Developing assessment criteria for a sustainable energy sector development project: shale gas exploration in the Karoo

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By

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During this research project, I have undergone numerous unfortunate circumstances but have managed successfully through the grace of God and my supervisor Dr Andrea Hurst. Dr Hurst has been a major support base for this research project and helping me better understand complexity theory, and the research process.

ABSTRACT

This research project aims to assess development projects in the energy sector with its focus on the shale gas exploration in the Karoo. The assessment is based on a critical analysis of the concepts and principles of sustainability, complexity and the National Environmental Management Act, using a critical hermeneutics methodology to develop an assessment criterion. Critical hermeneutics is the science and art of interpreting texts, challenging the status quo, its influences and assumptions. Hermeneutics is the reaction to enlightenment fundamentalism, which is an over-reliance on rationality and the scientific method as a primary means of obtaining truth. Hence this research has adopted a triangulation of ideas and concepts derived from sustainability and complexity to find the truth about the sustainability of development projects (Cilliers, 1998; Deleuze & Guattari, 1994; Byrne, 1998).

The Central Karoo is situated in the North Eastern part of the Western Province. It is characterised by dry, arid conditions with highly environmentally sensitive land. Central Karoo has the smallest concentration of people in the Western Cape (Van Vuuren, 2008). This research project offers an assessment that will help governments determine the feasibility of energy sector projects since it discusses the impact of exploration for shale gas in the Karoo and explains the process, recommendations and the environmental legislature required for any project to take place in South Africa. Further, it highlights the environmental damage caused by the shale gas exploration as well as the positive economic impact that it could have on the country. For this research, hermeneutics has offered a framework rather than a system; it is a research philosophy that places human experience at the forefront as it honours a variety of interpretations.

DECLARATION

I, ***Jyoti Badassey (210136499)***, hereby declare that the *Guided research Report* for *MA: Development Studies* is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

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LIST OF ACRONYMS

NEMA	National Environmental Management Act, No 107 of 1998
PASA	Petroleum Agency South Africa
EIA	Environmental Impact Assessment
UNCED	United Nations Conference on Environment and Development
EMP	Environmental Management Plan
WWF	World Wide Fund for Nature
UNDP	United Nations Development Programme
UNEP	United Nation Environmental Programme

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CHAPTER 1: INTRODUCTION AND CONTEXT

1.1 Context

As we step into an age of complexity, where we face the pressures of climate change, globalisation, an increase in trade together with economic catastrophe where the hike in oil prices have depleted budgets across the board, our fundamental task becomes one of seeking sustainable ways of living. Sustainable ways of living at present should help future generations to meet their own needs (Adams, 1991). It is essential to find ways not only of undoing past social and environmental damages associated with industrialization, but also of reducing importation of energy products and other resources. Reducing importation will increase local socio-economic growth and create a stable resource base (that is, maintain efficiency in resources in order to gain a foundation for sustainable resource development) (Harris, 2007; Norberg and Cumming, 2008). By implication, when we think of sustainable development projects, we are faced with diverse, possibly conflicting social, environmental and economic tasks.

Although many individuals are now beginning to save energy by using solar power, travelling less and other measures, the need for energy is still great. It should be noted that 67% of South Africa's petroleum is imported, primarily from Saudi Arabia and Iran (Zeiss, 2011). South Africa has very limited oil and gas reserves and Eskom relies on coal for 95% of its electric power generation (Zeiss, 2011). As a result the South African government plans to increase natural gas generation from 3% to 10% within 10 years in order to increase local economic trade growth (Zeiss, 2011).

Recently it has been found that shale gas, a natural gas that is increasingly becoming an important element in government plans to improve electricity supplies in South Africa, exists in the Karoo (Oliver, 2008).

The existence of a natural gas resource base in the Karoo is viewed as good news for local economic development, and various fuel and gas companies were quite until recently given

the go-ahead by Petroleum Agency South Africa (PASA) to explore the potential of shale gas in the Karoo for energy production in South Africa. This is also known as "fracking" (Khuzwayo, 2010). Technically, fracking is the hydraulic fracturing of underground rock formations, mainly shale, which is readily cracked and contains gas (Khuzwayo, 2010). Fracking forces open cracks in horizontal rock layers 4 – 6km underground. Fracking forces a high pressure liquid (consisting of millions of litres of water, sand and chemicals) into underground rock formations to release and collect otherwise inaccessible pockets of gas (Le Roux, 2011). This process creates cracks in the rock, releasing a gas called methane, also known as shale gas or natural gas. This process can create small seismic events that have caused earthquakes in Arkansas USA, the UK and other regions, as well as volcanoes in Lusi in Indonesia/Java (Le Roux, 2011).

However the Karoo, a semi-arid area that extends over the mountains of the Southern Cape in South Africa, has a unique biological and physical character. It is rich in plant species, some of which are not found elsewhere in the world (Van Vuuren, 2008), and is one of South Africa's most natural untouched and environmentally sensitive areas. Environmentally sensitive areas are those areas that are demarcated open green spaces that cannot be used for any physical development and must be left untouched (Adams, 1991). Many environmentalists are against prospecting for shale gas in the Karoo, arguing that it will irrevocably damage the sensitive ecosystem (Stahl, 2011). A further environmental constraint pertains to water, since drilling for shale gas (fracking) uses enormous quantities of water (approximately 20 million litres per well) (Stahl, 2011 and Zeiss, 2011). In comparison, Graaff Reinet uses 20 million litres in 3 days. South Africa, particularly the Karoo region, already faces drought (Stahl, 2011 and Zeiss, 2011). Taking complexity theory as their point of departure, these environmentalists argue that humans are an integral part of ecosystems and should not harm the environment, in doing this they ultimately also harm themselves (Harris, 2007; Noberg and Cumming, 2008). Facing this issue of whether or not the exploration for shale gas in the Karoo for economic growth is a viable and worthwhile project, is a fundamental question.

Fronting these opposing attitudes, it is difficult to decide whether or not prospecting for shale gas in the Karoo is a worthwhile/sustainable development project. Broadly, a worthwhile/sustainable development project is one that is managed efficiently in a way that promotes local economic growth without impacting negatively on local populations, towns and the surrounding environment.

1.2 Research Question

The research question has two parts. Firstly, it is asked: "According to what criteria for a worthwhile energy sector development project can the opportunities and constraints associated with the shale gas exploration in the Karoo be evaluated"? Secondly, given this evaluation, it is asked whether the proposed exploration of shale gas in the Karoo is a worthwhile/sustainable development project.

1.3 Research Aims and Objectives

Gathering information on the opportunities and constraints of the proposal will make it possible to draw conclusions that can direct responsible policy-making in order to fulfill the mandate for sustainable development entrusted to public servants via the National Environmental Management Act No 107 of 1998 (NEMA). NEMA aims to strengthen the role of local government through greater devolution of power, ensure that service delivery strategies are in place to meet the needs of all segments in the urban market, and strengthen the regulatory capacity of local government. Urban and other environmental problems are often fundamentally managerial problems (Chambers, 2005 and Padayachee, 2006). Hence NEMA assists in the control, assessment, and management of environmental problems, which are mainly caused by physical development in South Africa.

In addition, this report will list the criteria for a worthwhile development project, using complexity theory and a theoretical understanding of sustainability as guiding discourses, together with NEMA. The benefits and constraints associated with the shale gas exploration

in the Karoo will be investigated and critically analysed. Finally the proposed shale gas exploration will be assessed in terms of the list of criteria for a worthwhile development project.

CHAPTER 2: LITERATURE REVIEW

The purpose of the following literature review is to develop theoretical criteria using complexity, sustainable development and NEMA as guiding tools for assessing the value of development projects in the energy sector. This will assist in deciding whether or not the proposed shale gas exploration is a worthwhile development project.

2.1 The Progress of Development

The modernist concept of development, which took us through the industrial and technological revolutions, focused mainly on improving our material conditions through economic growth. Broadly, after the Second World War economic theory has shifted from neoclassical economic positivism, through Rostow's theory of stages of modernisation, to the basic needs approach, followed by structural adjustment, and finally global development (McMicheal, 2000; Willis, 2005; Padayache, 2006; Harris, 2000). In spite of these shifts, economic theory has been positivist rather than normative (ethical), and for this reason development has been uneven.

Development in an era of globalisation and modernisation assumes that social development will eventually take place under conditions that are set out by global powerhouses and western thinkers (Harris, 2000 and Adams, 1991). However, social development is often in competition with economic growth, creating conflict within and between each aspect and the developed and developing world. According to Harris (2000), Pieterse (2001), and Padayachee (2006), this discrepancy occurs because the structures of imperial and colonial power, made little provision for economic development and social justice in those areas we now call "developing nations" widening the gini-coefficient and leading modernisation to a development error.

> *Modernism and its more recent manifestation as development have betrayed progress ... while a few have attained material abundance, resource depletion*

> *and environmental degradation now endanger many and threaten the hopes of all to come ...Modernization betrayed progress by leading us into, preventing us from seeing and keeping us from addressing interwoven environmental, organizational and cultural problems* (Norgaard 1994: 2).

The growing awareness causes the need to shift to a new, more complex way of thinking, which in turn is associated with the relatively new concept of "sustainable development". As a complex concept, sustainable development must include multiple factors, such as sustained economic growth levels; appropriate public health care and education systems; international partnerships; the development of human capital; infrastructure; social inclusion; regional competitiveness; environmental sustainability; and innovation in public policy, attitudes and values.

2.2 Complexity Thinking for Sustainable Development

The theoretical background to this research is complex systems thinking. This focuses on sustainability as a matter of negotiating the multiple, conflicting demands placed on policy-makers for economic growth, social upliftment and environmental preservation. Harris (2007), Cilliers and Preisers (2010), and Norberg and Cumming (2008) all agree that the limitation to development during the industrial revolution was social capital, whereas natural resources were thought to be unlimited. Today, while social capital still places important constraints on development, there is also an urgent need to live within a limited supply of natural resources. It is not just a matter of saying that the decreasing availability of resources limits economic growth but also that economic growth itself has become problematic due to the negative ecological consequences of human materialism (or excessive consumerism), such as a reduction of biodiversity. Harris (2007), Cilliers and Preisers (2010), and Norberg and Cumming (2008) argue that it is important to recognize that the interactions between the biosphere and the human-dominated world of social and economic needs are highly complex and variable in space and time, forming a set of complex interacting and adaptive systems. Harris (2007), Cilliers and Preisers (2010), and Norberg and Cumming (2008) have agreed that all living systems experience gradual changes that are driven by factors that are more or

less external to the system, and this will require adaptive capacity. Adaptive capacity is a measure of how important system structures, processes and components can be sustained under changing conditions (Harris, 2007). Overall, complexity theorists believe that human actions should only be carried out after thorough consideration of the surroundings to avoid energy sector development projects (such as mining and drilling) becoming a cause of environmental degradation.

Complexity thinking insists that sustainable development must take account of multiple social, economic and environmental demands. Hence complexity thinking provides a platform for developing balanced assessment criteria to evaluate the opportunities and constraints of extracting shale gas in an environmentally sensitive area such as the Karoo.

2.3 Sustainability

Although the term sustainable development first emerged during the 1970's, it only became integrated into the mainstream vocabulary leading up to and following the 1987 World Commission on Environment and Development (WCED, 1987), also known as the Brundtland Commission. However, thinkers like Todaro (1998) argue that the concept of development itself is a multi-dimensional process. The Earth Council therefore later refined the concept of sustainable development, holding that it "should be economically viable, socially just and environmentally appropriate" (Payne and Raiborn, 2001:157).

Harris (2000) explains that in the extensive discussion and application of the multi-dimensional concept of sustainable development which has taken place since its inception, three essential aspects of sustainable development have been recognized: environmentally sustainable systems, socially sustainable systems and economically sustainable systems.

Firstly, Harris (2000) argues that an environmentally sustainable system includes maintenance of biodiversity, atmospheric stability, water quality and other ecosystem functions. Harris (2000) adds that physical capital and natural capital fall under two different categories. Goodwin (2003) thinks that physical capital is a part of natural capital since it

takes human labour to produce manufactured goods to increase the production of goods and services and hence increase the demand and supply that will further increase employment and create sustainable economic growth rates.

Secondly, Harris (2000) insists that socially sustainable systems must obtain distributional equity, i.e. adequate provision of social services including health and education, gender equity, political accountability and participation. Furthermore, Harris (2007) adds that heritage and cultural values that are important throughout the world must be respected. Harris (2000) argues that social sustainability means the involvement of both private and public sectors to increase understanding as well as community and institutional involvement and collaboration.

Thirdly, an economically sustainable system must be able to produce goods and services on a continuing basis, to maintain good governmental management systems and avoid external debt, and extreme sectoral imbalances such as labour market imbalances affecting the level of unemployment. This can be measured by the standard deviation of sectoral excess demands for labour, which damage agricultural or industrial production. Concerning methods and patterns of production, Harris (2007) adds that production must be maximized through the efficient use of water, electricity and nutrients.

Many people call for new, alternative, sustainable, ways of providing energy. However, the question arises whether new ways of providing energy really do provide sustainable development or whether they are tacitly depleting energy (e.g. in their very production) more than they should. Jaccard (2005) insists that energy efficiency is a highly contested topic. Energy efficiency should bring about a sustainable way of life for nations where primary energy is converted to useful goods and services. However, energy efficient technologies also lead to a rise in the demand for energy services. Issues arise relating to economic parity. For example the rich may think they are contributing to environmental sustainability by using new, energy efficient technological resources such as jacuzzi's, wine coolers or dishwashers. However the use of these more energy efficient technologies presupposes access to a high level of energy resources that far exceeds that of the poor, who struggle to achieve access to the most basic level of energy resources (electricity and water) just to make ends meet.

Jaccard (2005) argues that we may never know what can and cannot be protected for future generations since the need for energy resources changes over time. We can merely accept a moral obligation to fulfill the mandate for sustainable development in the present. To be sustainable, therefore, Jaccard (2005) argues that the flow of any energy system's material and energy by-products must not exceed the capability of land, air and water to soak up and recycle them without momentous negative disturbance. The known, cumulative impacts of the energy system must be insignificant and any extraordinary risks to be faced must be extremely unlikely. Further, the system must be able to recover from these impacts and risks within a reasonable period of time, perhaps aided by rehabilitation efforts.

Jaccard (2005) states that when analyzing alternative forms of energy to fossil fuels we need to question the environmental sustainability and economic cost. The idea of sustainable development encompasses the environmental, social and economic factors of development, but the problem is that often one factor or another is given preference. It is a fundamental truth that in development projects not all factors for sustainable development will be given the same amount of importance and some development projects do not always consider all the fundamentals of sustainable development. For example, the Forbes and Business Live websites revealed that petroleum companies involved in shale gas exploration in the Karoo have missing information in their environmental impact assessment. It is such selectivity that ultimately leads to unsustainable development. It is therefore extremely important to include policies that will strengthen the capacity of local government to think in terms of complexity and sustainability.

2.4 NEMA

The role of government in setting and enforcing regulations is key to minimizing the potential environmental impacts of development projects. Performance based regulations such as those in NEMA, have the potential to assess the sustainability of development projects and stimulate more innovative and effective environmental management (Harris, 2000).

According to NEMA (1998:3), sustainable development is defined as "the integration of social, economic and environmental factors into planning, implementation and decision making, so as to ensure that development serves present and future generations". We can safely say that sustainable development is a fundamental factor of environmental management.

NEMA (1998) has included the following mechanisms to achieve a healthy environment for all people:

- It highlights the duty of all people to take reasonable measures that help prevent environmental pollution or degradation from occurring or continuing to occur.
- For any employee or worker who refuses to do environmentally hazardous work, the Act has provisions in place to protect these individuals from prejudice and harassment.
- It provides for the use of procedures for the control of emergency incidents such as fire, explosions or any other form of emission that may endanger the environment or result in any detrimental effects to the environment during an energy sector project process.

NEMA's priorities that are linked to key outcomes of the act aim amongst other things to build capacity while protecting the environment, and to promote a bottom up approach in local governance. The act seeks to achieve the following:

Building of capacity and confidence in interpreting and implementing the Act	**Co-operative governance procedures**	**Quality and consistency in decision making**	**Public participation and NEMA response systems**
Building of capacity in both local and provincial levels of authority	Establishment of a committee for co-ordination with the Department of Environmental Affairs and Tourism	Assistance to provinces with EIA's	National Environmental Advisory Forum Protection from environmentally hazardous work provisions

Implementation of an overt communication strategy	Environmental implementation and management plan guidelines coupled with network systems for monitoring and communication	Regulations on assessment procedures in sensitive areas	Emergency incidents Access to information Environmental management co-operation agreements
		Regulation in cross border activities Access to environmental expertise	Whistle blower provisions

Table 1: Aims of the National Environmental Management Act

2.5 The Exploration for Oil and Gas

According to UNEP (1997) scientific explorations for oil in the modern sense began in 1912, when geologists were first involved in the discovery of the Cushing Field in Oklahoma, USA. While modern technology and engineering have vastly improved performance and safety, the oil industry faces multiple environmental challenges. The UNCED held in Rio de Janeiro in June 1992 ("The Earth Summit") focused world attention on the close links between the environment and oil-dependent socio-economic development. The summit reviewed global environmental issues, which resulted in two conventions: Agenda 21 and the Rio Declaration. The broad environmental issues faced by oil and gas exploration include habitat and biodiversity protection, air emissions, marine and freshwater discharges, accidents and oil spill, as well as soil and groundwater contamination (UNEP, 1997). The environmental challenge is to ensure that all operations conform to current good practice (UNEP, 1997).

It is imperative to ensure that environmental issues are key components of a shared culture of sustainable development, with issues related to health, safety and environment often being

considered together to help ensure that integrated development takes place (UNEP, 1997). According to the UNEP (1997) the energy sector exploration and production process is made up of a number of activities: a desk study, which identifies areas with favourable geological conditions; aerial surveys in which favourable features are revealed; seismic surveys, which provide detailed geological information; exploratory drilling, which verifies the presence or absence of a hydrocarbon reservoir and quantifies the reserves; appraisal, which determines if the reservoir is economically feasible to develop; development and production, which produces oil and gas from the reservoir through formation pressure, artificial lift and possibly advanced recovery techniques, until economic reserves are entirely depleted; and finally, decommissioning and rehabilitation may occur for each activity (UNEP, 1997).

Oil and gas industries are expected to grow and meet the needs of rapidly industrialized countries, as long as they achieve the most cost effective and environmentally sound approach (UNEP, 1997).

2.6 Impacts of Explorations for Shale Gas

There could potentially be a large number of impacts as a result of shale gas exploration and production. Key impacts include changes in land use patterns and access routes, which may lead to unplanned settlement and exploitation of natural resources (UNEP, 1997). They also include changes in local population levels as a result of immigration of the labour force and immigration of remote populations in search of increased access and opportunities (WEC, 2010). Further, socio-economic systems could change due to new employment opportunities, income differentials, inflation and differences in per capita income when different members of local groups benefit unevenly from induced changes. Socio-cultural systems could change due to social structure, organization and cultural heritage, practices and beliefs, and secondary impacts such as effects on natural resources, rights of access and change in value systems influenced by foreigners (UNEP, 1997). Exploration and production of shale gas could bring changes to the availability of access to goods and services such as housing, education, healthcare, water, fuel, electricity, sewerage, waste disposal and consumer goods brought into the region. It could change planning strategies, where conflicts arise between

the protection of natural resources and their development for use; industrial uses of natural resources and their recreational use, such as in tourism; and economic, historical or cultural resources. Aesthetic changes can occur due to unsightly or noisy facilities and transportation systems; increased road, air and sea infrastructure, which have associated effects such as noise or accident risk; increased maintenance requirements; or changes in existing services (UNEP, 1997).

2.7 Successful Energy Sector Projects

Strong economic growth driven by technological advances and accompanied by increasing integration between countries has lifted the economic and social well-being of billions of individuals. However many individuals and countries have remained at the margin of this process, failing to share the benefits of economic growth. Given the significant use of energy that will be required to improve human well-being in much of the developing world, the size of the global energy system should ideally grow substantially over the next century.

However Jaccard (2005) clearly indicates that energy sector projects must have good Environmental Management Plans (EMPs) if they are to last for a sustainable period of time. This means that extraction; transformation, transport and consumption of energy must be economically viable, as well as compassionate towards people and ecosystems.

Successful energy sector projects require elements such as careful planning, leadership and commitment, policy and strategic objectives, organization, resources and documentation. They also require evaluation and risk management, implementation, monitoring, auditing and reviewing (UNEP, 1997).

CHAPTER 3: METHODOLOGY AND RESEARCH METHODS

3.1 Broad Approach and Framework

This research project falls within the domain of Development Theory. Its approach is theoretical and it proceeds through critical document analysis. The first component of this research involves developing criteria for the assessment of a worthwhile/sustainable development project. The second component of this research takes the form of a critical assessment of the proposed shale gas exploration and extraction in the Karoo according to the criteria developed. Data has been collected by qualitative rather than quantitative methods. The methodology for research of this kind is called "critical hermeneutics". Critical hermeneutic research primarily aims to come to an interpretation or understanding of a phenomenon or situation such as prospecting for gas with a view to offering a critical assessment of its current condition and making suggestions for future practice.

3.2 Research Delimitation

This research is specifically based on the shale gas exploration in the Karoo, a large environmentally sensitive area in the North Eastern part of the Western Province in South Africa. The Karoo is semi-arid area and extends over the mountains of the Southern Cape in South Africa. It has a unique biological and physical character and is one of South Africa's most untouched and environmentally sensitive areas. Many environmentalists are therefore against prospecting for gas in the Karoo, arguing that it will irrevocably damage the sensitive ecosystem (Stahl, 2011).

3.3 Research Design

Creswell (1994), in de Vos (2002), defines design in the qualitative context as the entire process of research from conceptualizing a problem to writing the narrative On the other hand

Grinnell (1981: 198) defines research design as the plans, structures, and strategies of investigations, which seek to obtain answers to various research questions. In this research, the question asked is what constitutes a worthwhile development project in the energy sector. The concepts of sustainability and complexity, as well as those policies that are most effective in relation to environmentally sensitive projects (one of which is NEMA), are studied and interpreted in an attempt to reach a complex answer. A critical hermeneutic approach is adopted in this study. Hermeneutics is particularly suitable for qualitative enquiry, in which work of a textual and conceptual nature is done. Hermeneutics is the art of interpretation and seeks a complex understanding of a phenomenon through conceptual analysis of texts, rather than attempting to offer simple explanations or absolutely authoritative readings.

3.4 Research Process

The overall hermeneutic task of theoretical research may be divided into the following consecutive research tasks: *auslegung* (uncovering), critique, and application. My research method, or method of data collection, reflected below, is designed to follow the structure indicated by these tasks.

Auslegung (uncovering) names are the first analytical/descriptive task of the researcher, and it involves the detailed "laying out" of a phenomenon. This process involves two tasks. Using the method of conceptual analysis, which pertains to the definition of phenomena, in this case, sustainability, complexity theory and relevant policies, relevant literature, was investigated in order to uncover or lay-out the concepts of complexity and sustainability. This conceptual analysis was aimed at understanding and interpreting information concerning shale gas exploration in the Karoo. The National Environmental Management Act 107 of 1998 (NEMA) was also uncovered/unpacked in order to help assess the proposed shale gas exploration in the Karoo.

Concepts from sustainable development theory, complexity theory, and NEMA were then used to create criteria for the critical assessment of energy sector projects in South Africa.

Sustainability and complexity theory were not treated merely as ideologies but as conceptual tools that can assist in making development projects sustainable for future generations. It is fundamental to note that the different conceptions of what sustainability means, as shown in the literature review above, reflect not only an opportunity for critical examination but also for envisioning development projects in a broader and more positive light. These criteria were offered to people involved in the shale gas exploration in the Karoo for comment and assessment, and amendments were made accordingly.

3.5 Limitations

The researcher was limited to communicating with people involved in the shale gas exploration in the Karoo for first-hand information. Many of those approached were reluctant to divulge information about the proposed project, stating that this was a highly sensitive topic and that they did not want to get involved with the research, even after it was explained that this was purely for a Master's Degree Research Programme in Development Studies. However those involved in energy sector projects and environmental projects commented upon and assessed the given criteria and were given the opportunity to make additions as they saw fit to the given criteria for a sustainable/worthwhile energy sector development project.

3.6 Data Collection

According to Creswell (1994:148), the data collection steps involve setting boundaries for the study, collecting information through observations, interviews, documents and visual material, and establishing the protocol for recording information.

In this research project, the primary method of sourcing data was through the critical analysis of existing documents and literature resources. Key sources used were online articles on sustainability and experiences in other countries with shale gas exploration and the use of

natural gases; newspaper articles; and Business News and Forbes websites. More especially, NEMA was most efficient in providing concepts and ideas concerning what would fulfill the mandate of sustainability. NEMA represents four pillars of sustainability, each providing resources for good decision-making. These are capacity building, co-operative governance, quality and consistency in decision-making and public participation. They help researchers assess development projects to enable them to become sustainable projects. The sources were consulted to assist in defining the opportunities and constraints of the proposed shale gas exploration in the Karoo. Thereafter, concepts from sustainability and complexity theory were used to propose and justify an integrated list of fundamental assessment criteria for what constitutes a sustainable development project in the energy sector. This list of assessment criteria was then sent to those involved in the environmental and energy sectors, including that of the shale gas project in the Karoo.

On 19 October 2011, first hand information was received from Environmentalist Jeanie Le Roux, who has extensive knowledge of the Karoo and the effects of shale gas exploration. She was referred by Mr J. Deal, who also currently features in debates on shale gas exploration. Mr Deal's details were found on the Internet. The list of criteria developed was sent to Jeanie Le Roux for comment and he answered the questions on the assessment attached in Tables 2 – 4. Jeanie Le Roux and Mr Deal are currently involved in projects to treasure the Karoo.

Some of the most important aspects of the study were energy efficiency, natural resources such as water during the fracking process, employment (economic) and environmental impacts of the shale gas exploration in the Karoo. An understanding of the use of energy by the energy efficiency industry was developed and insights were generated into potential efficiency measures and performance indicators. An understanding was also developed of the relation between reduction goals, costs and their wider environmental implications, and an understanding of the practical meaning of this exploration. In terms of the employment, initiatives on employment were reviewed in the context of a mature industry in transition in order to understand stakeholder issues and contribute to the development of a methodology for a longer term skills forecast.

As stated in the literature review on energy sector projects criteria, each of these themes has been addressed using a similar approach First it was necessary to identify the key questions to be asked when developing an energy strategy (qualitative assessment) and to present analytical methods for informing the decision making process. Then examples were used to illustrate the various decision-making processes and the application of the analytical methods.

Together with this, shale gas exploration in other countries was researched in order to learn from other experiences and apply them to South Africa. There are both positive economic conditions and negative environmental conditions, making this exploration difficult to justify for the so-called developing nations[1]. For example, North Dakota experienced an oil boom in December 2010 as a result of its exploration and drilling for shale gas. It was seen as a long-term opportunity to produce alternative fuels and cheap fuel closer to home. Money was spent on research and development so that new sources will be available when shale supplies run low, decades into the future. On the other hand some countries stated that shale gas deposits occupy large areas but have extremely low permeability compared to conventional gas deposits.

Finally, stakeholders involved in environmental and energy sector projects have been approached to further assess the assessment criteria for a worthwhile/sustainable development project. The aim of this list of assessment criteria was to aid reliable decision making on development projects.

[1]The concept of development has derived through westernization. Hence the concept of developing countries and developed countries is defined according to westernization and not what people believe in. A developing country's people may believe that they are more developed than those in developed nations. This is the reason for them being called the so-called developing nations".

3.7 Critique of Data Gathered

The second research task of the critique involves assessment of the data gathered. It was proposed that the assessment criteria be used to help ascertain whether or not a project is worthwhile for development. In addition, the success of energy sector projects through their impacts on environmental, economic, social and managerial sustainability was questioned.

3.8 Methods for Application

Although theoretical work is concerned primarily with understanding and interpretation, it is hoped that the understanding generated by the research will lead to a change of spirit and a new way of thinking.

The application phase is highly significant and cannot be neglected. It is necessary at least to draw some conclusions or make some suggestions about how the insight gained by doing the research may be applied. In the concluding section of this study, suggestions will be made concerning the nature of a responsible policy or strategy for shale gas exploration in the Karoo. In other words, the study will describe the kind of development policy or assessment concerning energy use that would fulfill a mandate for sustainable development.

CHAPTER 4: CRITICAL EVALUATION

4.1 Critical Evaluation of Shale Gas Exploration

According to (WWF, n.d.) the exploration for shale gas in the Karoo is resource-intensive, requiring extensive fracking to determine the probable extent of the resource that may be available for extraction, as well as the scale of geological modification that would be required to access it. This uncertainty is already a cause of unsustainable development. While there is a limited, though growing body of knowledge regarding the impacts and risks of such an exploration, initial studies by WWF suggest that they exceed any possible benefits in terms of sustainable development. WWF South Africa states that the country does not need unconventional gas to meet its growing energy demands, since it has far more viable and sustainable energy development options than shale gas. Scenarios for energy supply, both nationally and globally, that are consistent with strong economic growth highlight the imperative for not utilizing the full extent of fossil fuel reserves already established, but rather prioritizing the use of renewable energy resources. WWF also stated that unconventional gas is carbon intensive – it involves extensive greenhouse gas emissions, probably more so than petroleum products – and is possibly no better than coal. Exploitation of such resources is not compatible with our international commitments to address climate change. Exploitation of shale gas would present a barrier to achieving truly sustainable energy supplies and the opportunities and benefits of a more sensible transition to renewable energy. It would accelerate the on-going decline in the energy return on energy invested in fossil fuels and divert investment away from better options with far greater public benefits. Fracking requires huge volumes of water, a particularly scarce resource in the Karoo. It also needs extensive infrastructure, typically requiring several injection wells per square kilometre, as well as management of significant volumes of flammable, potentially toxic drilling mud from each site. The full impact of extraction is only beginning to emerge internationally (Le Roux, 2011).

According to Derek Morgan (2011), the use of the UNDP MDG Carbon Safeguard Principles should be used for all energy sector developments. As stated below in the criteria for sustainable energy sector projects, the rights to life, liberty and security preclude any form of slavery, servitude, torture or cruel, inhuman, degrading treatment or punishment by a project.

The findings on the UNDP MDG principles clearly state that the project must respect social security and the economic, social and cultural rights that are indispensable to human dignity and the free development of each individual's personality. Individuals must receive equal payment for equal work and a favorable remuneration that ensures for the worker and the worker's family an existence worthy of human dignity. The project must also recognize the right to form and join trade unions, the right to rest and leisure, reasonable limitations on working hours and periodic holidays with pay. In addition, at the national level, the right to a standard of living adequate for health and well-being, including food, clothing, housing, medical care, social services and security must be realized. Moreover, and if necessary, the rights to education and to participate in the cultural life of the community, including the protection of the moral and material interests resulting from any scientific, literary or artistic production should be promoted. It was found that a project in the energy sector would be guilty of human rights abuses if it authorized, tolerated, or knowingly ignored human rights abuses committed by an entity associated with it, or if it knowingly provided realistic assistance or encouragement that has a substantial effect on the perpetration of human rights abuse.

4.2 Assessment Criteria

In short it was found that complexity thinking, the idea of sustainable development and the National Environmental Management Act make it possible to group the criteria for worthwhile development projects in the energy sector under four headings: environmental, economic, social and managerial sustainability. It can be argued that energy sector projects will be worthwhile if they fulfill the following criteria for environmental, economic, social and managerial sustainability.

Below is a lickert scale used for more definitive answers to the criterion. Each assessment criteria is measured using this scale based on information obtained during the research. The scores are totaled and divided by the total number of assessment criteria.

Category	**Level**	**Score**
0	Meets not at all	0%-20%
1	Meets it minimally	21%-40%
2	Half meets it	41%-60%
3	Meets it quite well	61%-99%
4	Completely satisfactory	100%

4.2.1 Environmental Sustainability

Energy sector projects will be worthwhile if they take environmental impacts into account and minimize their environmental footprint. In Table 2 below specific criteria are listed, in the form of questions, according to which environmental sustainability may be assessed, as well as an assessment of the shale gas exploration project according to these criteria.

Table 2: Assessment Criteria for Environmental Sustainability

Assessment Question: Will the project:	**Level**	**Evidence**	**Score %**
Conduct a desk study that identifies the area with favourable geological conditions?	Completely satisfactory	Draft Final Environmental Management Plan drafted by Golder Associates, 2011.	100
Conduct aerial surveys revealing the favourable features?	Completely satisfactory	Draft Final Environmental Management Plan, drafted by Golder Associates, 2011.	100
Conduct seismic surveys that provide detailed geological information?	Meets it quite well, but the results are not guaranteed to be detailed enough, therefore fracking will be a part of	Draft Final Environmental Management Plan, drafted by Golder Associates, 2011.	75

	the exploration phase		
Maintain biodiversity?	Meets not at all	Fracking only causes environmental damage and has negative impacts on biodiversity changing the land-use pattern to extreme industrialisation or mining in the area. (Fox, 2011 and Le Roux, 2011).	0
Maintain atmospheric stability?	Meets not at all	Studies in other nations, especially United States of America, prove that fracking does not maintain atmospheric stability; atmospheric stability only reduces and causes health risks to people living near the projected site for exploration (Fox, 2011 and Le Roux, 2011).	0

Utilize efficient resource management e.g. use water, electricity and technology efficiently during and after the project process?	Meets it minimally	Water will be wasted in the end (returns as toxic waste water and is hazardous) (Le Roux, 2011).	25
Improve technology to supply better energy alternatives and develop new ways (such as developing cleaner and more efficient) for the extraction and production of oil and electricity?	Meets not at all	Shale gas is still a fossil fuel and fugitive methane emissions (according to the Cornell University study) make shale gas in terms of GHG emissions worse than coal in some cases. Methane has a 70 times greater global warming potential than CO_2 and after 20 years in the atmosphere, methane is broken down to CO_2 and water, therefore having a double effect on climate change (Le Roux, 2011).	0
Undergo a full EIA in accordance with NEMA?	Meets not at all	Only after the exploration phase can an EIA be requested (Le Roux, 2011).	0

Focus on environmental preservation and rehabilitation if there are negative impacts, associated, for example with ricks and wells?	Meets it minimally	To a certain extent, although if water is contaminated, it will remain contaminated and unfit for human consumption, irrigation, etc for probably centuries to come (Le Roux, 2011).	25

Have adaptive capacity which is a measure of how important system structures, processes and components can be sustained under changing conditions during the project. For example, any project that has set out a project process or system should be adaptable to the conditions for the project and not contradict the project?	Meets not at all	Floods and droughts will be a challenge and create significant risks regarding pollution (waste water dams overflow) or water scarcity (Le Roux, 2011).	0

Consider their surroundings and avoid negative impacts such as noise, traffic, damage to the earth surface, etc.?	Meets not at all	The mentioned impacts can't be avoided: its part of the process (Fox, 2011).	0
Make sure that the flow of any energy system's material and energy by-products must not exceed the capability of land, air and water to soak up and recycle them without momentous negative disturbance?	Meets not at all	Fracking does exceed the capability of land, air and water as proven to other countries throughout the world (Fox, 2011).	0
Consider all environmental components in decision-making at strategic and operational levels?	Meets not at all	All factors of environmental sustainability have not been mentioned in the EMP for the exploration of shale gas.	0
Ensure that there is control of emergency incidents such as fires or any other that would endanger the environment?	Meets not at all	Not specified in the EMP's (Golder and Associates, 2011).	0
Prevent waste at its source through pollution prevention techniques and making maximum re-use of waste components rather than installing expensive treatment for discharges?	Meets not at all	Waste water can't be treated or avoided in hydraulic fracking and the water is highly toxic and radio active and can't be discharged (Le Roux, 2011).	0
Make sure that there is access to environmental expertise for the project locally instead of importing skills?	Meets it minimally	Oil companies bring in their own experts usually. Dependable on availability of such skills. Majority of people in the Karoo are unskilled (Le Roux, 2011). In my opinion, since the shale gas exploration has not yet been tried and tested in South Africa, many skilled workers from other countries will be asked to come here for the exploration, especially since those involved in fracking are multinational corporations who have access to global employment.	25
Indicate the expected emission reductions that will occur due to the project by providing annual and total emission reduction in tonnes CO_2 equivalent?	Meets not at all	Reductions, considerable amount of additional GHG emissions. A lot of additional GHG's will be added to the atmosphere in the process (Le Roux, 2011). No such statistics have been revealed in the EMP.	0
Define the project in terms of the Kyoto Protocol? Result in a	Meets not at all	It will not reduce GHG emissions. Methane is a far more potent greenhouse gas than carbon dioxide, but methane also has a 10-	0

reduction of at least one of the following greenhouse gases: $CO_2/CH_4/N_20$/HFCs/PCFs/SF_6?		fold shorter residence time in the atmosphere. As a result, its effect on global warming falls more rapidly. Methane dominates the greenhouse gas footprint for shale gas on a 20 year horizon, contributing up to three times more than does direct carbon dioxide emission. At this time scale, the footprint for shale gas is at least 20 percent greater than that for coal, and perhaps twice as great. Please follow the link http://www.sciencedaily.com/releases/2011/09/110908124505.htm	
Describe the parameters that will be used as performance indicators that will be monitored to verify that emission reductions are taking place (parameters may include emissions output, energy production, energy sales, environmental impacts etc.)?	Meets not at all	At this stage, if the applications are granted, the processes will be regulated by the oil industry themselves as South Africa does not have any laws in place to regulate oil and gas (Le Roux, 2011).	0
Use and exploit non-renewable and renewable resources responsibly and equitably, and take into account the consequences of the depletion of the resource?	Meets not at all	The use of tonnes of water clearly speaks for itself (Fox, 2010).	0
Define the impact of the project on the generation or disposal of solid waste?	Meets it minimally	It's catastrophic in my opinion. Wind, solar and tidal energy and biogas will prove to be a much better and responsible choice for sustainability purposes (Le Roux, 2011).	25
Identify the greenhouses gases that will be targeted in the project?	Meets it minimally	Draft Final EMP drafted by Golder Associates, 2011.	25
		TOTAL SCORE	17.4%

Discussion: According to the criterion of environmental sustainability, the shale gas exploration/extraction project scores **17.4%**. This falls in category number **1**, not meeting the criteria at all. This means that oil companies do not adequately take environmental impacts into account and minimize their environmental footprint. To improve their sustainability, they should take into consideration the consequences of the depletion of resources, especially that of water and the negative environmental risks together with the health hazards that people

around the area are subject to. They should identify the greenhouse gases that will be targeted in the project in the EMP and in the public participation process. They should make sure that there will be access to environmental expertise in the country and not import these skills and undermine the expertise of local people.

4.2.2 Economic Sustainability

Economically recoverable resources are those natural gas resources for which there are economic incentives for production; that is, the cost of extracting those resources is low enough to allow natural gas companies to generate an adequate financial return given current market conditions. However, it is important to note that economically unrecoverable resources may, at some time in the future, become recoverable, as soon as the technology to produce them becomes less expensive, or the characteristics of the natural gas market are such that companies can ensure a fair return on their investment by extracting this gas. Table 3 should clearly depict if this energy sector project will be economically worthwhile.

Table 3: Assessment Criteria for Economic Sustainability

Assessment Question: Will the project:	**Level**	**Evidence**	**Score %**
Aim toward sustaining the economic growth levels needed to produce an economically developed state, as measured by a decent increase in per capita incomes and GDP?	Meets it minimally	This has not been sufficiently specified in the EMP drafted by Golder and Associates, 2011.	25
Provide affordable energy resources for South African citizens instead of importing fossil fuels from other countries?	Meets not at all	The petroleum companies involved have not provided any information on the access and affordability of energy resources for South Africans.	0
Incorporate economic risk assessment?	Meets not at all	According to Le Roux, 2011, there has been no mention of an economic risk assessment.	0
Increase employment for local citizens?	Meets not at all	Research shows that those involved with Shell and other petroleum countries believe that employment will increase. However many environmentalists argue that most jobs for local citizens will merely be temporarily and the permanent high level jobs will be taken by overseas experts who have experience in the field. Hence	0

		sustainable employment is not on the cards for local South African citizens. Source: http://www.gfz-potsdam.de/portal/gfz/Struktur/Departments/Department+4/sec43/Breaking+news/Dokumente/Proposal-GASHsa?binary=true&status=300&language=en	
Avoid external debt during and after the project process?	Meets not at all	Shell is a multinational corporation hence external debt is highly unlikely. Shell has budgeted 200 million US dollars for the project for the exploration phase. Resource: http://www.1485.org.za/fracking.html and http://www.businesslive.co.za/southafrica/sa_generalnews/2011/03/25/shell-could-spend-200m-on-karoo-gas-exploration	0
Ensure that the goods and services being provided will be manufactured for a sustainable period of time?	Meets not at all	The gas is exploitable and can be depleted within a few decades; it is definitely not sustainable (Le Roux, 2011).	0
Avoid damage to agricultural or other industrial production during and after the project process?	Meets not at all	It can't be guaranteed. Agriculture will without a doubt be affected negatively. Jobs that are currently sustainable in the Karoo (agriculture and tourism) will be negatively affected by gas production. If groundwater is polluted, most of these jobs will be lost and economic activity in the Karoo will get a very hard knock (Le Roux, 2011).	0
Draft a budget or feasibility study for the project?	Meets it minimally	Shell said it is willing to spend two hundred million dollars during exploitation. A lot of this money will not be spent within the borders of South Africa. No clear indication of a feasibility study has been conducted (Le Roux, 2011).	25
Avoid creating uneven benefits to the local groups during the project?	Meets not at all	Can't be proven. Highly skilled persons are more likely to be approached, especially from the USA (Havemann et al, 2011).	0
Create further forward planning for more sustainable economic growth levels?	Meets it minimally	According to Jan Eggnick (2011) the shale gas exploration will benefit all people and the economy. Resource: http://www.iol.co.za/business/opinion/columnists/karoo-gas-can-bring-benefits-to-all-if-done-carefully-1.1133106. However, if the exploration does not prove to be successful then the consequences of fracking will make things worse for the country and for climate change.	25
Evaluate alternatives on a cost, benefit and risk basis that include environmental values?	Meets not at all	There has been no mention of alternatives in the plans of the petroleum companies.	0
Use technology that has been previously tried and tested in South Africa?	Meets not at all	Not in South Africa but internationally tried. Not proven to be safe and without significant environmental risks and effects (Le Roux, 2011).	0
Define the impact of the project on foreign exchange requirements?	Meets not at all	There has been no mention of purchasing of equipment or goods for the project from other countries in the EMP.	0
Define the impact on existing economic activity in the area?	Meets not at all	Agriculture, tourism and transport, (on roads) will be negatively affected (Le Roux, 2011).	0

Define the impact on the cost of energy?	Meets not at all	According to the World Energy Council (2010), the global energy industry is facing a growing number of uncertainties, including price volatility, rising demand and increasing costs which are leading to greater pressures for energy producers and consumers alike. Furthermore, almost a quarter of the world population has no access to modern energy and little hope of joining the world's energy consumers any time soon. It is clear that the current energy system is unsustainable for the economy. However, there has been no specification on this matter in the EMP for shale gas exploration in the Karoo.	0
Define the impact on foreign direct investment?	Meets not at all	South Africa has put in place a moratorium on the issuing of hydraulic fracturing, or fracking, licenses to allow it time to understand the possible environmental, employment and industrial implications of unconventional gas mining. Davies stressed that these interventions did not imply a closing of the country to foreign investors, highlighting the fact that South Africa was actually seeking to increase its FDI level. He noted that his performance contract, as well as those of a number of other economic cluster Ministers, places emphasis on the need to boost investment, domestic and foreign (Creamer, 2011)	0
		TOTAL SCORE	4.7%

Discussion: According to the criterion of economic sustainability, the shale gas exploration/extraction projects scores **4.7%**. This falls in category number **1** meaning that the petroleum companies do not adequately take economic impacts into account. To improve their sustainability, they should reconsider all laws and policies in place in South Africa, such as the Constitution, of which labels human rights, rights to water, heritage, culture, clean and healthy environment and most of all access to basic needs. Other policies such as NEMA play a major role not only with the environment but also help protect the economy by promoting sustainable job creation and economic development. Little on economic sustainability has been exposed in the EMP; it has been vague in determining a feasibility study, forward planning, job creation or foreign direct investment.

4.2.3 Social Sustainability

Table 4 below will provide a clearer indication on whether or not energy sector projects will be socially worthwhile.

Table 4: Assessment Criteria for Social Sustainability

Assessment Question: Will the project:	Level	Evidence	Score %
Include elements of social upliftment (such as capacity building [training and education] to local citizens so that the unemployed stand a chance of being employed) during or after the project process?	Meets not at all	At the moment none are specified in the EMP.	0
Provide energy resources that will meet the basic needs of those who need it the most and not only the elite?	Meets not at all	The recoverability of shale resources are not yet determined in the EMP.	0
Increase employment levels for South African citizens?	Meets not at all	The trade-off between existing jobs and new jobs were never mentioned by the petroleum companies, however most skills for this project will be imported from abroad. Since the shale gas exploration has been tested and tried in places like the USA, most skills would come from there (Le Roux, 2011).	0
Make sure that gender equality is found in the decision-making process?	Meets not at all	Not specified in the EMP.	0
Ensure that health and safety play an integral part of the EMP for the project?	Meets not at all	It has been included in the EMP but not sufficiently. The lack of health services/hospitals/clinics was underemphasized.	0
Create awareness among local people in the area, to inform them of the expectations of the project and the process of exploration and production for shale gas?	Meets half way	Public participation process did take place but was rushed and answers were vague or false (Havemann et al, 2011).	50
Consider previous development initiatives that could take a back seat during new developments (the	Meets not at all	However, the SKA bid is protected under the Astronomical Advantage Act (Le Roux, 2011).	0

telescope and astronomical projects that were due to be implemented in the Karoo are now under threat)?			
Create distributional equity in terms of making sure that there is always an adequate provision of social services, health and education, gender equity in the capacity building or employment activities, political accountability, and participation during and after the project process?	Meets not at all	At this stage there has been no indication of the ability for distributional equity since this has not been spoken of in the EMP's.	0
Ensure that heritage and cultural values are respected?	Meets not at all	The heritage of the Karoo residents revolves around their environmentally friendly setting/surrounding hence fracking in the Karoo shows disrespect to the heritage and culture of the Karoo (van Vuuren, 2008 and Stahl, 2011).	0
Involve private and public sectors to meet and increase understanding and community and institutional involvement and collaboration?	Meets not at all	Not specified in the EMP.	0
Ensure that all South Africans will benefit from this project?	Meets not at all	Some will, especially those in the cities, but those near the gas extraction area will be negatively impacted (Le Roux, 2011 and Fox, 2011).	0
Cause positive changes in land use patterns and access routes?	Meets not at all	No positive land use patterns – agricultural land will become industrial/mining areas (Fox, 2011).	0
Have a positive impact on immigration of labour force or population levels?	Meets not at all	If so, only temporarily. The aftermath will leave the areas worse off than now (Le Roux, 2011 and Fox 2011). With regards to the health consequences according to the documentary called Gasland, local people have suffered a great deal of trauma and will soon move out of the Karoo, lowering the levels of skilled/positive population growth in the area.	0
Create fundraising and voluntary programmes for staff to involve the community on projects?	Meets not at all	Not specified in the EMP and no mention of it in other documents.	0
Will there be a positive impact on the provision	Meets not at all	Negative health effects and allergies/asthma may result from	0

of social amenities to the community in which the project is situated?		operations: lack of health infrastructure (Fox, 2011).	
Avoid involving any form of child labour in the project?	Meets not at all	Not specifically stated in the EMP.	0
Avoid any form of discrimination based on gender, race, religion, sexual orientation or any other basis related to the employment for the project?	Meets not at all	Most workers are male and will come from the USA. Skilled labour will be used. Discrimination against unskilled class (Le Roux, 2011).	0
Provide workers with a safe and healthy work environment?	Meets not at all	Not specified in the EMP. It's a mining/industrial technique, so that would be the nature of the environment.	0
Respect the employees' freedom of association and their right to collective bargaining?	Meets not at all	Not stated in the EMP.	0
Avoid any form of forced or compulsory behaviour?	Meets not at all	Not stated in EMP.	0
Avoid the alteration, damage or removal of any critical cultural heritage?	Meets not at all	Not guaranteed/specified in EMP.	0
Note the size of the population of which will provide an indication of the volume of demand for government services in a particular geographical area. It also serves as a planning measure to assist budget planners in matching available resources to the relative demand for infrastructure and social services including water, sanitation, electricity, housing and health care	Meets not at all	Not stated in the EMP.	0
		TOTAL SCORE	2.3%

Discussion: According to the criterion of social sustainability, the shale gas exploration/extraction project scores only **2.3%**. This means that it does not adequately take social impacts into account. To improve social sustainability, it should put more effort towards public participation, ensuring that all individuals affected by the project understand

each step in the process, and the harmful effects of the project should not be hidden to them. It should focus on respecting the human rights, heritage and cultural values of the Karoo residents and the environment itself. It should also provide a safe and healthy environment for its workers and members of the general public who could be affected by fracking. In addition the project should make mention of social sustainability in the EMPs, clearly defining the impact of the project on the provision of social amenities and human discrimination during the employment of workers for the project.

4.2.4 Managerial Sustainability

Table 5 below will prove whether or not energy sector projects will be worthwhile at a managerial level.

Table 5: Assessment Criteria for Managerial Sustainability

Assessment Question: Will the project:	**Level**	**Evidence**	**Score %**
Integrate those interested parties in the decision-making processes which are a part of the EIA processes?	Meets not at all	EIA process has not been conducted (Le Roux, 2011).	0
Systematically integrates environmental, social and economic issues into business decisions through use of formal management systems?	Meets not at all	Not sufficiently in EMP (Havemann et al, 2011).	0
Integrates health, safety and environmental, management into one programme?	Meets half way	It is in the EMP but not sufficiently integrated (Havemann et al, 2011).	50
Act to protect an employee or worker who refuses to do environmentally hazardous work?	Meets not at all	Not specified in the EMP, workers handle hazardous substances (Le Roux, 2011).	0
Strives and innovates for continual improvements in terms of sustainability, technology, employment levels, and maintenance	Meets not at all	No mention of this in the EMP nor is there evidence of this in the researched texts since most texts vaguely say that the project will create jobs but do not say to whom nor how many, neither has there been an indication of innovation for sustainability.	0

of the project process?			
Control and assess the performance of the project on a continuing basis for each phase of the project?	Meets not at all	No mention of maintenance, control or assessments (Le Roux, 2011).	0
Building capacity and awareness in both local and provincial levels of authority by making sure that all legislation has been complied with, and that all levels of authority in South Africa are aware and involved of the project process?	Meets not at all	This hasn't been done sufficiently at this stage (Le Roux, 2011).	0
Implement an overt communication strategy?	Meets not at all	No signs of an overt communication strategy (Le Roux, 2011).	0
Provide protection for whistle blowers?	Meets not at all	According to NEMA there should be protection for whistle blowers. The current EMP for this project does not cover protection for whistle blowers.	0
Ensure that the project activity has a positive impact for South Africa and that the following activities have been defined clearly in the EMP: energy supply, energy demand, industrial process, transport, waste management, forestry and land use?	Meets not at all	From the information that has been made available by Shell the proposed exploration will apparently entail drilling 8 boreholes in each precinct (i.e. 24 boreholes in total) of up to 5 km depth over a 3 year period, extendable to 9 years. It appears that each well will need between 0.3 million and 6 million litres of water (a scenario of between 7.2 million and 144 million litres of water required). Shell has been extremely vague as to its anticipated source of water, with no concrete indication being given neither to the draft EMP nor to the public consultation meetings as to where the multinational intends to source the requisite water from (Dr L Havemann et al, 2011).	0
TOTAL SCORE			5%

Discussion: According to the criterion of managerial sustainability, the shale gas exploration/extraction projects scores **5%**. This means that the project does not adequately take managerial impacts into account. To improve managerial sustainability, the project should ensure that all activities have been clearly defined in the EMP and that the EMP is implemented, and activities monitored, assessed and controlled. It is important to integrate decision-making in the various categories such as health, land use, water, and electricity with good communication strategies. More protection should be provided for whistle blowers, not just in the EMP but actively in order to gain administration efficiency.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

Today we need a multidimensional approach, which looks beyond the local environment and integrates a dynamic range of interactions between local, regional and global biophysical and social processes that are generated by and affect communities. An understanding of the relationship between natural and social sciences is necessary. A path towards sustainability can be created through the dynamic relationship between human and biophysical systems.

Complexity theory and sustainable development manifest themselves in a variety of ways, one of the more apparent being based on an understanding of the economic, environmental, social and political factors that affect the environment (Cilliers, 1998). This applies especially to the geometric and environmental uniqueness of extensive arid and semi-arid areas of the world such as the Karoo.

This research project assesses the environmental, economic, managerial and social impacts of the proposed shale gas exploration in the Karoo. Oil prices have been escalating, and time is running out for exploration of alternative energy sources that will reduce imports of oil from other countries. In recent years, shale gas has offered countries an alternative source of fuel and power. As a result South African energy and fuel companies have taken an interest in exploring for shale gas in the Karoo. However, if we want sustainable development we need to be careful with resource utilization to make sure that there will be enough for future generations. Complexity theorists believe that humans are a part of the ecosystem and should not harm their environment. Exploration for shale gas could harm the environmentally sensitive Karoo since drilling (also referred to as hydraulic fracturing) requires hundreds of thousands litres of water, which is a scarce resource in South Africa (Blaine, 2011, Zeiss, 2011 and Tekin, 2011).

Sustainable development requires the elimination of negative externalities that are responsible for natural resource depletion and environmental degradation. It also requires systems that promote lasting economic development, such as those provided by well-functioning ecosystems, a healthy environment and a cohesive society (Chambers, 2005).

In order to roll out an energy sector project, it is necessary to take many aspects into consideration. These include the availability of energy resources; national and local economic conditions of the geographic area that the project is based on; financing options; markets; who will benefit from the project; is it affordable financially; local and global environmental impacts; employment and other social impacts; technological capabilities; human resources; and most of all institutional capacity (Todaro, 1998). It is widely recognized that for energy sector projects to be sustainable, an approach is required which will combine all of these complex and interlinked aspects.

An energy sector project will be successful if it considers at least the following impacts on development projects: economic analysis of economic policies and market practices; full fuel cycle assessments of environmental impact and natural resource consumption; participative planning requirements in energy project development; an assessment of local technical capacity building needs; policy analysis; and multi-criteria decision-making (WEC, 2010 and UNEP, 1997). All these impacts are relevant to the shale gas exploration and production process.

The overall findings of this report are that shale gas exploration in the Karoo is an unsustainable development project in the energy sector not only because of its impacts but also because of the lack of relevant information in the EMP for the exploration.

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