largely on the operations."

While operational efficiency and cost savings are acknowledged within ATNS, these do not seem to be key motivators for climate change response. One of the executives mentioned operational efficiency but indicated that they did not see many opportunities to be more efficient because had already been practicing operational efficiency long before the decision climate change issues. The other reason for this could be due to the fact that there are not many opportunities

for them to be more efficient. The few mentions on operational efficiency are on business travel, where better route planning was seen as a key component to reducing the amount of fuel burn on maintenance vehicles. The major areas where ATNS see opportunities to drive efficiencies are in regional collaboration, where due to advances in technology, opportunities are available to share navigation equipment. This they see as an opportunity for nations to cut down on investments in technologies. This is not necessarily a benefit that would accrue to ATNS but to other countries in the region, which overall would assist in creating a more resource-efficient region. This quotation is testimony to this:

> "It cuts costs and you think about the way we are in this region like South Africa. Look at our neighbouring countries - Lesotho, Swaziland, etc. You may find that some of the technologies which may be sitting here will in fact also be used to control aircrafts which are flying within the Lesotho or Swaziland airspace. So Swaziland can channel those resources somewhere else because this asset is here; we use it as a region."

6.5.2 Security of Supply Risks: Energy and Raw Materials

Tongaat Hulett's operations are energy-intensive; therefore security of supply of energy is a business risk; a key lever to their sustainability as a business, and consequently a key climate change response driver:

> "So electricity is quite cheap. When we do projects converting stuff that use electricity going into gas, we have done that, we end up looking at, our one driver which was - to try and reduce the 10% that we were mandated e.g. by taking out electric heaters…"

> "But honestly, when we started the initiatives around changing and running highly efficient motors, it was also because of the electricity crisis of 2008."

There however uncertainties regarding price security:

> "The other issue with gas is that from 2014 the price of gas is going to come under the control of NERSA as well**....** So what will happen with the price of gas? There is some uncertainty as well."

Energy security of supply is especially relevant in South Africa because ESKOM has serious capacity constraints, and has instituted power cuts in recent years that forced industry to operate below capacity. South Africa is also a net importer of energy, including gas, so concerns are focused both on price security and security of physical supply. This has been a topic of much debate and discussion, particularly among the Intensive Energy Users Group (IEUG).

Due to the nature of their operations, raw material supply and energy price volatility are not big risks in ATNS' business. On the other hand, Tongaat Hulett's major raw materials (sugar cane and maize) are agricultural-based, a sector, which is susceptible to climate variability. Raw material price volatility and possible supply squeezes due to poor crop yields are key business supply chain risks:

> "But we are very aware that climate conditions can affect the availability of maize in Southern Africa because of what has happened in the past. If the dramatic climate change which is predicted and continued increasing global temperatures materialise, we can experience a shortage of maize in the future… without maize, we do not have a business."

> "The only way we can be sure to have non-GMO supplies is to physically secure supply with the farmers. We contract farmers to grow it for us… so that we have security of supply."

The price pressures on raw material is also a business risk:

> "So we are already paying a premium for that and I see going forward – it's not so much the risk of supply that is the main problem, but it's the premium we are going to pay for it."

Most of Tongaat Hulett's operations are water-intensive and so possibilities of water shortages in the country represent serious business viability threats, as the statements below indicate:

> "I remember in 1984, I was in Durban, the country was struggling with water shortages. There was a strategy within the country in the areas where there was drought that they would recycle water… organisations started coming up with strategies in terms of mitigating the shortages and loss of water, putting strategies of recycling… but also for us as TH, we went through that phase. We are a large consumer of water in our processes..."

> "We are aware that South Africa is not a very water rich environment and the scarcity is looming. …How do we modify our processes so that our water utilisation is not as intense as it is? What are some of the things that we could do? Are there other milling processes? Because our process is wet milling and we use loads and loads and loads of water and some of the water is the water that goes into the effluent. So part of the things that are being investigated is how that water could be recycled and be used in the process or if it's not used in the process, how else it could be put to other functional usages within the organisation so that it doesn't go out as effluent."

6.5.3 Gaining Competitive Advantage

Gaining competitive advantage from green initiatives is a motivation for both companies. Tongaat Hulett is capitalising on opportunities for cost leadership by being increasingly more efficient in terms of water management, waste management and material efficiency, i.e. the amount of product per tonne of raw material. This was a common thread in all the discussions held. A more telling comment is that:

> "… Those costs start making sense in terms of the benchmarking exercises we have embarked on. It does mirror in everything we do, because one of the things in terms of strategic objectives is that we want to reduce the amount of energy usage per tonne of product, which will have an impact in terms of carbon emissions per tonne of product. So most of these initiatives and capital that we spent are driving towards that strategic objective… it has become part and parcel of what we do. We have engineers; we have production managers. For us to be efficient, this is what we focus on."

ATNS, on the other hand, sees opportunities to position themselves as climate change leaders - not only in South Africa but in the whole of the African continent. Several statements from the executives talk to this aspiration, including the following:

> "In line with our vision, 'To be the sole provider of air traffic and navigation service', we want to be number one in Africa and the surrounding regions… so even in issues of climate change and sustainability, we want ATNS to take that leading role… We don't want Africa to be lagging..."

> "Luckily because it's still a new concept everybody is on the foundational phase,... but, if we can push ahead and take that lead role. That would be great!"

6.5.4 Moral Responsibility

Global citizenship comes out as a core driver for climate change response in ATNS, coupled with the need to make a difference - not just for the company, but for Africa. These two statement bears testimony to this:

> "I think for me, business is at another level. We are a national entity… But global citizenship is more than business... If you can leave a legacy for ATNS, whether it brings in money or not; If you can just leave that legacy to say we had a huge amount of influence on our continent in making sure that we contributed to the climate change initiatives. That would even be better

than getting money in for me, because it's a legacy and no one will take it away from you. But as profits, they come and go. People don't even remember that in 2008 you made a profit. But somebody will always remember that they have this plantation of trees, they have environmental protection in their country, and they contributed in this way because ATNS was a partner, because ATNS helped out. That stays, they can never forget it."

"We are, in my opinion one of the responsible corporations of this country- being the air traffic navigations services supplier. So I already feel inflated about that, that we have got an important role in this whole society. It's then incumbent on us to take the same responsibility when it comes to any humanitarian; any of these sustainable long-term projects. Climate change is happening. It's a big thing. We need to think about the future, we need to think about the people, our children, our region, our continent."

6.5.5 Organisational Legitimacy

ATNS seems to see big opportunities for perception enhancement. They view climate change response as an opportunity to change the way the world views Africa and the way other African countries view South Africa. Climate change response is seen as an opportunity to enhance the ATNS brand and build reputational value. The company also sees an opportunity to manage expectations from its shareholders, one of them being the Department of Transport (DoT).

Some of the statements talking to managing perceptions and the brand have already been quoted elsewhere in this section; however additional statements include the following:

"The Department of Transport is our shareholder… So if you look at the DoT strategic outcomes, KPIs, one of the outcomes is reducing aviation emissions and we have KPIs on environmental protection. We have to do our part…, it is a global thing."

"Besides positioning the brand ATNS, as an ASP we want to infuse the element, because we want to be the leader in this issue in South Africa and be the champions of it throughout the continent. That is why we are drawing (up) a communication plan that includes quick wins and those initiatives that we have achieved not just for ATNS, but the aviation community as well, so external communication is going to be key. We are pushing such achievements as INSPIRE. INSPIRE was well communicated, but we want to go wild with it…"

This statement talks to the need to manage the way Africa views not just the ATNS brand, but also brand South Africa:

> **"**We also have to change the perception. South Africa has been seen as the stuck up sister down there because we are so fortunate to have infrastructure and everything. I think we need to start driving towards changing that perception that we can actually assist, rather than just coming in and taking. I think people are trying to be aggressive now saying Africa is an opportunity and they are just trying to come in and grab. But we should really take another angle to say, 'Why can't we just donate where we can and help out, provide the skills, even for free?' So it's also those perceptions. We need to give people another angle that they didn't expect."

Tongaat Hulett, on the other hand, is being forced to respond to customer requirements for climate-friendly products. The influence and power of some of Tongaat Hulett's key customers is forcing them to comply. The pull from the supply chain, in this case as a result of a customer's customer requirements, means that Tongaat Hulett has to respond to keep their right to trade with the customer.

> "That said, our experience last year is, a customer came to us and said we need to calculate your carbon footprint, so they asked us for a whole bunch of information and they were saying that was coming from their market, the Builders Warehouse where consumers now are trying to ensure that they are building houses that have got a low carbon footprint. I think the movement is starting but it hasn't become mainstream, at this point in time."

6.6 Differences in Climate Change Response Initiatives

6.6.1 Raising Awareness

There is a marked difference in the level of effort and the number of projects or initiatives directed towards raising awareness between the two companies. ATNS is generally regarding awareness-raising as a constructive and potentially catalytic force that should ultimately lead to a positive change in actions, behaviours, attitudes and perceptions of key stakeholders, including employees, shareholders, competitors, communities, and the aviation industry.

ATNS has a number of initiatives underway which are tailored to understanding climate change, its impacts on their business and how best to respond to it:

> "But being a new concept, there is a lot of research that needs to be done. A lot of ground work about understanding what exactly we are trying to do and why we are doing it and who is doing what so that you can affiliate with those projects and understand the global reason why we are

doing it. So a lot of the work that has been done now in getting to understand everything about climate change, everything about the environmental impact of our business, everything about the human or our involvement as people who have lived a certain way and now we have to do a lot of change management to do things differently. There is a lot of that research going on to actually get the ground work and the foundation about why we are doing this and what we can learn from other people who have done that."

There are also efforts directed at the employees in order to help them understand the concept so as to build the commitment and buy-in required:

"…it is a lifestyle… we are discussing how to help all the people in the different departments to actually be able to relate what they are doing in their work environment to the climate change and environmental issues…. it has to have a meaning to an individual."

'We almost have to sell it to the people to say 'it's not the greeny beany stuff where you just recycle and that's it. There is more to it'."

Some of the projects underway to raise climate change response consciousness both internally and externally, include:

Internally:

"… The people are more aware of it,… we have discussed it with them. We are also going to make it a permanent agenda point in the meetings with the Senior Manager… so that the guys give us ideas from the field as well. Because many a time, we will sit around a table like this, we will come up with good ideas on how to be green but these guys out there have even nicer ideas and they are hands-on. They might be doing something at one of their sites that we are not aware of that can help. So definitely yes, people are getting more and more aware as we go along."

Internal and External

"We want people to adopt the lifestyle so we are planning to have road shows; we are planning to have competitions relating to the green environment. We have got one that's currently going on. We are designing a "green" logo for the company that we can use each time we communicate about the issue. We actually have three that have been submitted. We are waiting for approval from the Marketing Department on what we can use internally and externally for the communication. We are also planning to have a communication plan for the ATNS initiative as well as the aviation initiatives like INSPIRE that can be taken across the world…"

Tongaat Hulett, on the other hand, did not seem to have any initiatives planned around raising awareness, education and communicating with key stakeholders, except what has been posted on their website and publicly available information through the CDP or the JSE SRI reports.

When asked about the initiatives underway concerning raising awareness internally or externally, some of the executives said:

> "So this is why I'm saying there is a big consciousness in the organisation at a strategic level so we are still very much being driven by the senior executives who are putting out the tentacles and still trying to investigate and explore. This is why it hasn't cascaded to the level of now actually even formulating a proper response with awareness campaigns and training programs. Because even if we say we are, for example, conserving water, I sitting here today have no clear metric from operations what exact volumes of water we use in a day, per process, in a month, in a year …"

> "… but there are no tangible metrics at this stage … but those matrices have not yet been translated into something tangible, that could be communicated to the various levels of employees so that each individual understands how they contribute exactly to the achievement of that. People generally know, look, don't waste water and switch off the lights if you are not using them."

A similar stance seems to be prevalent for the external communication and awareness raising as well.

> "If I have to be honest, I don't think Starch Division is very big on this green concept yet. We do things to comply. We don't really have major strategies pushing the green thing."

> "That is not solely a defined strategy because of climate change or green concept. So far it's a defined strategy because that's what our customers want from us, so we don't market that as such and we don't use it as a leverage point in the market. We can debate whether we should or not and there might be very good reasons why should be leveraging it, but we don't at the moment. It's a given in our organisation because that's a requirement from our customers."

One of the Tongaat Hulett executives specifically mentioned communication and raising awareness as an area where there were opportunities for them to improve the way they were handling climate change response.

> "One of the questions towards the end, where you asked what we could do differently, that is an area that I have since discussed with … because there is a lot that they are doing but unless you

> are involved with it you are not aware. So I said that's what we could be doing differently, we could be communicating more what we are doing, and blowing our own horn so to speak."

The differences in the level of activities regarding awareness raising could possibly be explained by the differences in the timing of climate change response between the two companies, or the motivations and drivers for climate change response. ATNS has recently embarked on the climate change response journey, having identified climate change response as a strategic priority only in 2011, while Tongaat Hulett has been a participant to the Carbon Disclosure Project (CDP) for more than four years now. Climate change response within the aviation industry has only taken centre-stage in the last two years (see ATNS Case Introductory), implying that the need to research and understand the impacts and dynamics is still high and the level of education and awareness on the subject could still be very low, hence the need for such programmes.

Some of the key activities constituting building a brand involve communicating the brand position, which may explain the amount and level of communication and awareness building underway or planned. Tongaat Hulett, on the other hand, sees itself as a dominant player in the sugar industry and is the only local producer of starch in Southern Africa, with no excess capacity. Thus, the need to market and communicate climate change initiatives for competitive leverage is not as strong.

6.6.2 Adaptation and Operational Efficiencies

Top-line growth is slowing while operational and administration costs are rising for most businesses. Higher efficiencies are seen by Tongaat Hulett executives as an opportunity for sustained profitability. Due to the nature of its operations, Tongaat Hulett has a lot of opportunities to drive green-inspired operational efficiencies within its mills and other plants. They have embarked on an international benchmarking exercise with an American technical partner in their Starch Division to assess the efficiency of technical processes, manufacturing methods and processes, work processes and administration processes in order to identify areas for improvement, and in so doing identify opportunities for climate-friendly solutions.

There is a spectrum of initiatives covering energy efficiency, material efficiency and water management and redesigning operations. Some of the initiatives mentioned and documented in the Sustainability Reports include the following:

Water usage

> "For TH operations, the standard in terms of water usage has been four tonnes of water per tonne of maize; we have come up with a lot of initiatives… some mills are now using far below this standard... we are not there yet, we will have to do more in terms of recycling, water treatment plants. If we are to have real quality, we have to invest in terms of effluent treatment plants."

Concerning operations redesign and energy efficiency, some statements to validate it include:

Boilers

> "Our processes also consume lots of energy… we were utilising electrical boilers in our mills**.** We converted those electrical boilers to gas boilers, because it is highly inefficient for us to raise steam using electricity. In fact from a carbon footprint perspective, you are better off."

Dryers

> "We have a spray dryer and we had to pre-heat the air to put into the spray dryer to dry one of our products. We had electrical heaters that we changed into gas heaters."

Variable Speed Drives

> "We have been changing some of the technology operating and running our motors. We use variable speed drives (VSDs), so we are progressively going through our plants and going for the bigger drives and putting in VSDs… We have some major items of equipment that use fluid coupling to assist with the starting. We have replaced those fluid couplings which are very inefficient with VSDs as well. So we have just gone through a study where we saw opportunities where we could replace these things."

Operations Redesign

> "So you can go through the life of a boiler: how much would you have spent in terms of maintenance by the end of its life? It would be much better to go with gas. Also what you see as a benefit mostly is that when you want to start up your plant to produce stuff, with coal you have to get people to come through at about three o'clock in the morning to start making a fire for you to get the heat up to produce steam. Gas is instant! So when you do all those calculations it's still much cheaper to go with gas. From an efficiency point of view, when you have a 20 tonne boiler, you get about 18 or 19 tonnes of steam, (but) when you have a coal boiler because of efficiency issues you get about 14 or 15 tonnes. So you do the math."

Process Vapour Harvesting

"We have an effluent plant in Meyerton. Instead of letting the flame burn into the atmosphere like most effluent plants do, we utilise that heat to reduce the amount of steam we use in our processes. The other impact in terms of trying to reduce our carbon footprint is, through the process we end up with process vapour**.** We have identified those areas as sources of energy that instead of that vapour leaving and going into the atmosphere; we utilise the heat content of that vapour to reduce the amount of steam used in our processes."

Material efficiency

"One of the prime efficiency measures that we have lived with and is part of our business is the yield. For every tonne of maize that we draw in, we measure how much product we sell. It goes over a weigh bridge. That is the prime material efficiency and we are currently busy with the benchmarking process, working with our partner to do a step change in that material efficiency."

"…it's still being investigated. Even material efficiency - we are constantly trying to say 'how can we use the materials most responsibly and how can we use less?' For example, in our processes and in the wet milling process, we use quite a lot of chemical agents. There is always a huge focus on those to say how we can make sure that we reduce their utilisation? Again largely driven by costs, but also driven by environmental things because some of the chemical agents we use end up going as effluent, so we have to try and reduce those so that we can manage what actually goes out downstream as waste."

Waste Management

Waste is also a key environmental challenge for the sugar refinery and starch industries in general and for Tongaat Starch operations, however there are initiatives underway to generate electricity from the waste.

"There are lots of initiatives… some of them are driven by legislation interestingly and what comes to mind there is, the effluent from the plants - we need to treat it and take out any harmful substances so that the water can be reused. The second part is the actual reusing of the water because that then means we are using less water. The third initiative which is not driven by legislation but seeing as we have got this effluent, we have treated it, we have taken out the solids. There is a further thinking to use that waste to generate electricity?"

"… on waste management, I think we want to talk around the potential agreement with a waste management organisation that would take our effluent, together with other sources, harness methane out of the waste and generate electricity out of it."

Some barriers are slowing Tongaat Hulett's climate change response journey, such as expensive technology and partnerships which have not been successful. There is however, evidence to show that they are working on reducing the amount of waste generated from their operations.

> "We are not there yet, we will have to do more in terms of recycling (and) water treatment plants. If we are to have real quality, we have to invest in terms of effluent treatment plants… It is a priority but the technology is still very expensive when you look at it from a payback perspective."

> "One of the strategies is: we got involved with the local municipalities in KZN in terms of recycling with the view of a joint venture. We decided that we really have to work on this JV in terms of getting the capacity of the effluent plants to the levels where they are supposed to be. We were prepared to pay for consultancy and other resources. We were going to supply them with the technical know-how because we have the skills and to partner with their engineers in order to do it properly…"

Green IT

The innovative use of IT in business processes to reduce carbon footprint across an enterprise and beyond (Murugesan, 2008), in areas such as teleconferencing and tele-presence, is offering significant benefits to companies, including reduced travel-related carbon emissions, increased employee satisfaction, increased profit margins as a result of lower overhead cost (Molla, 2009) for office space, heating, lighting, air conditioning, water use, etc. Other related initiatives such as hoteling reduces the amount of office space per employee as office space is reserved as-and-when needed. Green IT is also finding use as a business enabler for e-business and supply chain management, regulatory compliance and governance, business process management and other applications, with significant return on investment (Ruth, 2009).

While such benefits exist, Green IT is one area which ATNS is currently exploring, but have not fully understood in terms of its contribution to climate change response and environmental sustainability:

> "I'm doing a research on green IT strategic planning but obviously I'm not a CIO…"

> "Because it's sad that people are saying aviation is the future tobacco industry. With all this flying going on, we need to work towards better management. If it's a meeting, a conference there is technology we can use; ways of saving all of those elements - video conferencing, telecommuting, etc. - working smarter basically."

Tongaat Hulett, however, had not considered this possibility and when it was pointed out during one of the interview sessions, one of the executives felt it was an area they needed to investigate and would recommend for implementation if it met financial investment criteria hurdles.

6.6.3 New Products and Revenue Streams

Integrated Value Chain Management

ATNS is working at incorporating climate change response into supplier evaluation criteria as part of their procurement policy.

> "… it's already been mentioned in our strategic sessions that they (Planning and Engineering Department) need to make sure that anything they deal with - any upgrade of equipment, any new acquisition of equipment is green-friendly – especially power consumption friendly… the whole process in any case goes through a tender evaluation process. So the tender documents include those aspects."

And more is planned for the rest of their suppliers:

> "Our suppliers, for example, I mean we deal with hundreds and hundreds of suppliers, from Eskom, Telkom, to people that supply us our stationery, to people that supply us our purified water, to people that supply us you name it in our Stations. All of those people are going to have to be evaluated; we are going to have to look at their "green" status… I think if a supplier wants to do business with us and again this is from finance's responsibility, they are going to have in their procurement policies and in their evaluation forms, somewhere there where this company has to state what its carbon footprint is or if they have got any environmental initiatives. I think it's going to have to become that, because otherwise what's the point of us trying to become green and do proactive work in that regard if our suppliers are not?"

6.6.4 Fully Integrated into Corporate Strategy

There are no significant differences noted between the two companies.

6.7 Summary of Findings

The general finding is that climate change response varies significantly between the two companies although they are operating within the same jurisdiction. The main factors affecting corporate climate change response suggested by previous research (Whittaker, 2004; van der Woerd *et al.*, 2000) are also applicable, such as the regulatory pressure in the particular industry, stakeholder demands and pressures, a firm's market positioning, financial and economic stability of the company, accessibility to alternative technologies and organisational and institutional differences such as the entrepreneurial flair of the organisation, or the dispositions of the executive managers within the business. Other company specific factors such as internal climate change response expertise, corporate histories of the companies, corporate culture, degree of centralisation and particularly the management styles of the key decision makers, explain the variations in the timing, pace and types (Kolk & Levy, 2001) of climate change response initiatives being adopted by the two companies.

Although there are significant differences which can be traced to industry differences, this study shows that industry differences are just one of the factors informing corporate responses to climate change. These will be explored fully in this discussion portion of this thesis, but as Kolk and Levy (2001:502) observed, "Company strategies can only be explained from a combination of distinct traditions, backgrounds and idiosyncrasies."

Cost savings, business opportunities, management commitment and compliance with existing or pending regulations are identified as the most important motivators and drivers to respond to climate change. Operational efficiency and cost savings are seen as the major benefits for the businesses to respond to climate change. But organisational legitimacy in terms of maintaining or building brand reputation is important to both companies. Lack of policy clarity and the immaturity of climate change legislation in South Africa were cited as major barriers to response. This was followed closely by the lack of financial resources to tackle the climate change challenge. Financial prudence is a key area of attention - particularly given the world economic recession and the continued uncertainties in the PIGS (Portugal, Ireland, Greece, and Spain) countries. Technologies are also still seen as expensive, which is slowing down the rate of replacement of legacy systems with more environmental friendly systems and technologies.

Both companies have a general understanding that climate change is impacting the way they do business. There is, however, varying levels of understanding of the climate change risks and opportunities among different executives within the same company. There are also varying opinions concerning what is motivating their respective businesses to respond the way they are. Neither of the two companies is actively legal and regulatory policy and outcomes. This is a surprising finding in view of the fact that climate change legislation is still very much in its infancy in South Africa, with the South Africa National Climate Change Response Strategy having only been published in September 2011, leaving many opportunities for both companies to play leading influencing roles. There is still lack of clarity in terms of the impact of different aspects of this strategy, with businesses still awaiting policy direction and clarity in terms implementation. For example, renewable feed-in-tariffs were gazetted in early 2010, revised later that year and finally withdrawn in 2011, leaving companies planning to venture into renewable energy generation in suspense.

The physical risks of climate change were not seen as a key phenomenon by both companies, but Tongaat Hulett expressed a serious need to actively and proactively monitor water availability, given that South Africa is a water-constrained country and Tongaat Hulett is in the agro-processing industry. Because Tongaat Hulett's operations are mostly based in the eastern parts of South Africa which has been positively impacted by changing rainfall and weather patterns (Collier *et al.*, 2008), the climatic variations have actually worked in their favour by increasing their crop yields (MD: Tongaat Starch). The issue of water is very salient in ATNS being in the service sector with a low-water footprint. Other weather-related business impacts were not mentioned as these were expected to be long-term issues that would impact everyone else on planet earth.

Both companies emphasised the business opportunities that climate change is presenting. There were key competitive drivers that both companies were exploiting or seeking to exploit, including opportunities to be more efficient, thereby increasing economic sustainability. They were also looking at ways to generate more revenues through the sales of waste and other by-products and other process innovations. Tongaat Hulett is considering an opportunity for new revenues as a result of innovative breakthroughs in the reuse of production process by-

products. Both companies saw opportunities to build and enhance their brands through partnerships with supply chain, value chain and industry partners, and the communities in which they operate. The opportunities for technological advancements and developments were emphasised in ATNS, largely due to requirements and expressions of interests from their customers in the airline industry and also as a result of the drive for climate change response in the aviation industry being driven by the world aviation governing bodies, such as IATA, ICAO, and the Civil Air Navigation Services Organisation (CANSO). By working closely with airlines and aircraft manufacturers, ATNS sees great opportunities for technological breakthroughs in flight practices that have significant fuel savings, and consequently significantly reduced carbon emissions.

Within both companies, some executives expressed their firm belief in the concept of good corporate and earth-citizenship, noting that each business doing their part to reduce the earth's overall carbon emissions was the right thing to do. They however stated that this was still an aspirational goal which both organisations are working towards.

Overall, economic motivations are still the dominant drivers for corporate climate change response. Financial and strategic benefits such as image and reputation, organisational legitimacy and industry leadership are key motivators for corporate action.

7 Analysis and Discussions

7.1 Business Risks Driven by Climate Change

7.1.1 Physical risks

Tongaat Hulett has been impacted by water availability risks due to the nature of its business, i.e. agro-processing. Changing weather patterns as a result of climate change have worked in Tongaat Hulett's favour to date, because their key suppliers of agricultural produce (being sugarcane and maize) are located on the eastern side of the country, which has been predicted and reported as getting wetter (Collier *et al.*, 2008), and are therefore experiencing increased crop yields.

7.1.2 Security of Resource and Energy Supply Risks

Global energy and resource security of supply risks are causing extreme volatility, driven largely by the rising world population and the growing prosperity of nations which is narrowing the gap between resource supply and demand. According to the World Economic Forum (WEF) 2011 Risk Report, demand for water, food and energy is expected to rise by between 30 and 50% in the next two decades, while the continued economic recession and disparities are incentivising short-term production patterns that undermine long-term sustainability. International tensions, terrorism and the potential for supply disruptions; the concentration of known hydrocarbon reserves and resources in a limited number of the world's sub-regions; restricted access to oil and gas companies for developing hydrocarbon reserves in some countries; the rising cost of developing incremental sources of energy supplies; lengthening supply routes; and the lack of adequate investment along the energy supply chain, including the electricity sector, are creating these risks.

7.1.3 Regulatory and Compliance Risks

In the Ernst & Young Top 10 Business Risks for 2009, the rise of "radical greening" was ranked number 4 after credit crunch, regulatory compliance and global recession. This suggests that companies are becoming more aware or are beginning to feel the real damage and risks to their businesses if they neglect environmental and sustainability stewardship. This is in line with

Carbon Point's (2010) finding that new regulations represent a big change management requirement, which places organisations in a state of operational risk given the tight financial budgets as a result of the continued global recession. Environmental regulations were mentioned by all the executives interviewed within Tongaat Hulett as key negative drivers (risks) in their business. The possibility of new and more stringent environmental legislation, coupled with talk within policy circles of more stringent policing, is creating unprecedented incentives for Tongaat Hulett, ATNS and business in general to proactively manage that risk. Because ATNS is a member of the International Civil Aviation Organisation (ICAO), complying with ICAO directives and legislation in order to maintain the license to operate is a key driver for climate change response.

Other business risk areas include brand value; political and legitimacy and the associated license to operate risks; credit ratings; and recruitment or staff retention (not yet a key issue in the South African corporate environment).

7.1.4 Reputational Risks

Failure to comply with climate change regulations and legislation and failure to demonstrate to stakeholders the responsiveness to environmental sustainability challenges represent big threats to corporate reputations. This is in line with the Economist Intelligence Unit's 2005 reputational risk report, where executives reported that reputation was an important corporate asset which was difficult to protect due to the development of global media and communication channels, increased scrutiny from regulators and reduced customer loyalty. Boycotts and consumer action such as the 2010 BP boycott and BP's subsequent expulsion from the Dow Jones Sustainability Index (Rueters, 2011), or the uprising against Coca Cola in Palakkad India (The Statesman, 2003), can spread faster and further than ever before and cause untold damages to corporate brands.

7.1.5 Investor and Shareholder Risks

A 2009 Trucost research on the carbon risks and opportunities for the Top 500 US companies on the S & P 500 showed that a shareholders and investors are more concerned about climate change liabilities. This finding was also confirmed in a 2010 Camco and TIPS study of the risks

and opportunities for the South African economy. Shareholders' stance towards companies' attitudes on climate change response have shifted in the last five years. The Pew Center (2009) reported that in 2008, 54 climate resolutions were filed with companies by shareholders. The companies in the study were wary of shareholder expectations regarding climate change response. One of the companies in the study specifically mentioned the need to be in line with shareholder expectations on climate change response during the interviews. The other company mentioned it broadly in its sustainability strategy statement.

7.1.6 Business Model Redundancy

Business model redundancy and cost disadvantages are the other operational and strategic climate change-induced risks confronting businesses.

Propositions

All the above risks were strong drivers for climate change response in this study. Climate-smart companies are instituting a robust risk culture focused on optimising risk-return trade-offs and turning them into competitive advantage. They are ensuring that climate change strategic decision making is risk-adjusted to focus on balancing risk-taking and risk avoidance as part of risk management strategy. Moving from a compliance-based risk posture to a growth-oriented stance, where a business is willing and positioned to take calculated risks and is taking a systematic look at the profitability of a business - especially in a down economy - can lead to surprising opportunities for new and profitable initiatives. This finding can be summarised in the first proposition:

Proposition 1:

Where the effects of climate-change induced risks are considered high, businesses are prepared to put in the extra resources to deal with the risks as part of overall risk management strategies.

Taking a risk-adjusted view and avoiding biases that mislead decision makers can assist companies to make correct strategic decisions. By combining risk management with strategic management and ensuring that risk-taking and risk avoidance is part of one integrated management dialogue, businesses can turn climate change-induced risks into opportunities to

create competitive advantage. The operationalization of this approach can be formally stated as:

Proposition 2:

By using a structured analytical approach employing multi-criteria decision aid tools, executives can clearly synthesise all information, to understand the value-creating and value-protecting levers of climate change response for competitive advantage.

Reputational capital has become a measure of extra financial value and business success (Obloj & Obloj, 2006), so that climate change-induced reputational risk is regarded as a significant issue in the two organisations in the study. The proactive management of the influence of stakeholders (whose relationship with the organizations is directly instrumental to the pursuit of long-term growth) such as climate change activists, non-governmental organisations, communities, shareholders, customers, suppliers and consumers, is crucial to maximizing consensus and minimizing conflict. Some companies are seizing these stakeholder engagements as opportunities to influence regulatory and legislative outcomes to their advantage because uncertainty over how different countries are implementing climate change legislation is increasing the risk of regulatory arbitrage which has significant bearings on global competitiveness. ATNS, one of the companies in the study, is leveraging climate change communication programmes increase collaboration in other areas of business as well. They are seeing opportunities to increase the equity of their brand not only among African counterparties but within the whole of the aviation industry. Improving the quality and timeliness of stakeholder interactions can ensure inclusion of their diverse interests and assist companies to come up with the best balanced choice response options that engender key stakeholder trust and support. This can be summarized in the next proposition:

Proposition 3:

Multi-criteria models provide a collaborative and efficient means for timely incorporation of stakeholder preferences in climate change response decisions to manage organizational legitimacy risks.

7.2 Business Opportunities Driven by Climate Change

For the agile firm, climate change is also presenting numerous opportunities, including the revision of business models to allow for greater efficiencies in such areas as materials, energy, water, waste, etc.; the development of new, cleaner and more efficient technologies and products and participation in industries which were non-existent a decade ago; participation in carbon markets and emissions trading - giving rise to new revenue streams, strengthening of brand and reputation and creating competitive advantage. Both companies are seizing such opportunities for their competitive benefit. Tongaat Hulett has easier opportunities to venture into cleaner energy production due to the availability of raw materials stocks in the form of biomass and bagasse (two key waste-products) from their manufacturing processes. They are also exploring opportunities for new agricultural products based on their current starch production processes. Many of these opportunities are in line with South Africa's objectives of economic growth, employment creation (through green jobs), energy security and overall industry or country competitiveness.

In the absence of strong economic incentives or regulatory sanctions for climate change action or inaction, there is no drive for radical changes in business strategies (Jones & Levy, 2007). As a result, only the entrepreneurial companies are pursuing long-term, high capital climate change related opportunities. This can be summarised in the following two propositions:

Proposition 4:

Companies are seeking competitive advantage by pursuing low-cost mitigation options that are creating efficiency improvements and/or new revenue streams.

Proposition 5:

Entrepreneurial and growth-driven companies are pursuing long-term competitive advantage in low-carbon technologies, products, services and industries.

7.3 Climate Change Response Initiatives

The companies in the study are addressing climate change risks and opportunities as part of their overall sustainability strategies. The key question though is: what should the components

of a smart corporate climate change response strategy be? Without setting up a company-wide climate change response strategy informed by both top-down and bottom-up approaches (Kolk & Levy, 2001), organisations are missing key opportunities for value-preservation or value-creation. The reason most corporations have not implemented successful climate change programmes, according to a Carbon Trust (2008) analysis is that they do not follow a holistic approach to the selection of the initiatives. For most companies there is no dedicated person responsible for climate change strategy or corporate sustainability (Setthasakko, 2009). This was true for both companies where the sustainability responsibility was one of several other roles and responsibilities within the organisation.

Most organisations, including Tongaat Hulett, have left the responsibility to either corporate social responsibility (CSR) or communications and public relations or facilities management or operations. This leaves a distinct gap because of the departmentalised, silo thinking and approach to the response. Setthasakko (2009) proposed that companies take on a holistic perspective and not a departmental time-static worldview when evaluating climate change and other environmental considerations. Communications and public relations or CSR personnel typically focus on value creation through marketing and communications (Obloj & Obloj, 2005), while operations managers are focused on manufacturing, production and engineering tasks directly related to energy, material, water or waste minimisation and efficiencies. A large number of companies rely on outside expertise, which is sometimes brought in in the form of speakers and technical experts (Kolk & Levy, 2001), who do not fully understand the corporate strategic direction of the organisation and often end up creating climate change response programmes that do not fit the strategic direction of the organisation.

Business has an opportunity to consider the full expanse of low-carbon strategies as an end-to-end process — across their operations and the supply chain and value chains for cost savings, brand building and revenue generation. This is because the motivators and drivers for climate change response are multi-faceted, covering efficiencies, emissions credit generation (through energy efficiency credits, renewable energy credits (RECs), Clean Development Mechanism (CDM) and other voluntary emissions reductions (VERs)), and diversification (for products, markets and industries).

7.3.1 Driving Efficiencies

As a member of South Africa's Intensive Energy User's Group (IEUG), energy efficiency is an important component of Tongaat Hulett's low-carbon strategy. Tongaat Hulett is not only experiencing bottom-line pressures driven by increasing and uncertain energy prices, but also a directive from the electricity supplier, Eskom, to actively reduce its energy consumption levels below some agreed threshold. This is also in line with Galitsky and colleagues' 2003 finding that energy efficiency can be a low-cost, efficient and effective strategy to work towards low-carbon objectives. Tongaat Hulett has installed adjustable/variable speed drives (ASDs/VSDs). VSDs better match speed to load requirements for motor operations yielding large energy savings. Although they are unlikely to be retrofitted economically, paybacks for installing new ASD motors in new systems or plants have been shown to be as low as 1.1 years (Martin *et al.*, 2000). The installation of ASDs also improves overall productivity, production cost structures, control and product quality, and reduces wear on equipment.

Carbon emissions have been lowered substantially via the replacement of coal as a fuel with gas in boilers used for steam generation. Other efficiency measures under investigation include process control; reduced heat loss and improved heat recovery; and flue gas monitors to maintain optimum flame temperature and monitor carbon monoxide (CO), oxygen and smoke. The cost-benefit profile of these measures is being carefully evaluated as part of equipment replacement strategy, according to the Operations Director of Tongaat Hulett. This is also in line with the Galitsky's (2003) study which recommended that such energy efficiency initiatives be applied to large boilers only because the initial capital outlay for small boilers does not justify the benefits.

ATNS' energy consumption levels are much lower and are largely limited to office and control room lighting, navigation equipment and vehicles. Heating, ventilation and air conditioning (HVAC) systems, is one area of energy efficiency where the company envisages opportunities to upgrade to more energy efficient equipment, as the current equipment has almost reached the end of its life. Electronic controls in the form of automated regulation and better matching of ventilation or cooling output to demand represent another opportunity. ATNS is incorporating green building concepts in the design and construction of its planned head office.

Other initiatives directly related to adaptation and operational efficiencies include lighting, heating, ventilation and air-conditioning (HVAC) retrofits, energy management, water management, green IT, fuel alternatives, and waste management.

The scale of business benefit from energy efficiency initiatives for Tongaat Hulett far outweighs ATNS', which would explain the differences in emphasis on energy efficiency. This is in agreement with earlier studies which showed that where possible, and particularly in jurisdictions where climate change legislation is not sufficiently developed, companies use climate change as an opportunity to increase competitiveness (Jones & Levy, 2007; Kolk & Pinkse, 2008; Porter & Reinhardt, 2007) through the cost savings and the development of low carbon goods and services.

7.4 Technology Choices

Companies with significant opportunities from low-carbon technologies often find themselves confronted with dozens of new technologies from which to choose. To make rational choices, a company must start with *a priori* of the value of the unknown technologies (Ellison, 2006), the cost-efficiency dynamics of the technologies, the technology maturity levels and up-take by other organisations. Through market research, supplier comparisons, product walk-throughs, reference sites, benchmarking and other similar information searches, decision makers learn about the suitability of a technology. Tongaat Hulett is using this approach by leveraging on the technical relationship they have with a USA partner in their wet milling starch production processes. ATNS on the other hand, is leveraging on the fact that aviation's response to climate change is being governed and driven by the mother-body, ICAO which is providing the necessary research and coordinating activities at an international level. Given the rapid rate of technology evolution, is this sufficient to ensure unbiased decision making? Even though companies are penalised for making sub-optimal choices through the force of competition (Ellison, 2006; Conlisk, 1989; Smallwood & Conlisk, 1979), is the amount of time, effort and cost required for such concise evaluations justifiable? Is it possible for companies to exhaustively assess all the technologies on offer to ensure best choice selection? Is there a trade-off between exhaustive selection and deliberation costs (Ellison, 2006)? These questions and more bring us to the same conclusion which Simon (1955:89) reached in arguing for a 'satisficing' model of decision making, and leads to proposition 6:

> "…the task is to replace the global rationality of economic man with a kind of rational behaviour that is compatible with the access to information and the computational capacities that are actually possessed by organisms."

Proposition 6:

Although competitive forces and organisational endowments push companies towards rational decision making, evidence suggests that deliberation costs cause business decision makers to gravitate towards 'fast and frugal' heuristics that provide pragmatic 'satisficing' solutions.

Conlisk (1996) proposed the use of deliberation technologies in which decision makers' cognitions and the costs of deliberation are balanced. Ermini (1991) related deliberation costs to hierarchical decision making. Several deliberation technologies have been developed with increasing levels of sophistication, but ultimately deliberation technologies should merge standard modelling techniques with boundedly rational approaches. This is summed up in the next proposition:

Proposition 7:

Combining bounded rationality approaches and standard modelling techniques in a hierarchical decision aid tool (such as AHP) produces a more plausible and practical solution to complex evaluation problems.

Such a proposition sits well with Magni's (2009) recommendation for further studies, where he hoped for more views on the interrelationship between bounded rationality and standard economics and finance, and how the two should not be treated as "rivals"; or Gigerenzer and Regier's 1996 proposal for the non-distinction of the two principles, arguing that the separation is artificial and only useful as a metaphor.

7.5 Considering all Plausible Options

This analysis shows that both companies in this study have considered or are considering as many possible low-carbon options as possible. A comparison of each company's responses vis-

à-vis their respective industry best climate change response considerations (as detailed in the literature) show that both companies are exploring all the best considerations. This is in direct contrast with and Gruber's (2006) organisational routinized behavioural explanation for "no-regret" and energy efficiency-gaps. The behavioural constructs in Table 5-1 details some of the routinized behaviours including status quo bias, i.e. the tendency to want things to stay relatively the same (inertia), usually because of an emotional attachment (affective bias) or lack of knowledge of the alternatives or holding inappropriate assets, and endowment effects bias i.e. resistance to offload certain assets due to fear of unknown assets, or attachments to legacy where familiarity is treated as having value.

Conlisk (1996) proposed that punishing errors in judgements, offering incentives for getting it right (such as market forces) and greater initial expertise attenuates biases. The debiasing has been shown to be limited (Ellison, 2006). Smith (1991) and Smith & Walker (1993) emphasised market discipline involving high stakes as enough motivation for reducing behavioural irregularities. To what extent do market forces drive optimal and not 'satisficing' decision choices? This is summed up in the eighth proposition:

Proposition 8:

Market and competitive forces compel organisations to pursue all climate change-related initiatives that create competitive advantage, so that routinized behavioural explanations are not sufficient to explain "no-regret" and energy-efficiency paradoxes.

The important point is that choice selection decisions are not always evaluated in a rational manner, but do the resulting biases matter enough? As Conlisk (1996:1) questioned, 'bounds on rationality are not always important, but are bounds on rationality often important enough to include in economic analysis, and if so, when?'

7.6 Sources of Information for Evaluation of Options

Both ATNS and Tongaat Hulett have the advantage of relying on some early adopters in their industries for information and guidance. ATNS mostly relies on guidance from the governing body ICAO, as well as regional and transcontinental initiatives such as INSPIRE, ASPIRE, AIRE and SESAR. Tongaat Hulett, on the other hand, uses an American technical partner in their wet

milling processes, for example, to provide guidance and benchmarking opportunities. This implies that the costs of deliberation are lowered while the expertise and experience is elevated, thereby significantly debiasing their decision making processes. There are, however, other biases, heuristics and rules of thumb possibilities even in such information-rich decision environments. For example, given astronomical rate of technology change, how relevant and current is such information? Conlisk (1996) argued that learning economic issues involving long time horizons, such as equipment and plant life-cycle decisions, technological evolution and unpredictability, do not meet the conditions of effective learning. What about hyperbolic discounting, where decision makers tend to have a stronger preference for more immediate payoffs relative to later payoffs? This tendency increases the closer to the present both payoffs are, i.e. a positive autocorrelation in returns over short time horizons and a negative autocorrelation over long time horizons. Simon (1996, 1955) also argued that in cognitively loaded, information-rich decision situations, not all information is used.

A more pertinent question to ask, particularly in Tongaat Hulett's case, is: could it be possible that the company is doing what their American technical partner and others have already done, rather than using their own information? Herding behaviour is defined as everyone doing what everyone else is doing, even when their private information suggests otherwise. Herding behaviour has been found to influence technology adoption decisions (Barnejee, 1992). The counter argument has been that paying attention to what everyone else is doing may be rational because those decisions could reflect valid, rational information which other decision makers might not have. Could this be the case with technology maturity as a key criterion in technology adoption decisions? When asked whether they had considered other suppliers in their low-carbon technology adoption decisions, both companies cited technology-lock factors and familiarity with current brands as key inhibitors for considering other technologies. Both companies admitted to the possibilities of having missed low-carbon opportunities as a result. One such statement worth quoting from the executive of Tongaat Hulett is, "But, as I think about it now, we may have missed some opportunities coming from different suppliers." This supports earlier arguments on the biases associated with technology adoption decisions (Ellison, 2006; Spiegler, 2006). The argument is condensed into this proposition:

Proposition 9:

Herding behaviour - where the sample size of low-carbon technology suppliers is small and opportunities for social learning in a geographical boundary are limited, suboptimal technologies could easily be adopted.

7.7 Barriers to corporate climate change response

A myopic focus on short-term economic performance, where companies that do not excel on short-term earnings are penalized by investors and analysts has been advanced as one of the major barriers to corporate climate change response success (Setthasakko, 2009). The challenge for corporations, according to a 2008 British Telecom and Cisco study entitled 'A New Mindset for Corporate Responsibility', is to find ways to balance market demands with long-term sustainability. Both companies in the study are currently concentrating on initiatives that give immediate payoffs and returns. One of the finance managers in the study indicated that they are mostly using the financial payback period in their evaluation of the suitability of climate change response initiatives. High costs associated with climate change strategies are seen as hindrance to competitiveness (Setthasakko, 2009; Walker *et al.*, 2008). This was cited as one of the major reason for slow progress in effluent and waste water treatment from Tongaat Hulett's processes. In order to get portable water from their waste, reverse osmosis is required – a technology that is still has to be imported into the country at a very high cost. Insufficient investible resources (Sutherland, 2000), weak institutional systems and structures (from the national energy regulator- NERSA), poor infrastructure (e.g. gas and gas pipeline shortages cited), the need to import technologies and technological capabilities, tariff and taxation distortions, regulatory uncertainties, misplaced incentives and competitive protectionism are the other major barriers. There were also disparities cited moving from one regulatory department to the next. One of the statements bearing testimony to this lack of clarity is, "*..for instance when we speak of generation of electricity using bagasse, creating employment, producing ethanol, those things can only be done when we have a government that is very streamlined in their thinking in terms of what must be achieved from the strategic point of view. But when we are dealing with the Department of Agriculture on this issue, when you discuss that with the Department of Trade and Industry, then you go to the Energy Department, there is no*

alignment of thinking. It becomes a big issue". All these were barriers advanced in this study as hindrances to faster uptake of more efficient and climate-friendly technologies. This is in direct contrast to the behavioural explanations advanced as causes of 'no-regret' and energy-efficiency gap paradoxes. This can be summarised in the following proposition:

Proposition 10:

Market barriers such as short-termism, expensive technology, access to technological resources and capabilities, and tariff distortions are plausible explanations for "no-regret" and energy efficiency gap paradoxes.

7.8 Product and Market Diversification and Vertical Partnerships

7.8.1 Supply Chain Partnerships

Achieving low-carbon objectives along a whole supply chain is complex due to global business management (Welford & Frost, 2006) trends such as global sourcing and offshoring. Tongaat Hulett mentioned the case where some of their customers are demanding greater environmental responsibility through genetically-modified organism free (non-GMO) products. This requirement meant that Tongaat Hulett is imposing non-GMO input requirements from its own suppliers (the farmers), who in turn are demanding non-GMO seed and manures from their own suppliers further down the supply chain. For ATNS, regional collaboration opportunities are being enhanced by technological advances, where surveillance and navigation technology has advanced from local station to regional or intercontinental coverage. The push and pull of greener standards along the supply chain is necessitating collaboration along the chain. The argument is that companies should move away from demand-driven compliance (Cheung et al., 2009) to a more proactive stance, where they actively engage both their suppliers and customers in order to create value along the whole supply chain (Luetkenhorst, 2004). Proactive collaboration will result in integrated climate change response from inputs sourcing, raw material selection, product design for recycling, disassembly, extended life cycles and future innovations (van Hoek, 2001); development; production; packaging, marketing; logistics and distribution; and end-of-life recycling (Cheung *et al*. 2009) to create competitive advantages.

There are several areas and benefits to green supply chain partnerships for South African businesses, including shared responsibility of the burden of reducing greenhouse gas emissions, enhanced customer and supplier relationships filtering to other areas of business through increased stakeholder engagement, and opportunities for learning and capacity building (through information, knowledge and technology transfers) which can drive efficiencies up in product, process, and supply quality, and raise productivity. This is especially relevant given the fact that climate change response is still in its infancy in South Africa with limited skills and case studies to learn from. Reinhardt (1998) showed that supply chain partnerships among companies aimed at cost savings or cost containment are viable where costs are distributed along the supply chain, or when there are economies of scope to be realised (van Hoek, 2001). This finding is summed up in the eleventh proposition:

Proposition 11:

Adopting a proactive stance by actively engaging both upstream and downstream supply chain partners in climate change response can be an effective means of lowering greenhouse gases and generating value.

Conditional Cooperation and Reciprocity

Thaler and Sunstein (2003) and Camerer *et al.* (2003) proposed a concept called 'soft paternalism', in which it is possible to help people make their own decisions without compromising their freedom of choice. At a micro level, people have been shown to be willing to cooperate when others do (Gachter, 2007), a phenomenon which Brekke and Johansson-Stenman (2008) termed 'conditional cooperation'. ATNS, although not calling it by the same terminology is pursuing opportunities of conditional cooperation particularly with other African ANSPs. They are assuming a role of big brother in this drive, particularly in the use of shared navigation and surveillance equipment. The sentiment was shared by almost all the executives interviewed within ATNS. Other activities engendering soft paternalism within the aviation industry are being driven by the governing body ICAO. These include some regional and transcontinental collaborative efforts such as the ASIA and South Pacific's ASPIRE green flight demonstrations, or the Single European Sky (SESEAR) and Atlantic's INSPIRE green flight trials of which ATNS is a major participant. Tongaat Hulett is both experiencing pushes for conditional cooperation from its major customers and is also exerting forces of conditional cooperation to

its supplier chain partners along the agro-processing supply chain. Brekke and Johansson-Stenman (2008) argued that soft paternalism is applicable to recycling, eco-labelling and environmental labelling, concepts that are easily applicable to supply chain and industry collaborative efforts. The argument was extended to macro levels, where countries and regions have been found to be more cooperative and willing to portray social responsibility rather than pure self-concern in climate change negotiations (Brekke & Johansson-Stenman, 2008; Dannenberg et al., 2007). While it is not as straightforward to generalise from multi-country negotiation settings to inter-company collaboration, the insights are transferable. This is summarised in the following proposition:

Proposition 12:

Supply chain collaborations are an effective way of using reciprocity, conditional cooperation and soft paternalism to advance the corporate climate change response agenda.

7.8.2 Green Marketing

Green marketing is a viable market development strategy in which a company attempts to adopt its present product line (with some modifications of product characteristics and/or sometimes highlighting of "green" characteristics to environmentally friendly missions. It involves developing and promoting products and/or services that dramatically increase the productivity of natural resource flows (Polonsky, 1994), biological or cyclical production models, encourage dematerialisation and reinvest in and contribute to the planet's natural capital (Ottman *et al.*, 2006). ATNS' green marketing strategy is being driven by the need to build a stronger reputation within the aviation industry as evidenced by extensive communications and publicity of the INSPIRE project during the COP17 in Durban in December 2011 and several white papers and other publications. As a leading ANSP in Africa, ATNS is aiming to maintain its dominance by being a pace-setter in climate change response.

The Marketing Director of Tongaat Hulett said that they had not taken deliberate steps to get green marketing mileage in their Starch Division largely due to the market share dominance they enjoy in that sector - implying that the marketing spend would rather be used elsewhere in

their budgets. Another major reason advanced was the fact that green consumerism in South Africa is not yet at levels where customers were willing to pay a premium for such products or services. This in support of Orsato (2006), van Hoek (2001) and Polonsky (1994) assertions that customers should be willing to pay for the differentiated value for green marketing campaigns to make business sense. This is also in line with Reyers (2011) and colleagues' finding that companies are responding to climate change only where the business case prevails, unless there are other strategic decisions such as regulatory or social justifications. In such cases heuristically-determined hurdle-rates (Magni, 2009; Gigerenzer, 2006; Jagannathan & Meier, 2002, McDonald, 2000; Simon, 1955) and not the opportunity cost of capital are used to make such investment decisions.

Proposition 13:

Where it makes strategic business sense, companies that offer products and services with differentiated "green" value propositions can gain significant competitive advantage.

7.9 Towards an Interpretive Model of Climate Change Response

The outstanding question remains, however, where does a corporate executive begin when thinking about a corporate climate change response strategy? In the concluding remarks of his paper, Ellison (2006) stated one of the two main advantages of bounded rationality as being the opportunity it affords researchers to incorporate additional features into rational models. The synthesis of this study then, is the combination of the rational economic models with bounded rationality approaches, to produce a more pragmatic climate change response framework.

The rational economic man theory is built on the premise of flawless logical abilities and low computing costs. But as propositions 6, 9 and 12 suggested, there are costs to defining and searching for information and solutions to a problem which rational models do not adequately cater for. In the face of uncertainty and complexity, decision makers are pulled towards heuristic and bias (Tversky & Kahneman, 1973) that can result in 'satisficing' rather than optimal solutions as suggested by rational utility-maximisation models. Secondly, the role of risk and uncertainty in complex decision making and the tendency for people to think of risk

differently when they are losing rather than when they are winning (loss aversion- Benartzi & Thaler, 1995; Kahneman *et al.*, 1991) and, thirdly, the tendency for people to fail to update their choices and solutions in the face of new information (anchoring & adjustment- Slovic *et al.*, 2002; Finuacane *et al.*, 2000; or experienced utility – Kahneman *et al.*, 1997; Kahneman & Thaler, 2006), are all key reasons for marrying rational and boundedly rational models in climate change response decisions. The cognitive limits of decision makers in information-overload situations (Jones, 1999; Simon, 1955) is also a good reason for incorporating elements of bounded rationality into the framework. This study retains the basic architecture of rational models of decision making, but adds the assumptions of cognitive limitations to account for some of these observed anomalies. For example, most business executives in this study seemed rational in their selection of climate change initiatives, but tendencies of hyperbolic discounting (Lee & Swaminathan, 2000) were evident.

Proposition 2 offers a structured, analytical approach to incorporating all the different aspects to climate change decision making, which is the rational portion of the modelling process. An understanding of all the levers and drivers of climate change response is an important part of the process of creating and understanding the options available. AHP's ability for hierarchical structuring (Saaty, 2008; Saaty, 1980) of quantitative and logical complexity (Frior, 2009), making it possible to consider a variety of data, relations and criteria as found in climate change response (Hwang & Syamsuddin, 2010) problems. This holistic and comprehensive approach to corporate climate change response is unlike any approach proposed before.

Due to the presence of multiple criteria, preference information has to be incorporated into the climate change response problem to obtain a set of possible alternatives. The process of arriving at a decision on the type of criteria, the weighting of the criteria and ultimately the evaluation of the solution (Gigerenzer, 2007) is where rational models are challenged (Simon, 1955). It is also at that point that bounded rationality becomes useful, because deliberation of the type and weighting of criteria is not an exact science (Ellison, 2006; Simon, 1955). Equally important is the practical assessment of a company's key climate change response drivers, which should be performed with an understanding of propositions 1 and 3, where the severity of climate change induced risks is balanced against a diversity of interests of multiple stakeholders (Raymond & Brown, 2011; Cook *et al.*, 2007), the resources and capabilities at an

organisation's disposal (Porter, 2008) and the synergies and interconnectedness (Wind, 1987) of the response system.

Propositions 4, 5, 11 and 13 are opportunities which also have to be assessed against an organisation's resources, capabilities, strategic direction (Porter, 2008) and planning horizon (Beale & Fernando, 2009; Berg & Gigerenzer, 2007). Subjective judgements (Magni, 2009) get in the way, and in some cases, considerations that cannot be reduced to numbers or financial figures (Meier-Rigald, 1991) have to be considered. The addition of the behavioural aspects to such decision making moves us closer towards a true reflection of how businesses make strategic decisions (Gigerenzer, 2007; Simon, 1976*a*) in general and specifically how businesses should select climate change response initiatives. The proposed framework argues that the process to arrive at a solution (procedural rationality – Simon, 1956) is just as important as the solution itself (goal rationality – Simon, 1976*b*) because procedural rationality considers uncertainty as impacting not only the outcome of a decision, but also the specifications of that outcome (Simon, 1976*b*).

Proposition 10 suggests that perfect rationality hypothesis explanations of the concept of market failures such as hidden costs, and market imperfections such as misplaced incentives and other barriers (Sutherland 2000) identified in this study, provide rational and compelling explanations for 'no-regret' and energy efficiency gaps. The organisational and institutional behavioural explanations (Schleich & Gruber 2008; Shove 2005; DeCaino, 1998) proposed such as routinized behaviour and inertial tendencies for wanting things to stay the same (status quo biases) are unsatisfactory in explaining these paradoxes, which is summed up in proposition 8. The idea that locked-in habits and routines (Schleich & Gruber, 2008) may serve to explain the no-regret paradox could not be proved in this study. Instead, both companies seemed keen to explore all available low-carbon options in order to be more climate friendly, barring the barriers to action as detailed in proposition 10.

The statement made by Pompian (2006:16), regarding people's wealth management habits is very relevant: "People are neither perfectly rational nor perfectly irrational; they possess diverse combinations of rational and irrational characteristics, and benefit from different degrees of

enlightenment with respect to different issues". The same can be said of corporate climate change response.

This discussion leads to the construction of a response framework incorporating both rational and irrational concepts.

7.10 The Corporate Climate Change Response Framework

7.10.1 Finding the Best-Balanced Choice Responses

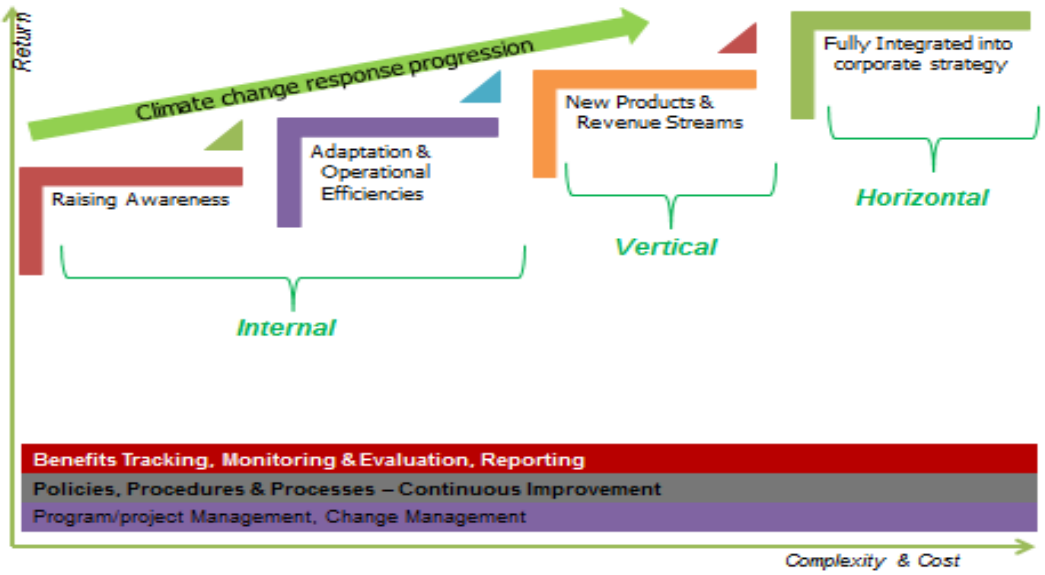
Simon's (1976*a*) definition of strategy as a series of decisions carried out to determine alternatives for a specific moment's behaviour is the key determinant of a best-balanced choice response. Articulating the consonance of climate change and business interests constitutes a win-win situation (Jones & Levy, 2007). The challenge for business executives lies in reducing the totality of the costs and risks associated with climate change response against the spectrum of choices to find the optimal portfolio of climate change response initiatives representing that win-win frontier. Behavioural researchers (Lovallo, 2009; Flyvbjerg *et al.*, 2005) have shown that even after extensive information gathering, analysis, debate and discussion, and with all the intended rationality (Zacharakis & Shepherd, 2007), managers still tend to gravitate towards heuristics and biases in choice decisions. Without a comprehensive framework from which to work, companies pursue piecemeal climate change response initiatives that are not synergistically linked and do not realise the benefits which they could otherwise be enjoying by pursuing a best-balanced choice response.

7.10.2 The Building Blocks

As Orsato (2006) acknowledged in his Competitive Environmental Strategies framework, the progression from one level of the climate change response continuum to the next is hypothetical. In reality companies are jumping in at random and are moving back- and-forth along the continuum depending on the capabilities, skills, opportunities and risks assessments at a point in time. This was evident in the types of initiatives the two companies are pursuing. Both companies have initiatives spanning all four levels of the continuum, howbeit at different levels of progression and receiving different levels of attention in terms of time and resourcing.

There is however, argument for making the level distinctions, because depending on the corporate strategic focus of the organisation as well as the organisation's stance the emphasis in terms of time and resources allocated to climate change response will vary, even for companies faced with similar climate change related risks and opportunities. Another reason for separating the levels is what Kolk and Pinkse (2004) defined in their study as the degree of cooperation and the form of organisation which companies choose in pursuing climate change response.

Figure 7-1 Climate Change Response Framework Skeleton



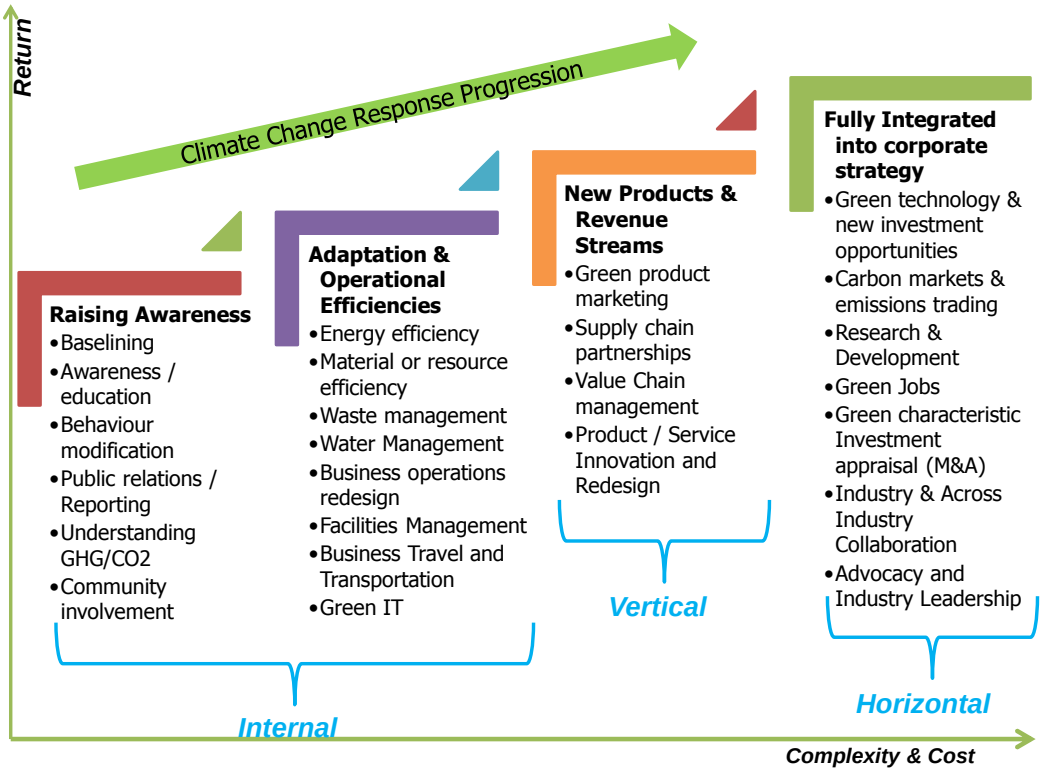
The first two levels of the continuum have an internal focus with emphasis on understanding "operating in a carbon-constrained world" and realising operational efficiencies and cost savings along the journey. The next level of the continuum is more outward looking, with a key focus on low-carbon product development and supply chain involvement. The final level involves companies going beyond the supply chain in search of value by collaborating with competitors or across industries into different business sectors, in order to capitalise on opportunities for diversification and competitive advantage. The cooperation of Exxaro Resources with Tata Power to form Cennergi, a renewable energy company (www.engeeringnews.co.za) is a case in point.

7.10.3 The Detail

A framework, by definition, gives only guidance and is in no way prescriptive, neither is it meant to be. The framework is designed for a variety of organisations in different industries, hence the need for a best-balanced choice response. Thus success in crafting a successful climate change response strategy lies in business executives skilfully generating and evaluating the alternatives against set criteria. Reviewing will be necessary as new information and new technologies becomes available; new skills and competencies are acquired; and as the planning horizons or climate change missions mature.

Internally Focused

Figure 7-2 Climate Change Response Options

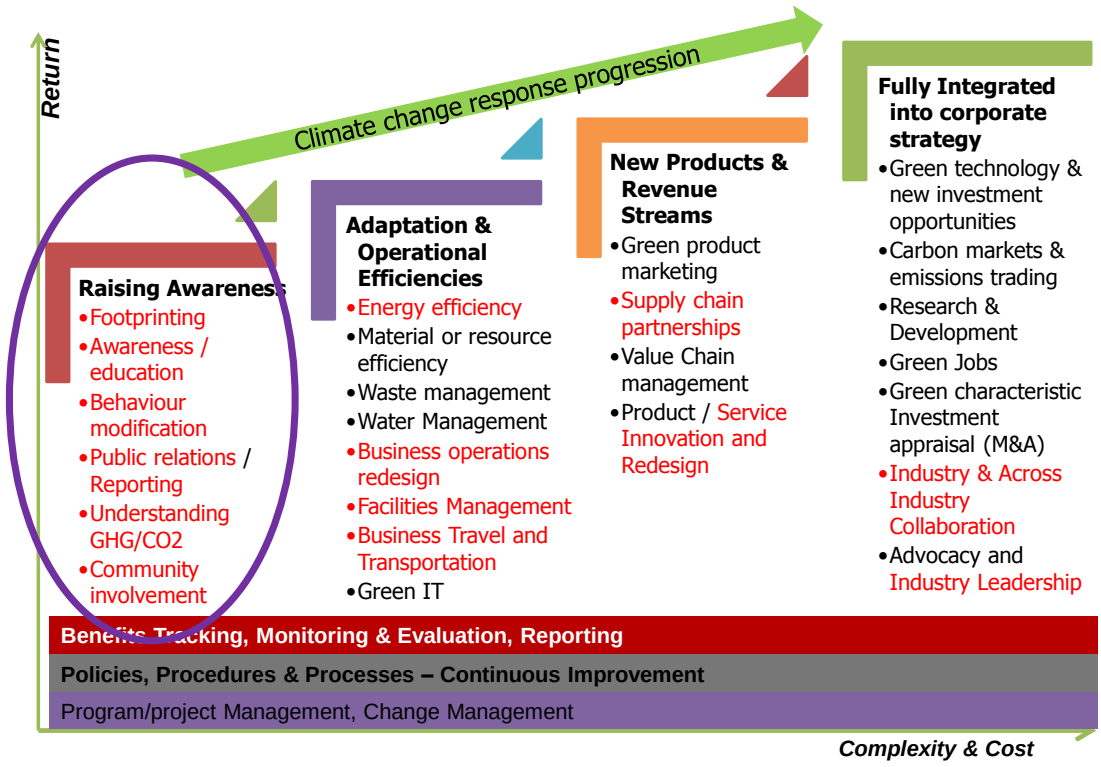


The first two levels of Figure 7-2 shows a spectrum of internally-focused climate change response initiatives ranging from carbon and water foot printing; communication; education and training programmes in order to raise awareness on the subject of climate change; efficiencies

in materials, energy and water and behaviour modification on reducing, reusing and recycling. The major preoccupation is on understanding climate change impacts on business, establishing the baselines and mitigating or adapting as necessary.

While both companies in the study are working on initiatives across the spectrum, ATNS's current emphasis is on level 1 initiatives, i.e. the Raising Awareness level. This is understandable given the fact that ATNS' Sustainability and Climate Change Strategy was only crafted in 2011 in response to the formalization of the aviation industry commitment to fighting climate change in late 2010. As Figure 7-3 show most of ATNS' climate change response initiatives show the infancy of the phenomenon in the organization.

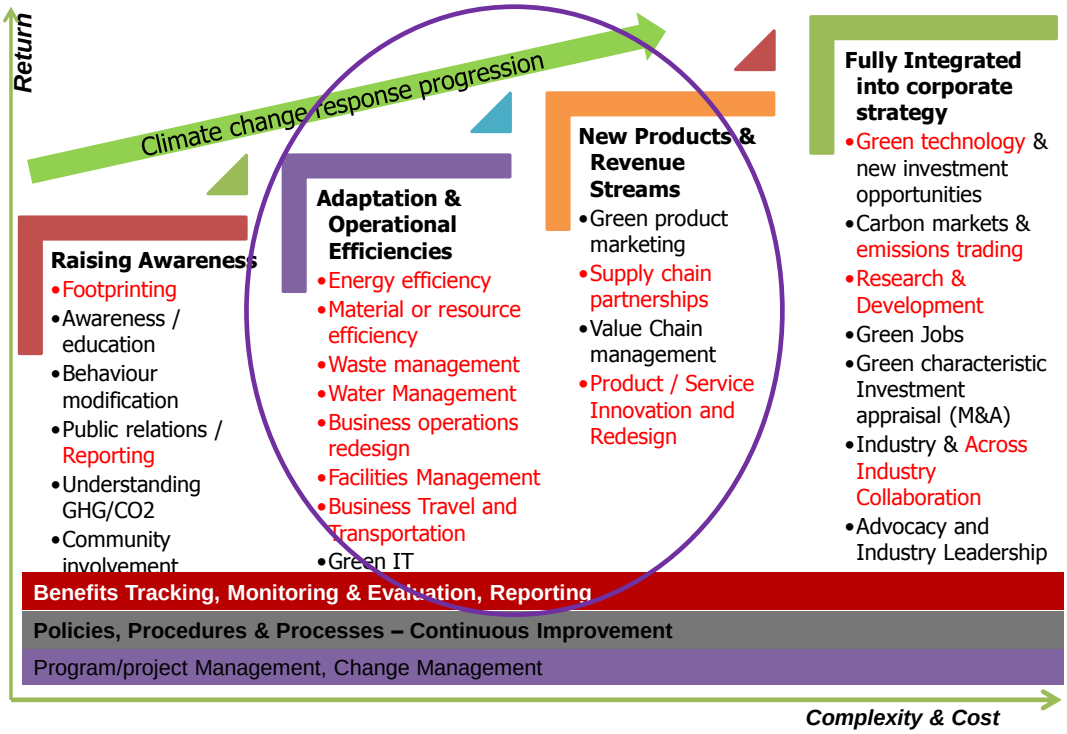
Figure 7-3 ATNS' Climate Change Response Initiatives



In both organisations, some of the executives interviewed showed a lack of understanding of the drivers, the current and planned initiatives or the general roadmap and climate change response strategies in their respective organisations. This serves to underscore the importance

of making climate change response an organization-wide initiative and not something driven by a few executives, some department or some enthusiasts. The need for raising awareness and creating internally-focused educational and awareness programmes cannot be over-emphasised.

Figure 7-4 Tongaat Hulett's Climate Change Response Initiatives



For reasons stated under ATNS' initiatives, there is still merit in the company working on Raising Awareness initiatives. This was evident particularly with newer members of the executive team who did not seem to be conversant with most of the initiatives currently underway particularly in the Operations Department.

Vertically Focused

The third level of Figure 7-2 shows a spectrum of vertically-focused initiatives where the emphasis is on creating new products, finding new revenue streams from green initiatives and finding ways of collaborating across industry supply chains. Smart companies are finding opportunities to redesign their products and services, and marketing those to green-conscious

consumers and buyers. They are also designing completely new products and services for new uses and users. Others are finding opportunities for conditional cooperation and reciprocity (Brekke & Johansson-Stenman, 2008; Gatcher, 2007; Dannenberg *et al.*, 2007) up and down their local, regional or global supply chains realising significant greenhouse gas emission reductions and competitive advantage.

Horizontally Focused

The fourth and final levels of Figure 7-2 is where entrepreneurial companies are finding opportunities to fully integrate climate change response into their businesses by looking horizontally partnering with competitors, non-profit organisations (NPOs) and across industries to participate in low-carbon technologies, carbon offsetting, green jobs and other initiatives that move them towards zero emissions while creating significant competitive advantages.

7.10.4 Support Elements of the Climate Change Response Framework

Effective climate change response involves a shift from the subject being driven by enthusiasts or a single department to being streamlined in an organisation. This allows an integrated approach across the organisation with metrics and targets, monitoring, reporting and incentives attached (*see Figure 7-5*). Employee involvement is required to change the culture of the organisation (Setthasakko, 2009; Frahm & Brown, 2007) where the change is driven across the organisation through demystifying and simplifying the subject. Use of climate change champions and public recognition of innovative solutions also helps in embedding the changes and raising the awareness in the organisation (Setthasakko, 2009).

ATNS has set up a climate change response project office with a steering committee made up of executives and representatives from the different business functions including operations, finance, risk and compliance, marketing & communications, engineering, air traffic management, human resources, etc. The project office is responsible for all reporting and monitoring and evaluation of the different climate change response initiatives. They are driving project management and evaluation of the types and timing of the different initiatives. The project office is also driving communication, education and awareness programmes in the organization.

Figure 7-5 Supporting Elements of the Framework

Setthasakko (2009) argues that staff training and capacity building programmes should also be rolled out across the organisation. This not only improves the knowledge and skills of the organisation, but also increases employee awareness. One of the executives indicated that a key member of one of the operational teams turned from being a climate change sceptic to an evangelist after a climate change response awareness and training programme. Standards, policies and processes also play a role in changing corporate behaviour by ensuring that the organisational norms and values are integrated into the "way of doing business".

7.11 Using AHP as a Strategic Decision Making Aid

In order to avoid the piecemeal activities in corporate climate change response, rigour and creativity and procedural rationality (Simon, 1956) are necessary. According to Roy (1990: 78),

> "In general, it is impossible to say that a decision is a good one or bad one by referring only to a mathematical model: organizational, pedagogical and cultural aspects of the whole decision process which leads to a given decision also contribute to its quality and success."

Financial valuation techniques (such as net present value, payback, internal rate of return) and algorithmic solutions of multi-criteria problems geared towards optimisation were found not to be very useful for environmental problems (Funtowicz *et al.*, 1999), and in particular climate change response problems, because the methodology offered must offer a consistent framework for structuring the problem and allowing for a process of debating and learning, so that "soft" issues such as ethical and moral-motivated initiatives are catered for in the response strategy.

7.11.1 Climate Change Response Mission and Planning Horizon

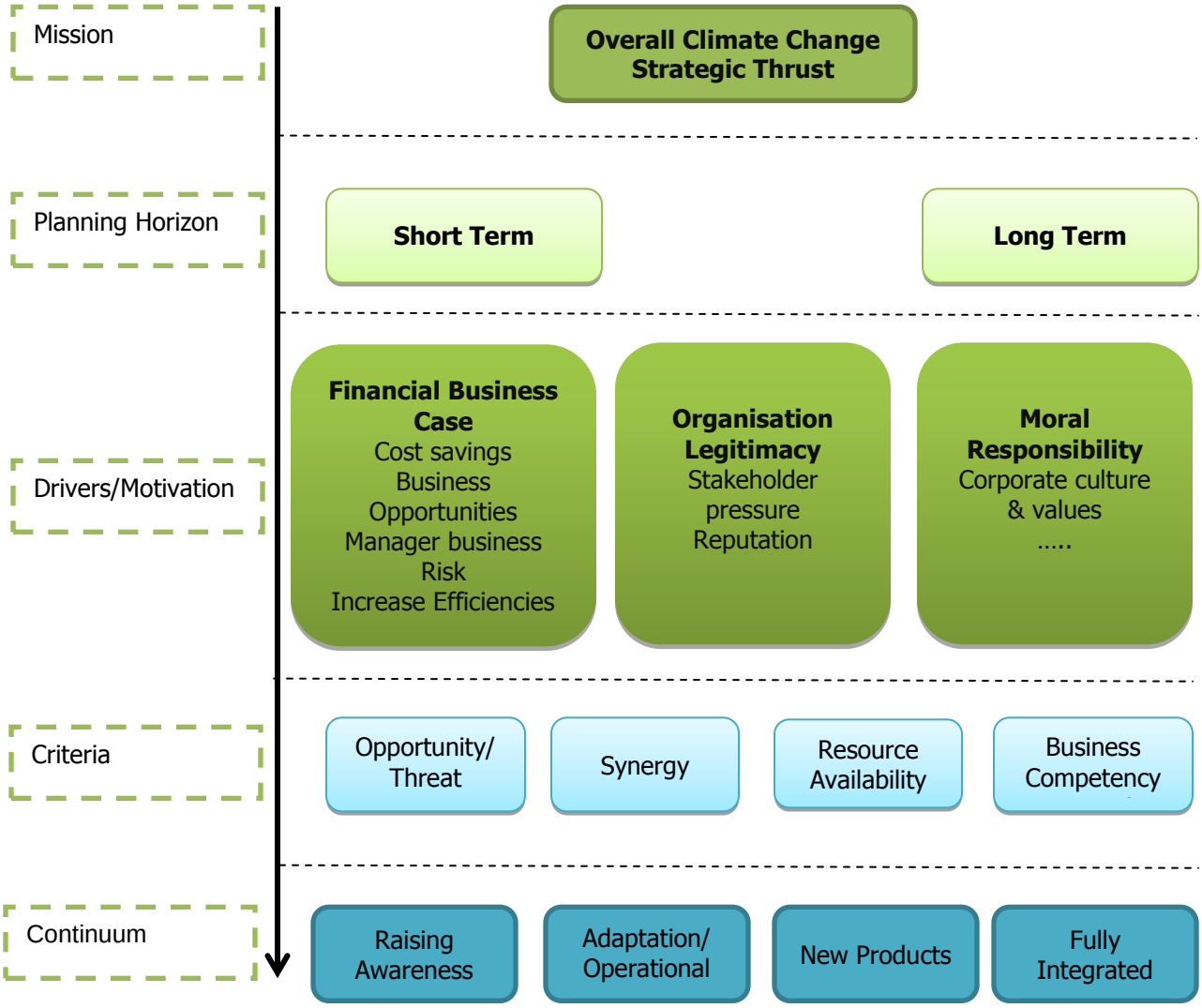
Mission

The first step in the crafting of a well thought-through corporate climate change response strategy should be the crafting a climate change mission (Figure 7-6). This should flow from the corporate strategy of the organisation. Both organisations in the study have documented climate change response strategies with varying levels of comprehensiveness. Tongaat Hulett's climate change response strategy is part of the bigger Sustainability Strategy, (see Findings section for their sustainability strategic intent). ATNS' climate change response mission is articulated in their Sustainability and Climate Change Response Strategy. Conversely, climate change response can shape corporate strategic decisions, where an organisation could leverage its existing competitive advantage in promoting value and ensuring growth (Lynch, 2009). This seems to be the case with the company used in the pilot study, where climate change response is charting new territories for diversification away from the core mining business into renewable energy generation.

Planning Horizon

The climate change response planning horizon informs the investment horizons. This is important because the concerns of shareholders and business executives are not always compatible (Beale & Fernando, 2009). Beale and Fernando (2009) and Jensen (2004) argued that the chase for share price rise encourages short-termism which compromises environmental (including climate change) and social sustainability.

Figure 7-6 AHP Tree for Climate Change Response



This argument was supported in the study where concerns for short-term performance as measured by the payback period are the biggest selection criteria for climate change response initiatives in one of the organisations. In short-term planning cycles, businesses focus on short development cycle initiatives that drive short-term profitability and organisational legitimacy (Lynch *et al.*, 2008) such as social acceptability, reputation or legal compliance. This is what Beale and Fernando (2009) termed mitigation strategies, where companies use existing environmentally tools and additional resource allocation is minimal. ATNS has an elaborate planning horizon with some initiatives ear-marked for the short-term period of 0 to 3 years. The medium-term initiatives falling within the 5 year window are vaguely defined and the long-term initiatives falling within the 6-10 year planning horizon are yet to be clearly defined. Tongaat

Hulett's planning periods were not articulated, but there is evidence and statements from the interviews indicated that there are a number of both long-term initiatives planned or currently underway such as the feasibility study on the use of a starch product for water retention; the desire to move into ethanol production at a commercial scale; the joint-ventures with some municipalities on effluent treatment and engagements with various authorities on electricity generation. Long-term planning horizons largely focus on initiatives that fall on the third and fourth levels of the climate change response continuum largely driven by the need for competitiveness.

7.11.2 Climate Change Response Criteria

Climate change response drivers and motivators extensively discussed in the Findings section are an important determinant and criteria for response. In his design of a market driven corporate strategy using AHP, Wind (1987) argued for the inclusion of synergy as one of the evaluation criteria (*see Figure 7-6*). Synergy is a dimension that recognises the interdependency among initiatives that can enhance or magnify the response impacts of an initiative or conversely negate it. Synergistic effects can often provide functional advantages and economic benefits but can also be a source of progressive complexity in climate change response.

7.11.3 Qualitative and Quantitative Evaluation

Qualitative Evaluations

How should executives apply these criteria in the selection of individual initiatives? AHP lends itself usefully in hierarchically structuring and evaluating the different alternatives within a cluster using the Saaty's Linguistic Variables. For example, while water shortages are a genuine climate change concern for Tongaat Hulett, and the need to contribute towards water sustainability are high, the economic justifications of reverse osmosis are not yet favourable. How do companies put a financial value to moral responsibility and earth citizenship? Subjective and moral-inspired actions are better valued qualitatively than quantitatively, a fit which financial valuation or cost-benefit analysis methodologies do not handle well, particularly when the said benefits only materialize well into the future. As Ansoff (1957) advised, it is important that a company considers and plans for unforeseeable contingencies and technological

advancements - an aspect which AHP handles better than cost-benefit-analysis and financial valuation methodologies.

Quantitative Evaluations

Quantitative measures should seek to answer such questions as: will the climate change response initiatives portfolio address the key risks and opportunities confronting the company? Will the profit or cost structure, business legitimacy or business competitiveness positions improve as a result? Different aspects of performance are measured by different performance tests such as income adequacy measures, attractiveness to key stakeholders and productivity efficiency measures (e.g. use of capital, physical assets or personnel). Consistency in the definition and application of evaluation criteria is important.

7.11.4 Understanding the Decision Environment using SWOT

Kurttila (2000) and colleagues proposed the use of AHP and SWOT (strengths, weaknesses, opportunities, threats) as a hybrid method yielding analytically determined , quantitative input for strategic planning. It is not sufficient to list a collection of internal factors (Strengths and weaknesses) against external factors (Opportunities and Threats), as one of the companies in the study seemed to have done in deriving its climate change response strategy. An in-depth and analytical appraisal of the internal factors in relation to the external factors (Kurttila *et al.*, 2000) gives business executives a concrete, analytically derived and unbiased basis from which to select appropriate climate change response initiatives.

The advantages that AHP brings to the process are the ability to produce a commensurate set of factors from both qualitative and quantitative data; the expert knowledge; objective information (such as cost-benefit analysis or other financial valuations) and the subjective preferences of the executives.

Conducting the SWOT and Criteria Analysis

Step 1:

Climate change response drivers and motivators as proposed in Reyers *et al.*'s (2011) code clusters are used. For example the relevant factors for the Tongaat Hulett study should be: cost savings, managing business risks, regulatory and legal compliance, stakeholder pressure, business opportunities and the role of the corporation in social and environmental responsibility. For ATNS, the factors to be considered are: regulatory and legal compliance, corporate values and culture, stakeholder pressure, reputation, increasing competitiveness, the role of the corporation in social and environmental responsibility and cost savings. The organisation's iinternal strengths and weaknesses should also be agreed.

Step 2:

Pairwise comparison of the factors is carried out for each SWOT group or Criteria using the following questions:

1 Which of these two factors compared is of greater strength?
2 By how much? (Answered using the Saaty Linguistic Variables)

After the comparisons, the relative local priorities of the factors are computed using the eigenvalue method described in the Methodology section.

Step 3:

The factors with the highest local priorities represent the specific SWOT group. The global priority is calculated by following process similar to step 2 above.

Choosing Among Climate Change Response Initiatives

Step 4:

The results of this analysis are then used to decide on the initiatives to pursue from the climate change response continuum. A similar process is used to select the initiatives under each level of the climate change response continuum. Two alternatives are compared against the agreed criteria. The alternatives should be analysed at the lowest hierarchical level. Starting at the

bottom level, pairwise comparisons are conducted between the elements immediately below each other element. For example, energy efficiency for Tongaat Hulett has sub-categories such as office lighting, HVAC, motors, compressors, pumps, etc. Pairwise comparisons should take place at this level so as to decide on the local priority under energy efficiency. Similar analysis should take place for each of the other categories such as water management (recycling, reducing, treatment, etc.), waste management, business travel and transport, supply chain partnerships, green technology, etc.

The result of this analysis is a quantitative value indicating the preferences of each climate change response alternative. In line with Kurttila *et al.*'s (2000) recommendation, companies should consider incorporating senior level and other operational personnel in the analysis process in order to introduce new ideas and new knowledge. The project steering committee structure which ATNS has set up is a good platform for such an exercise. This is especially relevant because climate change understanding is still limited in organisations in general, and companies could benefit from the so-called "greeniacs" and climate change enthusiasts, who may not necessarily be business executives.

7.12 Conclusion of the Framework

The climate change response hierarchy focuses on the clusters of target initiatives and ensures that the planning process is mission's driven. The process is easily implementable and offers a relatively quick, simple and rigorous approach to climate change response planning in any size business or industry. The development of a viable climate change response strategy for business depends on the proper identification of the current, as well as the foreseeable, impacts of climate change on a business. For example, the relative influence of environmental activists and community lobbyists are more marked in the agricultural sector where Tongaat Hulett plays than the aviation industry where ATNS operates. Moreover, the level of willingness and preparedness attached to climate change response is closely related to the overall strategic direction and resource endowments of an organisation.

Corporate strategy formulation and planning should mainstream climate concerns concentrating on priorities and options that change the 'business-as-usual' mind-set where corporate finance and climate change response funding is integrated. It is argued that a top-down, holistic,

seamless integration of strategic and climate financing results in more cost-effective climate change response strategies. Mainstreaming climate change response efforts results in the adoption of non-climate strategies, with ancillary climate benefits that would create a context in which climate change initiatives are funded through regular corporate investment channels. A top-down strategic approach also ensures that climate change response decision making is not delegated to senior and operational level personnel – a situation currently resulting in sub-optimal responses. The added value of integrating corporate and climate change initiatives was illustrated by the positive examples cited by both companies.

8 Conclusions and Further Study Recommendations

8.1 Conclusions

The objective of this study was to develop a climate change response framework for corporations, noting existence of bounds on rationality in strategic decision making. A corporate climate change response framework emerged using a comparative case study of two organisations in different industries but the same jurisdiction. The framework is flexible and simple to use since computational requirements are reduced to pairwise comparisons employing simple spread sheet software. A more important conclusion from the study is the importance of company-specific, context-specific, organisational and behavioural variable influences on corporate climate change response. Similar to other business phenomenon such as broad based black economic empowerment (BBBEE) in South Africa; customer relationship management (CRM); total quality management (TQM), climate change response must be mainstreamed into corporate strategy in order to satisfy multiple objectives at optimal resource allocations. In so doing, companies can contribute immensely to greenhouse gas reductions and the environmental good of society, while simultaneously gaining competitive advantage. Dynamic businesses are unearthing ways of gaining competitive advantage by turning the risks into key opportunities for harvesting cost savings, new revenue streams, product and market diversification and entering into new markets and industries that were non-existent a decade ago. Carbon is now a key input to any corporate strategic debate and has to be effectively managed.

This thesis raises several interesting questions, some of which have been asked in previous studies, such as: Do changing industry conditions (e.g. global warming and the associated legislation, technological advancements, industry globalisation, emergence of trading blocks, etc.), force business executives to rethink their business strategies? To what extent should international climate change legislation and treaties impact the rate and speed of climate change mitigation in an industry or firm? To what extent do organisational issues (capabilities, constraints, values, etc.) impact the rate and speed of climate change responses? The key finding was that the incorporation of bounded rationality in strategic decision making provides opportunities to explore new explanations and opens up new possibilities for richer and deeper

understanding of firms and their interaction with society. While the rational economic man theory has dominated economic and business thinking and provides plausible explanations for much of the business and societal phenomenon, incorporation of bounded rationality models is sometimes important enough and sometimes more plausible. This brings the debate down to the question: which one is more important? The simple answer is neither. As Conlisk (1999) noted, bounds on rationality are not always important, but there are situations when they are important enough to add value to warrant inclusion in economic modelling.

The climate change response framework developed argued for the importance of procedural rationality, particularly in areas of technology adoption and alternatives trade-off analysis. Information to make such decisions is costly; both in terms of the search for it as well as the sorting, analysis and evaluation thereof, i.e. deliberation costs (Ellison, 2006) can be prohibitive. Climate change response is a relatively new business phenomenon so that some information is totally missing, some information is not quite what it should be, and there could even be a surplus of certain types of information, i.e. the information is not perfect for the purposes for which it is meant (Berg & Gigerenzer, 2007). Added to that, only bits and pieces of information available are actually used in decision making. This, coupled with the role of risk and uncertainty, constraints in time, knowledge, self-interest, self-control (Kahneman & Tversky, 1979) or the need for organisations to respond to moral and other societal ramifications, seemed to favour the arguments that business decision makers do not always confine themselves to equivalent risk alternatives (Magni, 2009, Gigerenzer, 2006) in climate change response. In Simon's (1955) language, business executives were found to appeal to rule of thumb and hurdle-rate heuristics as 'satisficing' strategies to respond to climate change.

One of the major criticisms of bounded rationality research has been the failure to offer alternative frameworks to the rational economic man models, gravitating instead towards the pointing out of anomalies and the generation of lists of heuristics, rules of thumb and biases (Kahneman, 2003). While this study can in no way claim to have offered alternatives to strategic decision making, the proposed framework can be argued to be a first step towards the integration and the non-distinction (Gigerenzer & Regier 1996) of bounded rationality and rational agent models in strategic decision making. This is an attempt at removing the artificial separation and the creation of an interrelationship (Magni, 2009) between the two paradigms.

Adding the behavioural elements enlarges the world's understanding of strategic decision making as called for by Thaler (1999) on behavioural finance research. There are no simple solutions to such criticisms and clearly one simple framework cannot provide all the necessary answers, but is one step and move towards a solution.

Most multi-criteria decision aid (MCDA) methodologies work on the principle of utility maximisation, where decision makers' perfectly explicit preferences to a choice problem are synthesised into a structured mathematical decision model to produce a perfectly optimal, rational choice. The assumptions of optimisation in MCDA were questioned in this thesis because they were not always feasible in identifying and listing, accurately describing the consequences, evaluating them and accurately associating each of them with the alternative, or ranking them into some preference order and selecting the best performing alternative. The argument is that employment of simplification strategies in order to quickly and economically select 'satisficing' climate change initiatives, is acceptable. AHP allowed both quantitative and the qualitative components to climate change response problem structuring, evaluation and synthesis, while taking cognisance of perceptual distortions, inaccurate judgements and sometimes illogical interpretations found to be true of organisational actors.

8.2 Contributions of the Study

In their study of the key themes impacting international business in the future, Jonsen (2010) and his colleagues identified climate change as one of the key topics to be studied in the future because of its significance. These researchers argued for holistic, multi-disciplinary and contextual approaches in order to ensure that research users and society benefit from, and make sense of, multiple perspectives. This thesis explored multiple perspectives to the subject by combining the disciplines of corporate strategy and bounded rationality with a multi-criteria decision aid to propose a holistic framework for corporate climate change response.

Pfeffer (2009) observed that management research has become disconnected from practice and unconcerned with the larger issues of social and human welfare, suggesting instead that management research should explore topical issues for the benefit of society. Climate change is currently considered one of the top five businesses risks, according to a 2010 Gartner research

paper and a 2011 McKinsey survey, and was therefore considered topical enough to warrant this study. The topic is even more relevant in developing countries and particularly in South Africa, where climate change policy is still underdeveloped.

This study makes several contributions to the body of knowledge. By providing a more structured framework for corporate climate change response, business executives and managers have a strategic compass to employ to systematically and methodically plan climate change response initiatives suited to their resource endowments, strategic capabilities and climate change response missions. This process allows an organisation to develop best-balanced choice responses where the business, people and the planet all benefit.

By providing a better understanding of how corporations make climate change response decisions, the thesis will hopefully assist policy makers in designing more effective policy instruments that support and resonate with the key players in the reduction of greenhouse gas emissions, which in mostly jurisdictions are corporates. The findings should also assist policy makers in assessing the policies currently under discussion to ensure that these and future policies take cognisance of the impact of the policies on corporations and how an understanding of corporate behaviour regarding climate change informs future policy directions. An understanding of the true drivers of corporate climate change response should also provide feedback to regulators regarding some of the apathy surrounding climate change policy, and provide a framework and an avenue for future engagements with key stakeholders. Understanding the behavioural side of corporate climate change response, for example soft paternalism, should assist policy makers in their policy formulation processes. During stakeholder engagement sessions, regulators should be aware of such dynamics and ensure that discussions and policies are tailored to engender cooperation and reciprocity (Brekke & Johansson-Stenman, 2008). Other parties involved climate change, such as developers of voluntary carbon-offset projects, venture capitalist companies seeking opportunities in "green" business investments and non-governmental organisations championing the cause of climate change and calling on businesses to play a leading role in the reduction of greenhouse gases could also gain insights.

8.3 Study Limitations and Future Research Directions

As with any framework that seeks to capture a multi-disciplinary study within a limited time span, the climate change response framework developed in this study has elements that require further refinement. Although this study provides some insights rigorous empirical tests of the framework are required. Climate change response across industries is being shaped by the different drivers. However these differences do not seem to adequately explain the divergence of strategies between the two companies in the thesis. Organisational-specific drivers seem to be more relevant. As a recommendation for further studies, it would be beneficial for a more in-depth comparative study of companies within the same sector and within comparable competitive positioning and resource endowments, in order to isolate the influence of behavioural-specific determinants of climate change response.

Adherence to an interpretative pattern on moving from one organisation to the next is a key requirement in the interpretive content analysis in order to maintain quality and consistency. For this reason, it was a key requirement that the two companies used in the case study were studied in as close a time horizon as was possible to avoid the influence of changing regulatory regimes and other macro-economic fundamentals. A longitudinal study exploring the behavioural constructs over time could provide more insight into strategic decision making.

Tsui (2007) observed that important questions in novel contexts and across contexts are ignored by researchers, while Pfeffer (2007) claimed that generic review processes in journals generally favour existing beliefs. Jonsen *et al*. (2010) termed this incremental research which provides few or no surprises as "normal science." It is the researcher's belief that this study provided step changes in climate change response strategy, but incremental changes and no surprises to bounded rationality research. Future research could consider the step changes in the behavioural strategy research arena by exploring heuristics, biases and rule of thumb tendencies in group decision making sessions. Instead of administering the AHP tool to individual executive team members, deliberation sessions should follow the one-on-one sessions to allow team members to consider the diverse views and perspectives of other team members as stakeholders to the strategy formulation process, and consequently debate and agree the trade-offs (Seekamp *et al*., 2010) associated with the climate change response decisions.

Deliberation processes have been known to both promote and impede individual judgment based on the group's dynamics, such as balance of power in the group and personality types (Seekamp *et al.*, 2010). The behavioural constructs in Table 5-1 could be tested, for example, to check for evidence of herding behaviour (i.e. the tendency for some members of a group to mimic other members of higher status, thereby choosing the socially desirable options). A member's participation and responses in the session could also be measured against their one-on-one responses. Key questions to be asked during the analysis phase will include: Are some group members more motivated to consider information provided and presented to them in greater depth, and if so, how does this affect the participant's original preferences? Do group influences result in some members conforming to dominant opinions?

The climate change response continuum modelled using the analytical hierarchy process model assumed that priorities of items in higher levels within a cluster do not depend on the priorities of items of the lower levels, which may not always be true (Saaty, 1996). Other researchers and authors (Longo *et al.*, 2008; Saaty, 1999; Mingers & Rosenhead, 2001; Saaty, 2005; Meade & Sarkis, 1998; Simon, 1956) argued that the priority of two or more criteria at the same level within the same cluster can depend on elements within other clusters or levels, so that the global priority of a criteria within a cluster can be ranked as lower or higher than it would otherwise be had the ranking been performed considering these interdependencies. In order to improve the quality of the decision making process, it is recommended that analytical network process (ANP), a generalised version of AHP, be used to further this study. ANP is designed as a network framework that caters for dependencies and feedback among elements in different or the same clusters (Saaty, 2005).

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10 Annexures

Annexure 1: Introductory Session Agenda

1. Introducing the researcher, the research problem
2. Addressing any contractual, conduct and ethical concerns
3. Discussion on the research process to be followed & dealing with any issues and concerns raised.
4. Introducing the research subject and its benefits for the research fraternity and participant organisation
5. Soliciting archival data as necessary
6. Discussion and confirmation of archival and publicly available data
7. Discussion of availability and agreement on timelines for the first phase of the research process (i.e. the one-on-one interview sessions).
8. Setting up of one-on-one interview sessions
9. Agreement on possible dates for the first AHP tool feedback session and possible dates for the first group strategy deliberation session
10. Agreement on team's liaison person "the go-to person" for clarifications and other informational requirements
11. Session Closure

Annexure 2: Unstructured Interview Questions

- What is your role in strategic decision making in the organisation?
- How do you typically make strategic decisions in the organisation?
- How do you appraise investment or high value operational projects?
- What are the risks and opportunities that climate change is presenting to the organisation?
- What are the drivers and motivations for addressing climate change in firm A?
- How is your industry (industry bodies and competitors) responding to these risks and opportunities?
- Where in your current business model have you addressed these risks and opportunities?
- What has been done and what have been the outcomes of theses with respect to mitigating and adapting to climate change?
- What, if any, would you change about the way the business is addressing climate change?

- What barriers and challenges have you encountered in trying to incorporate climate change into your business?
- How are you addressing these?
- Does the current strategy address the long-term sustainability of the business?

Annexure 3: Selected Interview Scripts

The key informants' transcripts, one from each of the companies are included below. The rest of the interview scripts are available on request

Annexure 3a: One of Tongaat Hulett's Interview Scripts

Date: 20 April 2012
Time: 09h00

Legend: ***M – Interviewer – Muriel Chinoda***
C - Interviewee 1
J – Interviewee 2

C: Lighting sensors installed in the building.
M: But this fluorescent that you still have in this office?
C: Still have fluorescent in the offices because it is still cheaper. We have 360 degree motion sensors.
M: But the TCO of ballast and LED lighting is cheaper than the fluorescent.
M: How did you decide to get involved in the Climate change response issues because I know TH is quite big in it? What were the drivers and motivations for you to get into this whole climate change issues? Which driver was for which initiative?
C: Can we start with Germiston?
J: Generally, as TH Starch, (we will start off with starch) maize is our prime raw material. Without maize we don't have a business. Over the years, with climatic cycles in SA and Southern Africa we would have periods of droughts affecting crop yield.
Once every 7 years we would have Lanino, Almino effect we would have poor yields; we would have to import maize to meet production needs. This was normal climate conditions before this era. It was a long time ago, in the 80s. The
The history of maize in SA was shortage and importing.
Then climate change came about and the droughts went away. We haven't imported maize since and we stopped importing maize in about 1983/84, except small quantities like in our operations next to Dobson in Cape Town. when it is economically we will import maize which is cheaper than our local maize.
C: The country as a whole has not gone out and imported maize due to drought drivers since 1983/84
M: Oh, how is that?
C: The country as a whole has not imported maize in years
J: So the natural cycles we experienced for the last 30-40 years cycles have been broken. The Elinino effect has not been experienced in terms of the maize crop yield.
But we are very aware that Climate conditions can affect the availability of maize in Southern Africa because of what has happened in the past. If the dramatic climate change which is predicted and continued increasing global temperatures, we can experience a shortage of maize in the future.
M: But they are saying the Western side of the country is getting drier while the Eastern side is getting wetter. Would that be the reason why you have experienced increased crop yields? You don't have any operations in the west?
C: Where Most of SA maize crop is mostly in the east side. But also the impact of the weather patterns or climate patterns is that one year we would have an abundance of water and the following year when we have dry seasons we would have a shortage of water.
I remember in 1984, I was in Durban and in that area the country was struggling with water. In terms of recycling from the factories.
There was a strategy within the country in the areas where there was drought they would recycle water.
M: Was this a local government initiative?

C : It was just a 1984 strategic initiative in the country.
I do remember also that, when we opened the taps we would get brown water, instead of proper water.
But what worried me is that, when you looked at organisations they also started coming up and putting strategies in terms of mitigating the shortages and loss of water, putting strategies of recycling.……
We are just talking around water sustainability.
But also for us as TH, we went through that phase
M: So is water still an issue for TH?
J: We are a large consumer of water in our processes in starch.
Our maize usage is in the order of 600k tons per annum.
C: 600k tonnes of maize and we use 2.4billion litres of water.
For every ton of maize, we use 4 cubic meters of water.
We are trying to find a town that uses that much water in a year. Which town in SA uses 2.4 billion litres of water per annum?
C: That might sound like a lot for us, But if you start looking at mining operations and start quantifying the amount of water they utilise, combined i.e. being sourced from the Municipalities and sourced from Underground.
And when you look at our country being a water-stricken country, we really have to come up with initiatives to really save the nation.
M: So what are the strategies? What are you doing to address this?
For TH operations, the standard in terms of water usage has been 4 tons of water per ton of maize, we have come up a lot of initiatives. Put through processes. Some mills are using far below this standard. Klipp – 2, Germiston – 3.6
We are not there yet, we will have to do more in terms of recycling, water treatment plants. If we are to have really quality, we have to invest in terms of effluent treatment plants.
M: So why have you not been fully involved in Recycling. Is it that it is not a priority or are there other factors at play? Those things are quite pricey.
C: It is a priority but the technology is still very expensive when you look at it from a payback perspective.
M: So are you waiting for other players to get in whilst you play wait-and-see?
C: One of the strategies is we got involved with the local Municipalities in KZN in terms of recycling with the view of a joint venture.
Because one of the things we are seeing is that (and I am saying this, the infrastructure in the country especially effluent treatment is going down because it has not been proactively maintained adequately. There are always issues on TV, and everywhere because they haven't been proactively maintained. There is shortage of technical skills, resources are not allocated appropriately and so on.
And each and every year we have calls coming from Municipalities (Please help us) but we have not progressed.
But we decided that we really have to work in terms of this JV, in terms of getting the capacity of the effluent plants to the levels where they are supposed to be.
We were prepared to pay for consultancy and other resources
We were going to supply them with the technical know-how because we have the skills and to partner with their engineers in order to do this properly.
But because effluent treatment, but it is not our core business, we asked them to recommend some consultants to assist with the study. We went through that process, but when it got to the crunch time that we are ready to kick off the project, we said now we are really prepared for this, we started getting a round around.
M: How far back was this?
C: Last year
M: Oh, it's very recent, I am sure they will come round.
C: In fact, we started this initiative 2 years ago, last year we started getting a run around. We had allocated funds for the study to be done and funds coming from the organisation for the organisation.
M: What do you think were the reasons for their cold feet, besides bureaucracy? Could it be that this is not a priority for them?
J: Difficult to understand.
C: We can't tell. It's difficult to understand. For us it is really a key priority. Because if you have to spent R100m just for one mill for an operation in Germiston, because that is where the effluent plant would have been located somewhere in the Rondebult area.

We spent R100m, we still pay taxes to the Municipality and we still pay for treatment for effluent
Where do you draw the line? Whose responsibility is it to treat water or effluent?
But for us, it was going to be sort of an advantage to spent the R100m because we would be putting less and less down into the Municipality effluent line.
But from a revenue perspective, the Municipality was going to lose out because we are contributing about 60-70% just on the effluent stream. If we put up our own plant, they end up losing on revenue where are they going to hit us next in terms of revenues?
For us, it is it would be one thing is we can put up the effluent plant because we would end up getting portable water.
M: Did you actually do a cost-benefit-analysis for you, not for the Municipality?
C: Yes, we did. But when you look at it and really look at it, it is not cost-effective for now. Putting up an effluent treatment plant for one to do portable water is big. Those plants are not small. They need quite a big footprint.
J: And perhaps methane recovery
C: The negative or the challenging part of it is that those plants utilise lots and lots of electricity.
So that is why for the technologies we looked at, is that you can go through and treat the effluent but for you to go to the next process to extract portable water you need Reverse osmosis processes which utilises tons of electricity. And let's not forget what happened 2-3 years ago, we had black-outs in the country.
M: If you are using electricity from Eskom, then it defeats the purpose of lowering the carbon emissions.
C: In fact the study is…., In fact we are going to be sharing lots of information with you on our journey.
If we were going to utilise Eskom electricity to try and generate electricity, I think the number we were looking at are around 2MW of electricity from effluent.
M: From an economic perspective, it does not sound like this specific initiative would have generated much value for the organisation. So what were the drivers and rationale for this project?
C: The directive from Eskom was for us as part of the Extensive Energy Users Group to cut electricity usage by 10% after the 2008 power cuts. If we had put up this plant we would end up requiring more and not less electricity from Eskom. The effluent plant was not part of the equipment list of our electricity baseline in 2008, which would have been a problem. These were some of the issues which we have to deal with.
M: Still this does not answer the question: If there were all these factors working against you, what was the motivation for the project, what was the drive for the project?
C: I might have to go back a little bit. The drive is about water treatment, for TH to save water. The second part is that if ever we are to be a much more sustainable organisation and a responsible corporate citizen we have to save water because we are in a water-stressed country and we have to do our part and make a contribution to that. So it is not only about effluent.
We will give a few examples in terms of what has been done in trying to reduce our carbon footprint.
M: This is one initiative actually. This is very impressive.
C: Our processes also consume energy; we have just spoken about water. They consume tons of energy in the form of coal, electricity
J: Gas as well
M: But I realise that you guys generate your own electricity down in the KZN, why don't you consume all of it. Because I realise that you sell some of this electricity onto the grid and yet you still buy electricity from Eskom.
C: Bureaucracy. These are some of the initiatives from a Tongaat perspective.
One of the initiatives as an organisation is for us to generate electricity. For us to be able to generate electricity we need streamlined policies coming from NERSA. If we are going to generate electricity, what are the policies in terms of agreements, how do we sell and deploy it?
M: You mean in terms of Power Purchase Agreements?
C: Yes, all those things. I am not going to be very detailed about that. I think we have made some progress, but those PPAs and policies must be very clear, because at the moment, those policies are in favour of and are there to protect ESKOM.
From a TH perspective we have the capability and we have the raw materials. But if we ever get to a point where prices and other nuances are agreed, there is massive potential of creating lots of green jobs. Very, green jobs, because we would be allocated land and we can plant tonnes and tonnes of sugar cane. The bagasse coming from that would be utilised to generate electricity and if there is ever excess sugar it can be converted to ethanol which can be blended for fuels which would replace certain parts of fuel oils.

So it's quite a massive project. This project has a potential not only focused on SA but also Southern Africa, the so-called SADC. That would have a massive impact in terms of reducing our carbon footprint.
We would also be able to influence the economic growth in the country as Tongaat.
M: Wow, is that what you are aiming for?
C: Our objective, first price would be to be able to reduce our carbon footprint. We cannot continue to be where we were 40 years ago. That we have abandoned, to live as if we have infinite resources. If as an organisation we don't purchase a single ton of electricity from Eskom, then we will have achieved something.
M: Really, it is refreshing to hear that. Most organisations are not really worried about it.
C: The constraints currently are around Eskom's monopoly, they are protecting their turf. But as an organisation that is where we are headed, if we are given resources from an electricity production and ethanol production point of view.
M: You are not producing ethanol at the moment, are you?
C: In Zimbabwe we are.
M: Is that for own use?
C: Both, own use but some of it is sold in the market.
That is why we are saying the potential
C: But not petroleum it's unfortunately for the alcohol market, but there is lots of potential. That is why we are saying if there is a strategy coming from the government to say by 2030 the blending capacity of the country in terms of ethanol and petrol is going to be XY we need to be quite ready for that. But 2030 is still too far.
M: It's too far, that's 18 years away.
C: We have this model working in other countries especially Brazil, where there is a certain percentage blending in terms of ethanol to petroleum products.
J: I think its high as 20%.
C: Yes. So the model is there. We are a country that has tonnes and tonnes of unskilled human capacity and we have learnt that is not being properly utilized. So if we really want to build the capacity and reduce the unemployment in the country, to increase the employment in the agricultural sector that would have an impact in terms of the economy, people earning X being able to contribute X into the economy.
But also around electricity, not only are we producing electricity using by-products of cane. Up here on the reef we have taken initiatives to reduce our carbon foot print by converting some plants that were using coal to gas. We will take you to one or two if you are interested.
M: That would be good. Where are you getting your gas from? Mozambique?
C: Yes, through Sasol
M: MTN is piping it directly from Mozambique.
C: But when you fly off Maputo up to Xinavane you are able to see the gas pipe. It's yellow in colour. Above ground, all the way into the country.
J: We were actually ready post 2008 to start generating part of our own electricity using Sasol gas and we put a bid in to Eskom but they really made it impossible for us to go ahead with that project. They wanted us to take all the risk and they would benefit the most. When we negotiated with Sasol they were really keen to let us utilize some of the allocation of our gas. Since we are a big user of steam, it was impossible for us to burn gas to produce steam and electricity.
M: And if you actually burn it to produce steam it's much better than actually getting all the way to electricity so if you use lots of steam it would be good for you.
Have you not taken part in the independent power production tenders and requests, instead of going to Eskom?
C: The right person to talk to is Nico Kruger
J: He is the former MD of STARCH**.**
C: He is now based in TONGAAT**.** We are working very closely with the IPP.
M: So you are actually doing lots of stuff!
C: In fact what we are giving you is much. He will be able to tell you the journey in terms of where we are and where we have been.
J: And where we want to go.
C: I will just give you an overview. But if it was up to us we wouldn't procure a single kilowatt. The guys would have proper agreements in terms of engaging to say even if we produce power right down that way, there is a term that they use;

M: Wheeling
C: Yah, Wheeling. If we produce electricity down in KZN and we are utilizing X kilowatts from Eskom then we can be able to say put in the grid and be able to net off.
Can we share some of the projects in terms of reducing our carbon foot print?
M: Yes
C: We were utilizing electrical boilers in our dryers**.** We converted those electrical boilers because it is highly inefficient for us to raise steam using electricity. In fact from a carbon footprint you are worse off.
M: Yes! Do electricity then come back to steam
C: But we have just spent 30 million Rands on putting coal boilers but they are an interim measure until we get gas allocation done in the Western Cape. We are aware that there has been talk of gas being available around 2018 then we will be able to convert those coal boilers to gas as well.
M: Do you actually measure how much of the carbon you actually reduce from those initiatives? I'm assuming you do.
J: Yes.
M: And there has been a reduction definitely?
C: There is no question about it but we will not share those numbers.
M: I don't necessarily need the numbers as long as there was a significant reduction.
J: We are participating in the CDP, Carbon Disclosure Project so we have to calculate for CDP all the CO2 emissions from the various sources.
M: And this is a scope 1 for you
J: Yah. We have a Sasol gas line going to our Germiston plant and we converted one boiler from coal to gas about ten years ago and that reduced our carbon footprint.
M: 10 years ago!
C: You get quite amazed where we have been.
M: Yes I am!
J: And we were used as a model by Sasol. They were bringing their customers to our site to show what can be done in terms of physically converting a coal burning boiler to gas. So we were like a prototype.
M: I'm interested in that. Here is one aspect of my research that I really need to understand. In terms of technology adoption, what is the process that you use? So you are saying you are being used by Sasol as a reference site. Can you tell me a bit more, what was the rational, the reasoning behind you actually doing that? How did you get to do that? There was no precedence; there was no one else you were copying. Where did you get your evaluation of the technologies from?
C: We are very selfish as an organization.
M: What do you mean by that?
C: I think our primary responsibility is to all stakeholders. Secondly, what we were aware after a lot of research was that gas boilers are much more cost effective and highly efficient in terms of producing steam. So the drive was around efficiency. But when you look at it in terms of running a coal boiler, you have to have maintenance in terms of all the mechanical issues and secondly in terms of the costs. When we did all the numbers, comparing that we have been using gas and also the uptime of gas.
C: Am I forgetting something?
J: Reliability.
C: Reliability yes and also the ease of response and the ease of starting the thing. Just like having a bus and a small car. Are you with me?
M: Yes, I like your analogy.
C: I mean, for us to travel from here to Zimbabwe utilizing a bus it takes much longer and it ends up spewing tons and tons of smoke. A car does a similar thing but it's more efficient.
M: So how did you know what technology to employ? How did you do your research in terms of just the technology that you were going to use?
J: We partnered with Sasol and suppliers of burners so we drew on the technology from Sasol I think.
C: We were contemplating adding more boilers because 10 years ago Germiston was also on the critical path in terms of supplying to the market. The boiler house was one area where finding ourselves that we were quite exposed.
M: Was it a bottle neck?

C: It had capacity but we were not able to produce enough steam. So one of the few things that we started looking at through researching and being in contact with different suppliers of boilers and some of our engineers then said why don't we look at gas boiler and then Sasol.
Sorry we are making it very, very simple.
M: No I understand. For me it's just what I need.
C: So we were very selfish in that.
M: And it still worked? But it's not really being selfish. It's realizing that there is a business issue and then in solving it you actually are taking care of the environmental stuff as well because those initiatives are easier to motivate because there is a need. Whereas if you just say we need to go green people might say but look at what it will do to the bottom line. So that becomes more difficult to justify.
In relation to the same thing, do you have other boilers in other operations where you are having similar issues or where you are still using coal and you could have switched to gas and you haven't.
C: We will be having it because availability of gas is an issue. The newest plant that we have is Klippriver, the gas pipe is about 9 Kms away, on the R59.
J: And Sasol was prepared to lay that gas line at one stage.
C: But over time I think their priorities also changed.
J: They want all the gas for themselves now.
M: So there isn't enough supply of gas?
J: Sure. They got some environmental issues in getting out the gas out of the sea.
M: Okay. So how are you working with Sasol and any other suppliers to try and ease the issue? Are you doing anything in that respect? Because you are saying the shortage is the limitation in this case.
C: The limitation is just the amount of gas that we have in the country. The major supplier as far as we know is Sasol. We have not really looked at that.
M: Egoli gas? They don't supply any?
C: Egoli must be getting their gas also from Sasol.
M: Is it? I thought they also have direct lines from Mozambique.
C: Maybe. I was not very impressed when I looked at their infrastructure.
M: It's very old and shabby.
J: The other issue with gas is that from 2014 the price of gas is going to come under the control of NERSA as well**.** We have some beneficial agreements with Sasol in terms of pricing. So what will happen with the price of gas there is some uncertainty as well.
M: How does the price of gas and electricity currently compare? I know you have said in terms of efficiency it's much better, and maintenance more cost effective. But the actual price of the gas versus electricity?
C: The price of electricity in the country is still the cheapest in the world. But for us to use gas to produce electricity doesn't make sense, under the current region, unless if you start getting your price per kilowatt going up to almost 180 or 200.
M: It probably won't be feasible any time soon. We are already complaining with 130?
C: So electricity is quite cheap. when we do projects converting stuff that use electricity going into gas, we have done that, we end up looking at, our driver was one; to try and reduce the 10% that we were given. We will give you one mill that has been able to do that from a usage point of view. 2008 this is where we were and now we are here having saved that 10%, taking out the electricity heaters.
J: We have a spray dryer and we had to pre heat the air to put into the spray dryer to dry one of our products and we had electrical heaters and we changed those into gas heaters.
M: Okay.
C: You asked a question about is it still cheaper to run electricity or gas for the boilers. You see the leg, when you look at those things you look at the maintenance aspect because when you have coal you have grates that must carry these things and I can tell you these things are not cheap.
M: No. it's bulky.
C: That's it! And also when you start looking at the motors that we have in terms of electricity and how much you pay per annum. So you can take through the life of a boiler how much you would have spent In terms of maintaining and at the end of it, it would be much better to go with gas. Also what you see as a benefit mostly is that when you want to start up your plant to produce stuff, with coal you have to get people to come through at about 3 o clock in the morning to start making fire for you to get the heat up and for us to produce steam using gas

is instant! So when you do all those calculations it's still much cheaper to go with gas. From an efficiency point of view, when you have a 20 tonne boiler, you get about 18 or 19 tonnes of steam, when you have a coal boiler because of efficiency issues you get about 14 or 15 tonnes. So you do the math.
M: Yes of course. It doesn't need brain science for that.
C: It might have been a long way to try and explain it.
M: Ok. I hear you. In terms of other energy efficiency initiatives in your plants what are you doing? Are you replacing old equipment or there is more energy efficient motors, etc?
J: We have been changing some of the technology operating and running our motors. We use variable speed drives (VSDs), so we are progressively going through our plants and going for the bigger drives and putting VSDs.
M: How do you decide which one to replace and at what point? At the end of its useful life, when you are thinking of asset replacement then you go for the energy efficient ones or you are just saying for this plant we are going energy efficient and then you are removing whatever is in there.
J: A bit of both. We are going through our plants looking at where we can get the benefit of the installations not waiting for the economic life to be finished.
M: Really?
J: Yes. And all new installations, the VSDs are standard and we are progressively going through. We have some major items of equipment that use a fluid coupling to assist with the starting. We have replaced those fluid couplings which are very inefficient with VSDs as well.
M: Really?
C: So we have just gone through a study where we saw opportunities that we could replace these things.
M: So you did a full audit and you said this one is not as efficient and stuff?
C: We are not where we supposed to be but we have started with the initiative and we have spent I don't know how much per mill.
M: I'm not so much interested in the numbers, it's the principle that I need to understand, how did you actually get to it and what was the major motivation or driver for that. Was it also just efficiency, saving or it's really this drive for green.
J: Both
C: It is both. You are right.
M: What came first, the chicken or the egg?
C: We are becoming more efficient. Instead of us using a bus to Zimbabwe with four people,
M: You would rather get into your Mercedes Benz?
C: Yes and have four people. So you are still on which came first?
C: I was really thinking about some of these initiatives. We have a technical agreement with a partner in the US and we start looking at their usage in terms of electricity, their usage in terms of water, and we start looking at where we are. But honestly, when we started the initiatives around changing and running highly efficient motors it was also because of the electrical crisis in 2008. So for us it was that and we also an opportunity for us to become green and efficient.
M: Tell me more about this technical partner; are they in the same field as you guys?
J: Same field.
M: So are you learning from them or you are exchanging?
J: Exchanging.
M: So you see some nice stuff that they have done and adopt and learn from it?
J: In the area of energy, the cost of energy in the US and Canada is very high so they have been busy with the drive to reduce costs and energy consumption for many years. We are far behind so we have never felt under the same pressure so there is room for learning from them.
M: Interesting. So did you actually look for them for learning on this or they were already your partner before?
J: No. They have been a partner because of a specific technology that we are using in wet milling and the energy thing was just a side effect but now it has become more prominent obviously, recently.
C: In fact, in the current study, we are focusing on energy; we are focusing on the best practices on other areas but for us to become more efficient. The world has become much more smaller. And when you deal with people like SAB they are not a South African organization, they are an international, so when they do comparisons they do comparisons in terms of what they can purchase in the US, versus South America, versus Canada, versus Europe and they start looking and doing the comparisons in terms of the very same products they supply in South Africa.

M: Is that the kind of technology evaluation that that you go through as well. Do you like go to reference sites all over the world and come up with the cheapest. How do you actually purchase the specific technologies once you decide? Okay, let's talk about the VSDs; so you realize there is an opportunity to replace this fluid coupling and other things with VSD, in terms of the evaluation of the technology that you are going to use, how did you go about the process?
C: We have been utilizing VSD but not really focusing on costs or the energy implication part. We have had standard VSDs and now we have advanced ones and that implies that we are now more comfortable in terms of that specific technology. When we were identifying areas where we can install VSDs, we know about technology, we know where we are sourcing these things, and for us to start assessing whether to use the ones from the US, or ones from South America would be hard.
M: Yah, that's what I needed to understand.
C: So from a servicing point of view, we already had suppliers.
M: So you have a technology that you are already familiar with, you are happy with it, you understand it, the learning curve has already incurred and you have the relationships with the suppliers, etc.
C: If we were starting from scratch then we were going to be doing all these evaluations, but as I'm thinking about it we may have missed some opportunities coming from different suppliers. Because when you have four or five different sites in the country you try to standardize.
M: It's easier I think. Maintenance and relationships, etc
C: Because if you are to get this coming from China, this coming from Europe, they don't talk to each other and when you want to do stuff it becomes difficult.
M: What are the initiatives in terms of Climate change response?
J: One opportunity that we as accompany identified is there is a product, a starch which was developed in the US, not by our technical partner, by another organization and it's a process which coverts the starch into a product which absorbs water and it can be used in agriculture. When put into the soil it retains moisture in the soil so the water does not run away into the ground water or evaporate. We have done some studies here in South Africa where crop yields have been increased in doing trials, for instance, tomatoes with this product on the ground, and adjacent to it, tomatoes without the product and dramatic differences. And we have gone to the point of designing a plant to produce this product here in South Africa. But we wanted to establish it in the market place first by importing it from the partner that we found in the US. We haven't quite got to the stage where we made a success of the marketing strategy but there is a huge potential.
M: I'm sure the farmers will love you for it.
C: Unfortunately it's not cheap to produce so it has become sort of a constraint.
M: Are you partnering with the department of agriculture?
C: It is one of the journeys that we have to take.
M: Oh yes, I suppose it is a journey.
J: There are competitive products in the market and you can actually get them in the nurseries but they are petroleum based.
M: So it defeats the purpose of the green thing.
J: And they are being used extensively in the forestry industry, so we are busy with the Journey as Charles said, but we have spent some money on the pre- engineering to get ready to build a plant for this but we are waiting for the marking side to be established.
M: Interesting actually.
C: We have an affluent plant in Meyerton. Instead of letting the flame burn like most affluent plants do, we utilize that heat to reduce the amount of steam and the other impact on trying to reduce our carbon footprint is through the process we end up**..** We have identified those areas as sources of energy that instead of that **…….**only leaving and going into the atmosphere to utilize the heat content of that **……** to reach certain extremes for us to reduce the amount of steam.
M: So what are you using? Coal generation?
C: Not yet. I will give you a simple analogy. Suppose this is your kettle and you have your fire which maybe your coal boiler or steam underneath. When you heat the kettle you end up producing and it goes into the atmosphere. What we have done is to say;
M: You are harvesting the heat in that?

C: Yes. Though we use this somewhere in the process in areas where we have heated something, instead of letting it flare we put a certain stream of the process to be able to get this energy that is being exposed to atmosphere.
M: And what are you using it for?
J: In the process.
M: Is it joining that there or it's going somewhere else?
C: You use steam and you produce this wrapper you take the wrapper now and put it there. Instead of two sources of steam, you end up only having one. Utilization of process wrappers to make your process to be much more energy efficient.
M: Yah that becomes much more efficient because you end up using much less.
C: So these are some of the initiatives that we are currently busy with and we will be doing that continuously.
M: Interesting. I'm so impressed. I have got something that I'm hoping when I'm done I will have filled in that whole framework there. As the topic says, ''Climate Change Response Framework", so I need to understand what sort of initiatives and things people are working on that's why I have been asking you a lot of questions on that. So for me I see climate change response as a journey and journey says I start here. You are a child, they get born, at six months they can sit, as they get better they can stand on their own, before long they can run and the next time they are in a marathon. That's how I take it. So this first level and this is a maturity model, as you get better in the first level you move to the next level, you start walking and then you start running. By the time you are right at the end where there is that green there it's like you are full steam. So that first level for me I call it raising awareness, you are beginning to understand what this climate change is all about, what is carbon emissions, etc and employees and people are getting to be aware of it. But it's still just at that level and there are organizations that are still at this level believe you me. Lots of them.
C: We deal with them.
M: I'm sure you do. Your suppliers and customers?
C: Yes. Both ends.
M: I'm going to ask you about that. Anyway, sometimes at this level people are still very resistant saying we don't believe in climate change, etc.
C: You know they call them sun cycles.
M: Oh that's a new terminology.
C: The sun goes through this when we had an ice age, and we read about these and these are very esteemed people. They come through and tell you that we are going through another cycle, for the mere fact that the temperature of the world is going up by example degrees. And they will tell you that the whole movement around climate change only started when human beings that had seen the pictures of our planet from space and when they looked at that versus other planets they said we should try and save this. This is how the whole climate change thing started.
M: Which is great because the advancement is for our benefit. Imagine if there was no one to go up there and they couldn't see that the Arctactic Ice thing is …
C: But some of those people can with certain theories be able to prove that earth in the millions of years that it has been in existence has gone through massive changes. When we had an ice age we didn't have so many human beings on earth pumping $C0_2$ but why did it happen? So those are some of the questions that we have to continue asking ourselves.
M: I always say most of us we are far from that kind of science. We are not climatologists and we don't understand the science behind it enough to be able to contribute intelligent debate on that aspect but if the UN and other reputable organizations have said there is something happening here, for me that's a starting point. Also, like you have been saying, you are wanting to save the environment but also it is making business sense, so why don't you do it?
C: The argument is that before the year 2000, we had the United Nations and every reputable organization talking about and even supporting the so called Y2K friendly and nothing happened. So some of these initiatives, when they talk about climate change are we not making other people rich? Are we not falling into the phenomenon of some MBA students who come up with an exceptional way of money in terms of carbon reduction because we end up spending tonnes and tonnes? But these are some of the views.
M: My argument always says why can't you be that person who is making the billions?
C: What about if you are on the receiving end and you have to spend money to make somebody to be rich?

M: We are spending money through and through and someone thought of this and they are making money out of it, etc.
C: But it was very interesting to read about it. We do see some of our customers and at times you get shocked as some are international organizations.
M: So the next level is adaptation and operational efficiency. And obviously I have heard lots of initiatives that you have actually done. So you talked about energy, you talked about water a whole lot and redesigning operations and stuff was about your VSDs, etc. Waste management, I suppose your waste is actually going to the biomass for heat generation. What are you doing in terms of waste and other material efficiencies? You spoke about starch and stuff but in terms of material efficiencies how are you making sure that whatever material you get the best output?
J: One of the prime efficiency measures that we have lived with and is part of our business is the yield. For every tonne of maize that we draw in we measure how much product we sell. It goes over a weigh bridge. That is the prime material efficiency and we are currently busy with the benchmarking process working with our partner to do a step change in that material efficiency.
M: Is that the US partner again?
J: Yes.
M: Travel, transportation? You guys carry a lot of stuff. Do you use your own transport or are you using a logistics company?
J: Different companies. Incoming and outgoing.
M: Are you working with those guys at all to make sure that in terms of your value chain these green initiatives are spreading?
C: Depack will be able to give you the details.
J: We are reporting Scope 3 Emissions but purely on business travel only at the moment. Where that has impact on carbon footprint, I think cost saving and just normal business sense. We try to limit the amount of business travel. We are very conscious of the costs associated with business travel.
C: I think also on waste management, I think we want to talk around the potential agreement with a waste management organization that would take our affluent, together with other sources and generate electricity out of it.
M: Is that something that's in the pipeline?
C: We are currently in discussions.
M: Ok. At the next level in terms of new products and new revenue steams? So most of your stuff here is abut efficiency, cost reduction, etc, at the other level how are you generating new revenues? The new product would be that starch?
J: Yes
C: The other one of which we are still miles and miles away from, we don't want to start things from scratch but in the US and Europe, companies have been able to design tyres that use our products.
J: For example Goodyear
M: So you could be selling and making a bit of money soon.
C: It's still a bit early but it has been done and it's a matter of getting into the technology usage, and not only tyres but also plastics.
J: Bio degradable plastics. But we are not involved in anything like that at this moment but it's potential.
M: You intend to and it's stuff that you are looking at so I totally understand. And you were talking about green jobs and stuff at this level, the last one there. And you were talking about the municipal JVs, it's about advocacy trying to push for this green, industry leadership, etc. Is that correct?
C: Yes.
M: Are you doing any carbon trading, are you participating in CDM projects, etc?
J: Yes we didn't initiate this prior to the project, but with the conversion of the coal fire boiler in Germiston mill to gas we have applied for carbon credits posts, VERs not CERs.
M: It depends on which country you have applied to, they call them Verified Emissions Certificates and Certified Emissions and etc, etc.
J: That's the only thing that I'm aware of, we are doing this Tongat Hullet Starch, and I'm not sure about Sugar.
M: Tell me a bit more about your Bagasse**,** the technology. I'm suspecting you have been doing that for years.
C. Yes.

M: Was it just a natural progression or something that naturally fitted into this because of the waste?
C: To be honest with you, we would be lying if we were to explain to you what happened. The people to talk to are guys that produce sugar and they can tell you what is the background to it. But it might have been also trying to be efficient instead of depending on coal to produce steam, because bagasse is, when you chew and leave that other stuff, so what do you do with it?
M: I'm not sure. Interesting.
This you can have a look at and use it I suppose its part of the benefits of agreeing to have his interview. So my next set of questions will probably be around here. You have already had lots of successes what things you have done differently or are you looking at doing differently based on all these initiatives in terms of maybe it didn't work too well and what were the learnings and key issues that you could take out of there.
C: I think in terms of the things that we could have done better, I think having proper partnerships with our municipalities. During apartheid days as business people we knew who to speak to in the council. In terms of moving from that time to the current, we don't have any relationships with people who are in the position of power. For us to be able to have quite a positive impact in terms of issues around climate change, those relationships must start, for example, people knowing each other, and proper networking. Because we can only be able to influence politicians when we are able to really have proper relationships.
M: But I realize you guys are part of NBI and BUSA, are you not?
C: Yes, but it's up there.
M: You mean grassroots here?
C: Yes. For people in Germiston to be able to know not only who they can talk to but that they can go and have a chat, and we take them to lunch or they take us to lunch, and have proper relationships that is currently missing. Also, when you have a bureaucracy, what Dr Khosa says is that they don't understand the needs of the 21st century, when you have bureaucrats that do not really understand and not exposed to business needs. At the same time we have a responsibility in terms of influencing and also for us to be able to understand what is their strategy, what are their drivers, what are they are trying to achieve so that we can be able to influence them. For us, for instance when we talk of the affluent project, we spoke around this starch based product, why don't we have a link in terms of someone that we can influence. So we need to form better relationships with government agencies. The partnerships are very crucial. As an organization as we partner with government agencies, for instance when we speak of generation of electricity using bagasse**,** creating employment, producing ethanol, those things can only be done when we have a government that is very streamline in their thinking in terms of what must be achieved from the strategic point of view. But when we are dealing with the department of agriculture on this issue, when you discuss that with the department of trade and industry, then you go to the energy department but there is no streamline of thinking then it becomes a big issue.
M: How are you utilizing your relationships with suppliers and customers in the whole climate change initiative?
C: We are still in the early stages. We just approved a document in terms of a green initiative in terms of our suppliers. We are starting to ask them what is their contribution in terms of climate change, what are the initiatives on that score lines, in terms of suppliers? As well, we are being asked the very same questions by companies by companies like Nestle, Craft and SAB in terms of our own initiatives so the climate change train is gaining momentum.
J: We have had customers asking what is the carbon foot print of our product?
M: They are asking that?
J: Yes. How much CO_2 is produced by us to produce one tonne of starch and luckily we have been able to answer that question quite easily because of CDP.
M: Do you guys export to Europe at all or not?
C: Not mostly no. in very small passes but mostly to Asia, to Africa.
J: That's Starch. Sugar I think from Mozambique to Europe.
M: Because in Europe they are really big in this in terms of saying give us the carbon contents of your product, what are the practices and all that and if you are not very green then it takes you a little more.
So you were saying one of the key things is about relationships with all areas of government that's something that could be done better. Another area that I wanted to ask was about in terms of the synergies of all the initiatives do you find that's there and you are actually harvesting on the synergies so you are doing you are doing your energy efficient, or your VSD project here and you are doing your gas thing. Are those things being married so that you

realize what the benefits could be? One plus one equals to three and not two, that kind of scenario. How are you doing that, merging the whole thing together?
C: At the end of it, when we do the benchmark study we look at energy cost, energy usage per tonne or product. So when you start doing initiatives like this one, when we say energy it means everything. And when those costs start really making sense and really coming down in terms of benchmarking purposes then it does mirror everything we do. Because of one of the things in terms of strategic objectives is that we would want to reduce the amount of energy we use which will have an impact in terms of carbon emissions per tonne or product, so most of these initiatives and the capital that we spend are driving towards that objective.
M: Is there a single office that's driving your environmental sustainability, climate change initiatives?
C: In fact, that's his office but it started on an efficiency drive and I can tell you that on a day to day basis we can tell you how much we are using of water, how much we are using of electricity, how much we are using of coal, everyday. Because we configured SAPF**,** 10 years ago at the back of us having a much more efficient process.
M: That's great! I am impressed.
J: To answer the question differently, I don't think we have a sustainability office. We have some individuals who are part of that portfolio and sustainability reporting is there but we haven't got a department for that.
C: It has become part and parcel of what we do. We have engineers, we have production managers and for us to be efficient, this is what we focus on.
M: You guys are quite far!
C: In fact what we found out ourselves, and we are not bragging, is that in some of the initiatives we are slightly ahead in terms of similar organizations exercises.
J: We had a stall at COP 17 and what we heard is that some companies visited our stall and when they heard what we as a company are doing they changed the placing of orders away from opposition to us.
C: And we didn't talk only of initiatives, we also spoke of the projects that had been done and the reduction of carbon emission from there to here.
M: And these are local companies?
J: International. And some of them attended the display and asked questions and we didn't know they were CEOs and major guys and afterwards communication came through because we were significantly ahead in some areas, there was some competitive advantage.
M: Of cause! That's really the thrust of my research to say if it makes business sense why are we not doing it. Of cause there is some that could be at a cost but quite a lot of the initiatives are good for you. For me that's what I call green marketing. So you displayed your stuff and these guys thought, I like green and they actually come. Now it terms of you taking the initiative to actually go out there and say hey we are actually green and doing some stuff, what are the initiatives? Hopefully Depaak or someone can give me information on that.
C: In fact, that was also discussed during our sustainability feedback from Vuyo, that some of the things that we have achieved and have done, we are going to start to put that into our sustainability report, and also that the report will be put on the internet, and if anyone is looking for Tongaat area on the internet they know these are the initiatives, this is what we are currently doing and this is where we are supposed to be.
M: I'll tell you one example that I like about green marketing that is such a success. Frito Lays those guys that makes chips, in California in the States, said, everyone is going green so why don't we try it. So they commissioned a pilot project, a small one. Here is what they did, you do know the parabolic trough, like the solar panel, but bigger. So if you take that and the sun is shining, the reflection gets concentrated so that's how they harvest the sun. Now these guys put in a pipe on the point where it's concentrated and that pipe is carrying oil for heating the chips and they called it Sun Chips**.** It's a big brand in the States. And in the United States they say they consume 6 billion worth of dollars of the dried chips. So they put it out on the market and guess who got to hear about it? Wal-Mart.
C: It makes sense.
M: Wal-Mart has got a very big drive in terms of having green suppliers, for them it's a very big deal, if you go on their website they have got a whole document that says as our supplier of ours you have to meet 1,2,3. So they saw these guys and said there is someone who is green went there and said can we have your product? And these guys sad yeah but it's only a pilot project. And they said no, we want more. So from a payback period of 5 years to 8 months and instead of a little pilot project they bought the whole land around there because Wal- mart is buying from only them and supplying the rest of Europe and everywhere with those sun chips.
C: It's a very exciting project. I understand what you are saying.

M: So sometimes we actually have some stuff that we have done, a whole lot but if we actually haven't shared it. If it wasn't for the COP 17 these guys would probably not have known about the stuff that you were referring to.
C: Could you when you have a chat with Vuyo, also mention that, because we could also gain a lot.
M: Lots of mileage, doing business as usual but you are actually getting mileage from it as well.
J: You are aware that we are not in retail at all.
M: I understand totally.
C: As well Jan, from when we look at Sugar it goes directly to retail and instead of people really choosing between Hullets and opposition, let me say Hullets is green;
M: It's not just about direct marketing to end users, the reason why I brought it up was you said some of your customers then came in said we want your product because you are green. Market it to those guys so whether its wholesalers or pharmacies where you are selling your starch, etc because some of them are really interested in that. So for me that's part of the synergies.
C: I'll be leaving you not long, so are there any more questions?
M: Ok. I was talking about what you would have done differently, the key lessons and what have been some of the challenges and issues?
C: Bureaucracy
M: Internally or externally?
C: Mostly externally but as government, for example the issues around IPPS.
M: Independent Power Producers.
J: Yes, And its government at different levels as well, local and central.
C: Maybe other constraints as well include availability of resources, technical skills within organizations, and resources from a capital point of view. Another crucial part has been availability of infrastructure and when we talk of infrastructure, pipeline, gas pipeline, if we assess ourselves against Europe, we are still very quite behind.
J: We have had to move away from using rail transport to road rail for incoming and outgoing logistics because of inefficiencies around rail transport.
M: Lots of people complain about that.
C: Also when you talk of the carbon foot print, it's much more cost effective and much greener for us to be using rail.
M: Yes, definitely.
C: When we do exports, for us to be taking trucks down all the way to Durban doesn't make sense, instead of using rail.
J: We are very concerned that if we do have a severe drought like we have had in the past and we have to import maize on a large scale, how are we going to get that maize from the ports.
C: In fact it is a real risk from a food security point of view. Do you know how may tonnes of maize do we eat in South Africa?
M: No, I'm not sure.
C: I think we eat for human consumption around 6 million tonnes of maize and 3 million tonnes is for animal feeding.
M: That's a lot hey.
C: So if we have to import 9 million or 10 million tonnes we will be stuck.
M: Awesome. Thank you so much, let me not take more of your time. I'll also need to talk to the other guys and I will probably come back to you because when I do the analysis then I will say that part is missing then I might just want to come back.
J: No problem.
C: I think you have our email addresses, so just drop some feed back.
M: I realize you guys are doing year end.
C: Yah it is coming to an end fortunately.
M: Thank you so much. It was such a pleasure. Thank you so much for taking your time, a whole two hours.
C: And also for you painting the picture. We learn everyday.

Annexure 3b: One of ATNS' Interview Scripts

Date: 01 June 2012
Time: 09h10

Legend: ***M – Interviewer – Muriel Chinoda***
E - Interviewee 1
B – Interviewee 2

M: Like I indicated in the letter the issue is in terms of climate change response there are so many options and things that companies can do. It's a multitude of things that people can pick from. But we have limited resources; we have limited capabilities and capacities so we can't do everything. So what tends to happen as with strategy is choice, you choose what you are going to concentrate on. So what I need to understand is; I know you have that document and stuff like that. What is making you choose or pick what you are doing, or maybe the first question is what is making you want to respond to climate change? Because I saw that it's one of the critical issues in your strategy document. What brought about that, why are you wanting to respond, why do you feel that you have to respond to climate change?
E: Why we need to respond to climate change?
M: Yes?
E: If you look at ATNS, Air Traffic and Navigation Services, we are a parastal or sate owned enterprise and the industry we are in is Air Navigation Provision and mostly our aim is to provide safety. We separate aircrafts and so on. So basically that is our work. Through that and because of what we are, we are state enterprise and safety is a big issue, we need to actually respond to organizations on which we affiliate to, one of them being the International Civil Aviation Organization (ICAO). So ICAO is like the mother body of all civil aviations organizations in the world and they have come up with a request to say every air navigation provider, or should I say every civil aviation organization, not only air navigation providers but it could be airlines, it could be civil aviation authorities, etc. All should respond to this issue of climate change. Just for your information, our industry, aviation sector I think provides about 2% of carbon emissions in the world. Just for you interest's sake Muriel, measurements can be done per country, but with aviation they have been put separate and we are everywhere. So that 2% is not only for SA, it's actually across the globe. So there was a request from the mother body going to ICAO saying what are you going to do about that 2% and so on? And so ICAO has come up with CAEP.
B: Civil Aviation Environmental Protection
E: So that's a document that has been promulgated by ICAO to all its departments to say how do you actually respond to the issues of climate change and so on. So that is actually number one and then on number two maybe Brenda you can come in also on the national level we need to respond.
B: We need to respond to the national calls for climate change cultural behaviors in terms of the carbon tax that is proposed for next year 2013, the waste act as well as the national green and white papers, also because of the COP 17 that was hosted in this country. So it brought a high level of awareness around those issues which all government entities are expected to also respond to and up keep that momentum from the COP 17. You can't just have that awareness and host and then let it die off. You have to keep it raining. So that's another call. And also as part of ATNS being a global citizen, just being a company and being a responsible citizen we also want to get involved because of those reasons.
E: And to also add on to what Brenda is saying, we also affiliate to the Department of Transport. The department of transport is our shareholder. So there is DOT which is the shareholder, the minister, and then there is ATNS, ACSA, CAA, and other organizations. So if you look at the DOT strategy or let's say the DOT's KPIs (Strategic outcomes); one of the outcomes
B: Is reducing the aviation emissions so we all contribute as those entities or agencies to that strategic outcome.
M: So did you get a specific mandate from them to say you have to do this or when you report back to us we expect to see some stuff there.
E: Absolutely!
B: We got KPIs to environmental protection; it's for all the aviation entities and the KPIs reducing your aviation emissions and then because we are different agencies we all have our different measurements of how we do that. But overall it contributes to the larger DOT outcome for that particular strategic outcome.
E: So in a nutshell it's internal, it's national, it's departmental response.

M: Well, that explains it.
E: By the way we are like twins; we talk about the same thing.
B: So that's from the expectation level but like I said it's a global in thing, I don't have a better word for that. So we would like to actually also get involved and see ourselves contributing on that scale.
M: When you say we, who is really driving this from internally. Is there someone that's like an enthusiast, we really have to do green, or I'm a green person and I believe as an entity we should be green?
E: Interestingly, I think Muriel you were involved on the 11th May 2011 when we went out for our strategy session if you remember at Birchwood.
M: I was still new, I had just come in.
E: One of the objectives which came out of the strategy was to have this climate change and sustainability. So it was actually birthed through the ATNS strategy and it came on into ATNS and currently it's sitting in the CEO's office. So it is the CEO's project. The CEO is actually the sponsor and in response to what the CEO wants us to do now from the operational level, we have formed a steering committee which I'm sure you have met, it consists of some of the executives and some key interesting people, we have formed a project team which is led by Brenda and so this how it is actually running. So it came from the strategy though the CEO and now it's cascading down the entire organization.
M: Interesting. Now let's talk about the things you have done, the things you are planning to do and why you are picking those specific ones.
B: To be honest with you, it's something that's so new to me at least. I have seen the environmental affairs but being at a distance so now it's close to my heart. But being a new concept and all there is a lot of research that needs to be done. A lot of ground work about understanding what exactly we are trying to do and why we are doing it and who is doing what so that you can affiliate with those projects and understand the global reason why we are doing it. So a lot of the work that has been done now is getting to understand everything about climate change, everything about the environmental impact of our business, everything about the human or our involvement as people who have lived a certain way and now we have to do a lot of change management to do things differently. So there is a lot of that research going on to actually getting the ground work and the foundation about why we are doing this and what we can learn from other people who have done that.
M: Is there some one specifically in your project team that's working on that?
B: Yes, mostly me. Remember I have to lead everybody. To be honest with you everybody is still very much not reluctant, it's a change because I think this type of thing is not of those things you tell people to do and you do and then you do something else. You actually have to do your own personal change, you have to even adjust your own life style and live that green concept, in the office, at work, at home, everywhere.
M: So what are some of the things that you are actually doing in terms of that change and the lifestyle?
B: Some of the things I have become more aware of even little things like stationery in the office, power in the office, witching off, trying to live that so that I can understand and then you are able to drive people that way because you lead by example not just telling them ok let's do a project and everyone follows but actually in your normal life you are still doing everything that is anti-climate change. So I am trying to find those little things that you can adopt on a daily basis that you can also influence other people to adopt so that it makes the change easier.
E: It's true it's like it's a lifestyle. I was discussing with Brenda this week or last week, whereby our industry, like I have indicated it's all about safety, it's all about separating aircraft. But you'll be amazed how much things we are doing unknowingly or indirectly which affect the environmental issues and so on. We want aircraft to fly quicker, thus saving carbon emission for example. We want aircraft to fly at certain levels and so on. So all those things bring in the issue of environmental and sustainability issues so one of the things we were discussing with Brenda is to help all the people in all the departments to actually be able to relate what they are doing in their work environment to environmental issues. We had a good example of our good friend who came in one time. We invited him on an environmental project team meeting and he came in like Brenda is saying, people drag themselves, what is this all about, we are all busy and what is this new is this new initiative you are actually bringing in? But having sat there and then talking to him afterwards, he was able now to come to contribute to say actually I'm already doing these things. Now he was actually able now to get this topic and be able to put it in his own job profile. And because of that we could see that interest starting to come in. So it's that buying in which Brenda and I need actually to do.
B: We almost have to sell it to people to say it's not the greeny beany stuff where you just recycle and that's it, it's more that.

E: It needs to make a meaning to them. For me to abide to that it has to mean something to me.
M: Yes, to me personally.
E: Absolutely. And that's actually one work and Brenda you are suggesting to have a workshop where we could sit down and maybe bring all this, sensitize the environment into that.
M: I was actually going to ask what have you done in terms of creating that awareness to the organization not just your team but the rest of the ATNS organization. What have you done, what are you planning?
B: What we are planning to do and what we are going to be having shortly is to get our carbon footprint profile and then out of that start raising the awareness using those stats, because even now we don't know remember. We want to calculate it and get it in the open and then show people what is here. And then say this is what we are working towards so that at least we are looking at some quick winds with what you are going to be doing. Because currently we can't even say we are doing anything because we don't even know ourselves. Our carbon footprint has never been calculated. We don't even know where we at actually to be honest. We have to first see what we have in the organization to be able to work towards a certain goal. So once that calculation has been completed then we will bring that awareness to say look at what we have got. Are we good are we bad? This is what we need to do to get to a better stage.
E: That's correct. Like Brenda says we still need also to understand. This is actually a new concept altogether for all of us. We are on the learning phase and this is why we need people like yourselves and the other people, the expertise to help us, to conscientise us and to lead us in the right way and I think if you ask us where are we at the stage of awareness, like Brenda says we are at the level of trying to collect all the information internally and externally and then actually take it further.
M: Let's talk about the civil aviation environmental protection document,
E: The CAEP.
M: And you said it talks about how you respond and you also get from ICAO that every civil aviation agency or body should be doing something. What are some of the things that they are saying you should be doing and of those what are you going to do, what are you going to pick from that?
B: A lot of them are very operational. As ATNS we are an ASP. Most Asps around the world are actually fused in an SAP civil aviation as well as airport authorities as one. So what they talk about, there is a fusion of all those three. So a lot of the issues are operational, about reducing your aviation emissions using operational efficiency, so there is ATM efficiency, mechanisms, and there is that calculation of your carbon footprint. There are a lot of other programs that involve in the environmental protection per say. So the CAEP work group from CAEP sets those targets for the different states and says you are working towards these targets and you are working to implementing these programs within your states and then report it back. So then as South Africa we will the come together with the other three agencies and in fact they are going to start that initiative, the civil aviation. We will then talk about the programs that we each have to contribute to the larger state program. One person will then take that to the CAEP to say our state responds in this way, these are the programs we have implemented, etc.
M: Who are the other SA agencies that you are going to collaborate with?
B: CAA and ACSA.
M: And ACSA ok.
B: So you have to then respond from a national level back to CAEP in that work group, to say this is what we have done, these are the programs we have, these are the levels or targets we have reached or surpassed based on the initiatives and activities that are happening and you keep going and as you get better your targets get stronger as well.
M: What happens if you miss the targets or if you choose not to do anything about that directive?
E: At the present moment I think there are no repercussions but we can foresee that should actually come in. I think even in aviation industry everything is still in infancy. There is one committee which I want to bring in while we are talking about the initiatives we have done. You know ICAO is also responding from the United Nations. So we have got the United Nations. And then ICAO is like the mother body for United Nations dealing with aviation matters. Then underneath that because civil aviation is quiet a big industry you may find that there is airport related, they have got their own mother body. We have got the airline industry they have got their own mother body called IATA (International Air Transport Association) and then us the ANSP's we have got an organization called CANSO. Help me again with CANSO I normally miss it.
B: Civil Aviation Navigation Services Organization.

E: So you see the way that I have drawn it here, there is the mother body's CANSO and that's where we belong. Then AITA is for the airlines and then there is also one for airports like ACSA and so on. One of the initiatives which CANSO has promulgated is a project which is known as INSPIRE, Indian whatever, I'm sure you will see in it the documentation somewhere there.
M: I have just seen it in your environmental plan but I'm not sure what it means.
E: This INSPIRE is actually an initiative or project which came from CANSO of which at the present moment ATNS Australia and UAE (United Arab Emirates) have actually been involved fully. It is actually about measuring carbon emission where we work together with this organization, together with the airlines and then actually be able to measure the carbon emission.
B: So with each fuel saving you make as an airline because of reduced navigations operations and rerouting procedures that you get, you save fuel and in that saving of fuel then you are contributing to your carbon emissions.
E: I actually foresee that in the near future CANSO could say we would request every ANSPs to achieve maybe so many inspired programs in a particular way. I'm just thinking of that measurement or policing in the near future. Now they are run as initiatives but one time greater issues will come in from CANSO.
B: It's still in its infancy and they are not trying to bog down on compliance so much and I think it's also the change management. So they let you buy into it, let it get in your blood, in your culture. Once you all have it and you are doing it then you will have two or three compliance issues a year which will contribute to the targets that they want to achieve by 2020.
M: Oh your target is 2020?
E: Yes.
M: Let's talk some more about what you are doing, what you are planning to do.
B: Once we get our carbon footprint, going on we are planning to have basic road shows about what carbon footprint calculation or measurement is so that we can also start people somewhere. We don't also want to say, "You will save electricity, etc". We don't want to be preachy about it. We want people to adopt the lifestyle so we are planning to have road shows; we are planning to have competitions relating to the green environment. We have got one that's going to be going on. Now we are designing a green logo for the company that we can use each time we communicate about the issue. We actually have three that we have already submitted. We are waiting for the marketing department to agree on one that we can use internally and externally for the communication. We are also planning to have a communication plan for the ATNS initiative as well as the operational initiatives like INSPIRE that can be taken across the world and obviously that communication plan will also go to CANSO for approval with the other operational initiatives that we are planning in the house. So those are the activities that we have planned so far.
M: Why are you so fired up about wanting to communicate, what's the drive behind you wanting to communicate especially externally?
B: Besides positioning the brand ATNS just as an ASP we want infuse the element because we want to be the leader in this issue in South Africa and be the champions of it throughout the whole continent. That's why we want to have a communication plan that includes quick wins and initiatives that we have achieved internally as well as the ones we have achieved for the industry not just for ATNS but for the aviation community as well. So external communication is going to be key so that we can push those achievements. It's like INSPIRE, INSPIRE was well communicated but we want now to go wild with it and just throw it out there.
E: If you look at ATNS, unlike other NSP in the continent, I think we also got a lot of foot print in the continent.
M: How much is your foot print in the continent?
E: When I talk about foot print I mean where we have been. If you look at 55 countries now with south Sudan, I think ATNS has been in almost over 90% of those countries. We have there providing training and other services, aeronautic information services. We have done quite a lot in the continent. I think there is a map which I can show you if you are interested.
M: Yes, that would be good.
E: What's our vision Brenda? To be the?
B: Sole provider of air traffic and navigation services.
E: In other words we want to be the preferred supplier. We want to be the number one in Africa and the surrounding region. That has been our vision statement since 1993 and doesn't actually change much.
M: Really?

E: And this is why I'm coming from business development and I like I said we have covered almost 90%. Probably the only countries we haven't covered are the French speaking countries, but the majority of the countries we have actually covered.
Coming to Brenda's point, we want that communication medium to reach all those. We want to be the leaders, just like our vision to be the number one, the preferred supplier. So even in the issues of climate change, sustainability, I think we want ATNS to take that leading role, not in a boastful way but in a win win kind of situation. We don't want Africa to be lagging when we see the rest of the continents are far ahead and this is why ATNS felt that let's embrace this and drive the rest of our brothers and sisters in the ANSP's so that we can flow at the same level as the other ANSPs in other continents as well.
B: Because other continents are far ahead, way ahead and we are still behind. I think also of our own political issues. A lot of counties are dealing with environmental degradation themselves and to even do aviation environmental protection is another level. They first have to deal with that degradation before they can even think about protecting the environment.
E: Absolutely. Having travelled across the continent, the continent has got its own priorities. It could be that hospital and so on.
M: Poverty alleviation, water.
E: But just like we were saying internally to say only after attending Brenda's session they realized that actually environmental issues are living with us. Even a person living in Khayelitsha or another rural area needs water to live. To people this concept of environmental issues means we have to pump in more resources not knowing that this is already living amongst us in on way or another. So this is actually the message through the communication that Brenda is talking about that we go out and say, in fact when an air traffic controller is trying to talk about the red carpet;
M: I don't know what that is.
E: These are the terminologies that we use to separate aircraft or to provide services in a more expeditious, efficient way.
M: So the guys who get fast quick services, they are red carpet guys?
E: Not knowing that by doing that they are actually making that guy to reach quicker and in that line also saving fuel. So this is the kind of communication we would actually come up with to say you don't need to have a separate department with so much to pump in so much resources. It's already amongst us. We just need to be aware of it. This is why for me communication is very prime.
M: Do you see actually the communication or branding especially in Africa creating more business for you or you want to be just the leader; you are doing the right thing for Africa, you are taking Africa along?
B: I think for me, business is at another level. We a national entity. Of course our priorities are to the regulated market first but obviously we have other plans to be in a non-regulated part. But global citizenship is more than business, even more about the property. If you can leave a legacy for ATNS, whether it brings in money or not. If you can just leave that legacy to say we had a huge amount of influence on our continent in making sure that we contributed to the climate change initiatives. That would even be better than getting money in for me, because it's a legacy and no one will take it away from you. But as profits come and go people don't even remember that in 2008 you made a profit. But somebody will always remember that they have this plantation of trees, they have environmental protection in their country, they contributed in this way because ATNS was a partner, because ATNS helped out. That stays, they can never forget it.
E: Absolutely. And that's actually very true. Sharing my experience from the business development side, business when you are dealing within the continent is more relational. It's about relationships. You cannot just go out and sell a product or a service. It's more about win win; it's more about relationships and so on. And something that we have benefitted more than just business in that sense is actually relationships with other ANSPs. Now we know that if we need something we know where to go or if they need something they know there is ATNS who can help. So it's more relationship than marketing or business in that sense and also coming from the old school Thabo Mbeki's African Renaissance whereby it's said African solutions, for African problems by African people and it's also related to sustainability. You would find that Europe will come and bring in systems and equipment into the continent. They just dump it and off they go. They don't understand the environment. They maybe in Europe and they don't get affected with lightning like we actually get affected here. So something which we are saying is let we Africans; we know our environment, we understand it, and we know the catches and so on. Let's come up with our

own initiatives which we will be able to sustain. That's actually the message when we say get going out into the world.
M: I like that.
B: We also have to change the perception. South Africa has been seen as the stuck up sister down there because we are so fortunate with infrastructure and everything. I think we need to start driving towards changing that perception that we can actually assist in more than just coming in and take. I think people are trying to be aggressive now saying Africa is an opportunity and they are just trying to come in. but we should really take in another angle to say why can't we just donate where we can and help out, provide the skills, even for free. So it's also those perceptions we need to give people another angle that they didn't expect.
E: Absolutely, this is why you may see that in some of the initiatives that ATNS take; we work together in this region with SADC, the Southern African Development Corporation.
M: You are actually working with SADC?
E: We are working with SADC. I will give you an example of one big initiative which is known as the UASCC, the Upper Air Space Control Centre, where in Southern Africa we have one control centre and with that the message we are trying to send is that let's work together as a region. Not ATNS or not Namibia Civil Aviation doing that but we are working together as a team. So in the near future you will see that aviation will be done at a more regional level.
M: And you guys are actually championing this climate change response and all this at a regional level?
E: Yes at a regional level.
M: That's very good.
E: And also technologies are driving us to that.
M: I was going to ask about technologies.
E: Coming from the engineering side you will find that the old technology which we used to use was more national. For instance I would go out and buy what is called an instrument landing system. I will put it at a particular airport to help the aircraft to land at the centre or to navigate at the centre of the runway. But now the new technology is more regional or even continental. For example, instead of putting that instrument at the airport we have got what is known as the satellite system, GNSS (Global Navigation Satellite System). Once that is put say in this region, it will cover all the 15, 16 SADC countries. So even the technology itself is forcing us to work together in the region and that's why most of our effort like the GNSS, the UASCC, and the AFICAD as well, everything now we are trying to put it in more regional basis than independent countries.
M: And it cut costs for you as well.
E: It cut costs and you think about the way we are in this region like South Africa. Look at our neighboring countries Lesotho, Swaziland. You may find that some of the technologies which may be sitting here will in fact be also be used to control aircrafts which are flying within the Lesotho or Swaziland airspace and so on. So we are saying why reinvent the wheel? So Swaziland can channel that resource somewhere else because this resource is there, we are using it as a region.
B: I think we cannot ignore collaboration. Whoever tries to go their way, they will come back to that spot. So I think it's better to get accustomed to it now and in fact rationalize yourself to even enjoy it. It's difficult but you need to do it.
M: Like you said it's a mindset shift, it's change management, understanding that that's how business is going to work because that's how business is structured.
B: Even the world resources themselves are shrinking and we don't want to look into scarcity, no, but we must be realistic that now it's better to just do one instead of having a thousand to preserve those resources.
E: Just like in any family, not everyone could be on the same level. One success story I can give as an example is our V Sat. You have heard about the V Sat.
M: Tell us about it.
E: V Sat is a satellite communication system which initially we thought that it would help us because geographically speaking South Africa is right at the bottom. But later on it has up now to be the best communication system in the continent. Almost everybody now is using V Sat to communicate information from one airport to the other airport and so on. It's actually a success story to me.
M: Interesting.

E: And Brenda thinking about all these things, I think these are the things that you and I need to start putting up and start thinking about how they impact in terms of sustainability, in terms of climate. I'm just thinking about what V Sat has actually done.
M: Tell me more about that.
B: It's a whole program, like we said it's a lifestyle. My aim now is to keep pacing this, and not start and stop, start and stop. You need to run with this because it's actually so exciting. It's actually amazing once you get to know it.
M: Interesting. In terms of operationally, what are some of the things that you are working on, energy efficiency, changing some of your technologies to be more efficient?
E: You are talking outside our operational business or within operational?
M: Anything. Operational business within operations, facilities, your offices, anything.
B: What we have within this carbon foot print calculation is that we are going to have the carbon footprint measurement as well as the energy audit. In the energy audit we are going to be looking at all our assets.
M: By assets you mean?
B: Every single CAPEX item that we have that we use for these communication systems. We are looking at vehicles. We are looking at all the company assets that use energy to see how much each asset is using. And in planning for the future using the ATN road map, how can we put efficient assets that are going to drive us to saving even though they are still delivering on the mandate. The most important thing is planning those assets in a way that doesn't deplete resources and eat away at using so much energy. We must now plan better because we are running ….Cycle and in that …cycle we put a new infrastructure in place.
M: How often do you replace your assets?
B: It depends. Most of the assets have a 15 year life cycle but we are looking at this plan and what we are going to get out of this measurement is we have a research and development department now to go back to the research and development guys who can look at the industry requirements, look at the environmental impact and the start putting in intelligence into their buying or their sourcing in the future. Not just buying because here it is, that's what you need. But now looking at what type of environmental impact will this particular asset have for our footprint, for our footprint as ATNS, nationally and globally as well. So that when you even take that to the shareholder and to the community who is probably asking for this we can put that environmentally. But at least you have thought about it, you have done the assessment other than just ignoring it. But everyday you have a target to reduce your emissions but there they are eating away at your target every day. So we are hoping that type of intelligence will help R&D to plan better.
M: I like that type of intelligence, the kind of methodology that you are actually following to doing it.
B: And also because we are in Africa leading ANSP we now also work to influence suppliers and the makers of the assets to also think environmentally because probably they are not right now. They are just making for you to put the equipment in place. But then not thinking about the environment. But if you are the buyers you go back to them and you start drawing the specifications that you want and you are able to influence future developments of those assets.
M: Who are your key suppliers of equipment?
E: Just for your information our technology is divided into three, which is communications, navigations and surveillance. That's the radar.
Communications we have got people like the ND Sat Comm**.** These are the people who provided the V Sat to us. And like Brenda says we have got the French company known as Talis
B: The mighty Talis.
E: Brenda says it's the mighty Talis is because you see them appearing also in our navigation equipment.
B: You see I'm not making it up.
E: So you can see their mightiness!
M: Are they holding you to ransom or something? Suppliers do that sometimes. They have such bargaining power because they know supposing they pull out you guys are in trouble. Suppliers and customers do that.
E: They have really worked hard in that territory. We are bound.
M: So you are stuck with them?
B: I think most people are stuck with **Talis.**
E: That's right. You see this is where leadership comes in. Like Brenda says you find that people want to buy surveillance equipment, the first thing they say is who are the leaders? It's ATNS. What did they buy? And don't

forget like Brenda says that you may find that the life span of most of the equipment is 15 years which means that you have got a mileage now of 15 years.
M: And because you have this, if this expires 10 years to go but you still have that it becomes very difficult to do the integration if you buy something different.
E: Absolutely. It's interlinked so its something which we got for a long time and their services on the positive side are brilliant.
B: Now we have to stat now and say are they environmentally friendly? We need even to impact to the design, to say instead of this using electricity why can't you use solar.
E: Just like we want you to install a navigation system with a solar panel, issues like that. We don't want to see this kind of lighting in your systems, use this. So all these things I think we need to actually start impacting. This is actually huge Brenda, and then you and I can comprehend.
B: It's huge! That's why you have to take baby steps. People think it's a quick thing you just go in and say," you people, let's save electricity!" No expand across. It's huge.
E: This is not just your interview; Brenda and I are doing an introspection.
M: It's also good for you.
B: we are starting to comprehend this giant.
E: This mammoth task ahead of us.
M: I'm doing two companies; it's a comparative study so I want to understand what is driving you versus the other company. When we went through the session there were also two guys, the MD for the business and his deputy. So when we were talking they said, "Actually, maybe we need to think more about these things!"
B: That's what I keep telling people. They come up and say where are we with this thing? And I say relax. you have to research these things, you just cat come in and pretend it's another document you will read and finish and say now I'm ready to implement. You need to do absolute great planning across the organization and make sure you don't leave anything out and make sure that you got everything covered and you are doing it right. If you want to walk in and do it compliance way, people are going to say, got you!
M: That's true because are still worried about their money and you cant just waste it.
So in terms of influence you have talked about your suppliers, are you having issues with your customers which would be the airlines I'm assuming, actually asking you to be green, asking you to do stuff or asking to collaborate with you or stuff like that?
B: Luckily because it's such a new concept everybody is on the foundation things, some people are slower, they are going to be doing things because of the tax trading scheme, the emissions trading scheme. They are only going to comply even though they are still fighting it. So you don't even really want to do that.
But from a fuel saving point of view they have got procedures in place; performance based navigation; they are buying aircrafts that are fuel efficient as well. So we are helping them with those procedures and re-routing procedures to happen. But there hasn't been really activism that says ATNS help us with this, do this. In fact it's good that we are now taking the initiative to lead that activism and pull them along and say this is what we are doing, INSPIRE this is where you come in, ACSA this is where you come in, CAA this is where you come in, GA, General Aviation rather than them wiggling something, expecting things from us. But luckily like I said everyone is still trying to find their feet and so they don't really have programs in place. But if we can push ahead and take that lead that would be great
E: That's right. Interestingly Brenda, when we attended that user consultation with ACSA, it was so interesting. We are now, like Brenda says, putting up our permission plan which is our business case for the next five years. ACSA is also doing the same so we just went to see what is going on there, because the same customers, the airlines also affect ACSA and us. And one of the questions as they were presenting their CAPEX budgets is have you taken into consideration environmental issues.
M: Who was asking that?
E: It's the airlines, the customer. So that question is going to come to us because in the next few months or so we will be engaging the users on want we want to do for the next 5 years going forward.
B: Luckily we have those initiatives in place.
E: So as we are working through our permission plan I think we have to be cognizant of that because questions are already asked. For instance, ACSA was talking about putting all this infrastructure , when an aircraft comes it lands on the runway and then it goes on a tax way. And we are asking is there a better way of you can do it now with these environmental issues that are coming in?

M: I find it irritating, you land there and you are standing and then you go so slowly.
E: And remember fuel is burning.
B: And a lot of the accidents happen when actually taxing, not air borne.
M: Really?
E: So they want the land immediately there. So ACSA provided this 20 year plan on how ORT and other airports are actually going to happen. They were able to explain to say to do this we are going to expand, there will be a separate domestic launch, and there will be a separate international launch. So there won't be any holding on and all those things.
What I'm trying to say is our customers are already aware. They are actually asking that question. They maybe asking that question indirectly in order for them to save fuel or to save money, but it's an environmental issue.
B: Because remember which are assets. For me the assets are the biggest passport. This is the infrastructure we want to put in place and equipment and the maintenance of that takes a lot of money. It's not just putting it in and installing and commissioning it. The maintenance because of your energy usage is what's taking up the money. So if we can show them that yes we put this equipment but these are the mitigating things we have put in place to save you money. To save us energy and indirectly save you money. But you have to show them that and how you came to that conclusion and how you came to those initiatives that you are going to use on the equipment. You just cant say I'm doing it, implementation is the most important thing and for you to do it you need to calculate first and see how much you are using.
E: So all these things need to be looked at. Another issue apart from carbon could be the noise as well.
B: And the air quality.
E: All those things need to be addressed. The customers are actually asking to say how are we going to do that when we are putting up all this huge CAPEX?
M: Very interesting.
B: You want to join us?
M: No. Definitely no.
B: Come on Muriel you can't be scared now; I don't know you to be like that.
M: You have obviously seen this from the DPI thing and stuff like that; it's the same one that I'm using as I 'm developing it from the Doctoral studies and then adding stuff and changing things. So like I was asking in terms of your operations what are you doing? For example are you doing something in this respect? Green IT?
B: No. I'm doing a research on green IT strategic planning but obviously I'm not a CIO per say to document anything.
M: But then I'm assuming you have to be working with the CIO to be able to do that. But you haven't started doing anything on that?
B: No.
M: In terms of your own travel you guys have been all over the world in 20 days. Your business travel and transportation. What's happening there?
E: Are you talking about ourselves as individuals?
M: As ATNS. Dumi flying to Europe and back and every where.
E: Interestingly there is an initiative which Brenda and I and some guys from marketing and communication have actually embarked on. Maybe just elude on that.
B: Regarding conferences, meetings, workshops overseas, what we are trying to do is that in a year we want to, not limit per say. We want to choose and prioritize the conferences and workshops that we really need to attend as part of the global community.
M: Why do you really want to pick? What's driving that?
B: Instead of having a hundred where people are just going, but you don't know what they are doing there, whether they are bringing back intelligence into the company or it's just for their own. You don't even get any sense of collaboration in saying this is what I did, I got the report, and you got the report. You find that I go to anther conference of similar presentation just in the east you just went in the west, but there is no fusion of that infusion of that information into one. So what did we learn, what can this help us with the planning, do we need to go to the next one? Or you find that Ernest goes but he comes back with the information and he sits on it. In the next week somebody comes in says you are supposed to be doing this, and you don't know that, but you were represented at that meeting. Why we you not told? Things like that number one.

Number two we also have carbon emission calculator. You put your flight miles and the you are able to say in total to reduce this, this is what we used to have, also for your balance sheet obviously you know how much you spend on travelling. You work that in tandem with the calculator and say now you are working towards targets and say we are going to reduce it by this much and obviously you are going to see a saving in terms of profit.
So we are going to choose external stakeholders that we want to affiliate with every year and choose the people who are going to be represented and we are going to choose the type of teams that must represent ATNS and then the information that must be collected for company's benefit. That's a main initiative but also in future it will drive towards that carbon emission calculator.
E: It' a centralized database so to say so that we monitor. There was a time whereby I flew to Dar-Es- Salaam Tanzania, I walked in and found ATNS was there already, my colleagues there already and I didn't know that there were people there already and it doesn't actually ogre well. And what does it do in terms of the environment itself as well, the money? So there is a project that we are doing now in our office and the marketing guys are coming up with a central client relations database which will be able to control these activities and so on and they are indirectly affecting that issue.
B: Because it's sad that people are saying aviation is the future tobacco industry.
M: Really?
B: With all this flying going on. So we need to work towards better management; if it's a meeting, conferences there is technology we can use.
M: Yes, there is tele-conferencing, video-conferencing, etc.
B: Ways of saving all of those elements. Working smarter basically.
M: You guys are not involved in carbon trading, emissions trading at all?
B: No. It's mostly airlines. I was involved from SAA point of view.
M: OK. Anything else you want to talk about? Are you changing your policies, your procedures to do things?
B: Yes. Part of the initiative is to get a learning assessment. First of all we will do a learning assessment on climate change issues and then go into fully developed course at the ATA, a training college; that deals with climate change issues that will have sequence courses and curriculum that includes a number of those initiatives that are pure ANSP, that are pure climate change and generic in nature. So that just like the quality system in a company, we can have that for every single employee so that when a person walks into ATNS, they do the induction, they do the quality management system and they will even know the culture. Because it becomes a house rule, If you are in my house, this is how we do things.
E: And it may in the future affect individual BScs.
B: Of course it does.
E: Because first they need to know what they are doing, then it will impact now their balance cocas, their individual, so that each and every person should be relating to say what am I doing in this line of thinking.
B: And even in job descriptions it should be embedded in so that people carry that wih them throughout their work life.
E: And we are running it as a project, which means there is an element of monitoring, tracking, guidance, etc. I think it's well situated.
M: In terms of funding for it do you have a separate budget for it?
E: We have got a separate budget.
M: How did you justify it?
E: No, we didn't even fight because like we said this is an initiative coming from the CEO himself. Actually if you speak to our CEO, we did the other time, remember? Is very keen, he is very enthusiastic about this. Every time he meets me or Brenda he wants to know what is actually happening. It's his project and I'm sure at his level he communicates with other stakeholders, with his colleagues about what's going on. So I can say us in ATNS we are so much that we don't have to motivate maybe because it was up down and not from down up so we are so blessed that when we were putting up the budget for this financial year, we didn't have any difficulty per say.
B: and also out of it we understand investment that's going to happen here and also the returns that we will get and the savings over the years with the initiatives in place. Energy, how much it is costing us now, I saw the income statement it was shocking. We would like to get savings and report on those savings out of it.
E: Sooner or later we will be building our own compound in the next 5 or 7 years from now.
B: We build that in before we move in.
M: Green building and stuff.

E: That's why we say you should come and work with us.
M: No I will come and see you every now and then and say how far are you guys?
E: Even on a smaller scale I think we are doing quite a lot of things. If you had met us when we were at Isando, each office had a little kettle to boil their water for coffee and so on but you find that everything has been centralized. All those are small initiatives but they have got impact, they add up in a nutshell. It's actually our role to collect those things because people are doing it unknowingly. Brenda has stopped using handy andy.
B: I have stopped. Like I said you have to live it. I wanted to buy another car but then I had to drop and squash that idea fast.
M: Was it a fuel guzzler? Did you want to buy an X6 or something?
B: It was a fuel guzzler and I said there goes my dream.
E: I'm telling you guys this is actually big. What makes it interesting is I think none of us in our normal school days or tertiary went through environmental issues.
M: No.
B: We did to a certain extent, in fact at school we did but it was one of those where you said it's got its people. There were people who loved these things, who were passionate about them and now it has come back. Full force, full circle, it's new now.
M: So are you teaching your children to be green? But they are still a bit too young.
B: Yes. I was helping my husband write a paper, an essay and because I want to own a soccer team so I said you are the first green soccer team. And he could see now that this thing is already in now because every time I'm talking about green issues, I want to attend green conferences, smart city. Are you going to the smart city?
M: I'm hoping I will but I haven't registered but that should be very interesting.
E: Especially for you.
B: I think the one element to look at it is like IT. Think of IT when it came in there were geeks who just sat at the computers and we said what geeks they are but look at now. So the way I see this environmental and climate change awareness is the same thing. We are the greeny beany people running around, telling people do this, do that. but what's going to happen in the future is that we are going to be high tech climate change experts, top leaders. You know what I mean, start small.
M: I like your enthusiasm.
E: One day I was glued on the TV listening to environmental issues, you know those guys from Woolworths.
M: Those guys are big.
E: They are really big in the things they have done in terms of branding, in terms of awareness on their products and so on. That's where I realized that this is actually huge. If it's affecting the ordinary consumer it's something you cannot take it for granted.
M: The other guys that I'm working with supply stuff to SAB and the SAB guys said if you are not green we are not going to buy your stuff because our clients especially in Europe look at the beer, the packaging and say what is the carbon footprint, what is the water content?
B: You are right. It's viral, it now penetrates every single element of your business, global supply management, your branding, every single element of your business involves now green. Including yourselves as ATNS, before you even think about to other countries you might be even surprised Ghana saying are you green?
M: Kenya apparently is ahead of South Africa in terms of green.
B: So you will be surprised that you want to provide all these things, it might surprise you. So you better step up the game fast before it's a response.
E: As you can see it's not only you, me and Brenda. I think it's something that we would like to explode. One time talking about it to my boss you could see the enthusiasm. He says when we were talking about it he didn't think that it is this big or it has got that much potential or impact. And so I can see it actually getting bigger. I don't see it going down in ATNS. I know it's very much dependant on our office but with the enthusiasm which we have from the CEO to our executives, to the respective senior managers I see a great future.
M: Thank you so much.
E: And we appreciate your help, you and Greg. Please express our appreciation. You don't know the impact which you had on us when you came to meet us. You showed us another angle of what this is especially on the strategic side to say you guys need proper planning for this. It's not something like Brenda says you just walk in, write a piece of paper and say this is what I'm going to do. So when you were taking us through it really sunk in our minds and I was talking to Brenda and Dumi and you can convey the message to Greg that we are going to have a

relationship with you in the near future. I think they will come a time whereby we do some introspection to say we have reached this part, and now we need a strategy on how we can now take this to the next level.
M: Ok, thank you so much.