POSSIBLE HYDRAULIC FRACTURING FUTURES FOR SOUTH AFRICA TOWARDS 2055

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DECLARATION

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

Signature: F Naidoo   Date: 1 December 2020

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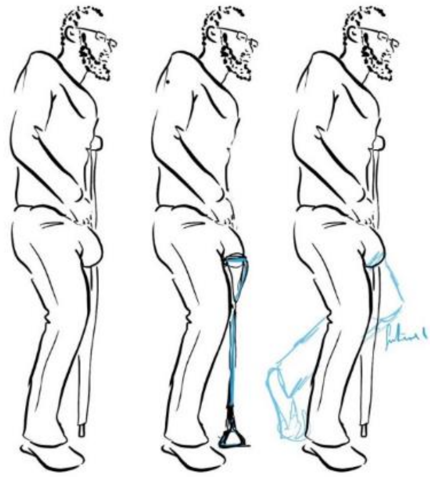
This research is dedicated to memory of the young law student who, despite major challenges, was a source of inspiration and hope to the rest of the respondents in the focus group. May his soul rest in peace.



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ABSTRACT

The successful exploration of U.S shale disrupted the global oil and gas sector negatively, creating a ‘bust’ to individual economies and a strategic boom to the U.S. economy. The phenomenon caused other markets to emulate the U.S success story. This research examines the reasons for the controversy which led to a partial or total ban on the exploration and attempts to unravel the myths and realities that must be managed or mitigated.

This research makes a contribution to the body of knowledge on unconventional oil and gas extraction (UOG) in the Karoo, South Africa. It provides a detailed analysis grounded in future studies theory and practice, which supports the argument that UOG extraction in the Karoo may potentially be conducted under the careful guidance of sustainable development and climate change principles. It is informed by the researcher’s perceptive and experience as a manufacturer of oil and gas products and his understanding of the fossil fuel sector and the role it currently plays in the South African economy. It is further informed by the researcher’s understanding of the sector’s damaging climatic and environmental impacts.

The practice of offering new insights through the application of futures studies is central to the process, and specific methodologies and tools have been used to develop four scenarios for the UOG extraction in South Africa. This framework allows for easy assessment for policy-making. Never before has scenario art, which has been expertly created during the workshops, been used in South Africa to generate memorable and lasting scenarios.

Purpose. This research seeks to provide insight regarding for South Africa’s quest for energy security in ways that support the climate change agenda. Given the shale controversies, most environmentalists prefer lower-carbon and reduced fossil fuel usage. However, South Africa can ill-afford this luxury at this stage and while the research considers the option of no-shale exploration and a direct path to renewable energy solutions (the ‘No-Shale, what now?’ scenario) it also. proposes other options for consideration.

An integrated vision is put forth as the preferred scenario in which shale is the conduit to a sustainable energy future and which implements wide-scale climate change

mitigation and adaptation strategies. Supported by a rudimentary business case, this scenario, named ‘Fracking with a smile on my face!☺’, answers the three primary research questions:

- Is the UOG extraction is safe to be explored in the Karoo, South Africa?
- Is it an economic game-changer for the South African economy? and
- For whom exactly is it a game-changer?

These two scenarios are viewed against the backdrop of the government's current energy plan towards 2030, which is referred to as the 'do-nothing, business as usual scenario' or the ‘Frack Off!’ scenario. In the Frack Off scenario, while gas is part of the energy mix, there is no specific reference to UOG extraction nor the latest Total gas condensate discovery, which could potentially yield R1 trillion to the South African treasury over the next twenty years. A fourth scenario, the ‘Frack and Go!’ scenario, examines options similar to the new wild west scenario of Williston, North Dakota, in which the early days of shale exploration saw many environmental misdemeanours.

Throughout this research, Inayatullah’s (2012) pillars of future studies are used to map the present and future, deepening the future, broadening the future with the development of scenarios and transforming and narrowing it down to the preferred scenario.

This research, which has been conducted over a five-year period, makes a pure contribution to the existing body of scientific, legal and environmental perspectives, which started after the government took a reductionist view that UOG extraction would take place in the Karoo, South Africa. This view led to the consternation of the South African environmental lawyers, scientists and academics, causing each party to table valid concerns on the South African case.

This research examines all viewpoints and under the ‘Planet, Profit and People’ approach and through the lens of the researcher, makes holistic recommendations to policy-makers, developers, international non-governmental organisations and civil society. The research questions the current legal frameworks, the use of the current petroleum contracts, the current property rights issues, the WTO provisions that allow for the active commercial trade and the net effect of these issues on the success of the UOG extraction in South Africa. In doing so, this research provides a framework towards a lower-carbon energy mix and adopts an approach which 'leaves no-one behind'.

Common words: Climate emergency, urbanisation, economic growth and inequality, energy sources and policy development, rural-urban migration, multi-polar worlds, technological advancement, water, energy food nexus, social cohesion, changing values across generations, leaves no-one behind.

ACRONYMS

AEON	Africa Earth Observation Network
AfCFTA	The African Continental Free Trade Agreements
AfDB	African Development Bank
ANC	African National Congress
ASCM	Agreement on Subsidies and Countervailing Measures
ASSAf	Academy of Science South Africa
BBBEE	Broad based Black Economic Empowerment
BGS	British Geological Survey
CBDR	The Combined but Differentiated Responsibility
CCEEL	The Centre for Climate Change, Energy and Energy Law
CDM	Clean Development Mechanism
CEF	Central Energy Fund
CLA	Causal Layered Analysis
CSG	Coal-seam gas
CSIR	Council for Scientific and Industrial Research
CTL	Coal-to-Liquids
DA	Democratic Alliance
DD	Development Diplomacy
DEA	Department of Environmental Affairs
DECC	Department of Energy and Climate Change
DMR	Department of Minerals and Energy
DoE	Department of Energy
EFF	Economic Freedom Front
EIA	Environmental Impact Assessment
EMRI	Environmental mineral resource inspectors
ETS	Emission trading scheme
EU	European Union
EUEI PDF	European Union Energy Institute
EXCO	Executive Committee
FDI	Foreign Direct Investment
FERC	Federal Energy Regulatory Commission
FFSR	Fossil Fuel Subsidy Reform

FGAF	Future Generations Alliance Foundation
FS	Future Studies
GBR	Great Barrier Reef
GHG	Green-house Gases
ICC	International Criminal Court
ICJ	International Court of Justice
IDC	Industrial Development Corporation
IEA	International Energy Agency
IISD	International Institute of Sustainable Development
IOC	International Oil Company
IPP	Independent Power Producers Act
IPPC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IWS	Integrated Water System (IWS)
JSSO	Joint Secretariat Support Office
LNG	Liquefied Natural Gas
Mb/d	Million Barrels per Day
MBTU	Million British Thermal Units (MBTU)
MCAA	Mountain Catchment Areas Act
MEP	Chinese Ministry of Environmental Protection
MFN	Most Favoured Nation clause
MHF	Massive Hydraulic Fracturing
MPRDA	Mineral and Petroleum Resources Development Act, No.28 of 2015
NCA	Environmental Conservational Act (NCA), No. 73 of 1989
NDC	National Determined Contributions
NDA	Non-disclosure Agreements
IP	Intellectual Property
NEA	China's National Energy Administration
NEMA	National Environmental Management Act No. 107 of 1998
NEMAQA	National Environmental Air Quality Act (NEMAQA
NEMWA	National Environmental Management Waste Act
NERSA	National Energy Regulator
NGO	Non-Government Organisation
NGPA	Natural Gas Policy Act of 1978

NGPA	Natural Gas Policy Act of 1978
NMU	Nelson Mandela University
NUM	National Union of Mineworkers
NWA	National Water Act, No. 36 of 1998
O&G	Oil and Gas
OEM	Original Equipment Manufacturers
OES	One Environmental System
OPEC	Oil Producing and Exporting Countries
OECD	Organisation of Economic Co-operation and Development
PA	Paris Agreement (2015)
PASA	Petroleum Association of South Africa
PetroSA	Petroleum South Africa
PS	Policy Sciences
PSA	Production Sharing Agreement
R&D	Research and Development
RE	Renewable Energy
SANEDI	South Africa National Energy Development Institute
SAOGA	South African Oil and Gas Alliance
SARB	The South Africa Reserve Bank
SCA	The Supreme Court of Appeal
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SLO	Social licence to Operate
SME	Small and Medium-sized Enterprises
TCF	Trillion Cubic Feet
TNO	Toegepast Natuurwetenschappelijk Onderzoek
TRR	Technically Recoverable Resources
UEF	University of Eastern Finland
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Education Council
UNFCCC	United Nations Framework Convention on Climate Change
UNLGA	United Nations Local Government Association
UOG	Unconventional Oil and Gas

UPRC	Union Pacific Railroad Corporation
USGS	U.S. Geological Survey
WEF	Water Energy Food Nexus
WFS	World Futures Society
WSA	Water Services Act
WTO	World Trade Organisation
WWF	World Wildlife Fund

AUTHOR'S PROLOGUE

By 2012, UOG extraction tipped for the Karoo, became a subject of intense curiosity and debate. This emotional debate lacked the facts that were required for practitioners in the South African oil and gas sector to establish the much needed local content, stipulated by the government. It was not until 2014, that the topic was discussed with Professor Adendorff, who agreed to supervise me through the doctoral study. Many friends in corporate and academic circles questioned my decision for such a study at doctoral level, given that I had just commenced the assembly of a lubricants blending plant in South Africa.

Moving into the manufacturing sector demanded differentiation as there were 39 private lubricants-blending plants in the country. While other African and global markets started recovering from the 2008 global financial crisis, South Africa, under the Zuma Administration demonstrated very slow progress. It was later known to South Africans that the crippling effect of state capture, was already embedded in all sectors of the South African economy. The energy sector was largely captured, notably Eskom and the coal sector and secret agenda with the Russians, which dictated a nuclear pathway rather than the preferred renewables pathway. Given the widely accepted successes of the U.S. shale, China and other BRICS countries started examining the merits of shale and other energy options to attain energy security. In light of the tremendous opportunity and the lack of data for decision-making, the subject matter was befitting in-depth research. The oil plant was poised for an investment in excess of R100 million and the launch of a new African energy company. The research into UOG extraction could provide differentiation for the new company.

The first years of the study 2014-2015 gathered information on UOG extraction from other jurisdictions. In South Africa, apart from the International Energy Association (IEA) assessments, which estimated reserves of 496 total recoverable reserves (TRR), South Africa has remained unsure of the market's readiness and the exact size of the prize. The government's strongly held view that shale was the nation's economic game-changer was strongly criticised by many economists. By this stage, the shale regulations were in the formative stages and had been incorrectly housed in the Mining Act, much to the consternation of the legal experts, academics and developers. Given that the extraction would take place in the driest part of the country, environmentalists were concerned about the human right to water as well as air and noise pollution, and damage to the flora and fauna, indigenous to the extractive area, much of which has not been surveyed.

During this period, South Africa was also preparing its National Determined Contribution (NDC) to limit green-house gas emissions, (GHG) as part of the preparations for the Paris Agreement (PA) in 2015. GHG emissions, together with water, occupied the central debate of UOG extraction in the Karoo. Post – Paris Agreement (2015), the emphasises of the Water, Energy, Food Nexus approach within the context of the United Nations Sustainable Development Goals (SDGs), became problematic to policy-makers. The entry into force of the Paris Agreement (2015), a legally binding treaty, together with a host of other legal instruments that came under renewed scrutiny, attempted to question the individual energy and industrial patterns which would, in turn, affect the global change of the climate. There was a renewed focus on the precautionary principle and the polluter must pay principle. These legal instruments provided the much-need ammunition that the environmentalists required to question UOG extractive industries and the future of the fossil fuel world.

By the beginning of 2016, the research met several data challenges in the initial attempts to unravel the safety questions in favour of the environment. The economic benefits, being part of the oil and gas sector, as well as the tangible learnings from the U.S., provided adequate data to assume that the extraction could be economically viable. It was only in the latter part of 2016-2017, that South Africans, including citizens of the Karoo, ethnographic researchers and journalists, became aware of the capturing of the state and large-scale corruption, and to ask, “For whom exactly, is UOG extraction, an economic game changer. The specific courses on sustainability, that I took at European universities, were selected in order to help answer these complex, legal environmental questions.

In 2017, I was awarded a scholarship to study for a Master’s Degree in Environmental Policy and Law at the University of Eastern Finland’s School of Law. The university is one of Europe’s leading institutes promoting climate action. The legal internship required as part of the law program was conducted over an eight-month period at the International Institute of Sustainable Development (IISD) in Geneva. As part of the global research team, the internship focused on Fossil Fuel Subsidy Reform in South

Africa. The research culminated in a paper to the World Trade Organisation (WTO) ahead of the 2020 Summit in Kazakhstan. The study questioned the ‘favourable’ pricing of fossil fuels and focused on the future expected concessions and support in favour of the gas and renewable energy sectors. This was the first attempt that unemotionally tackled the cornerstone issues of fossil fuel reduction and supported legitimate arguments that new energy forms, such as shale gas and renewables, may claim support from governments, which would equalise the pricing playing fields.

By 2018, the U.S. started to witness declines in emission levels, which are attributed to the lower coal usage and power replacement by shale gas. Gas, a cleaner burning energy form, is put forth in South Africa as a stepping stone towards renewable energy such as solar and wind technologies. With the plant situated in the rural area of Harrismith in the Free State province, the continued lack of maintenance in water and power infrastructural, led to disruptions in production. Since 2017, water has been distributed in water trucks in the neighbouring black townships and 2019 saw rolling black-outs on a daily basis.

In late 2019 I was contracted by the municipality to address the water, energy and food problems of the constituency of 1 million people. Drawing on the support of the IISD, UN Women, the Africa Union and the African Development Bank, I have drafted strategies for:

- The industrialisation of the poultry sector maximising on South Africa’s comparative advantage;
- A proposed new energy system, which would be financed by green bonds;
- The construction of a dam, which would provide 50 litres of water per person per day, meeting the United Nations minimum quantity in respect of the human right to water;
- Large-scale agricultural projects using artificial intelligence techniques in animal husbandry and crop rotation, and
- Development of the eco-tourism industry.

The plant continues expansion plans, which sees a shift towards the production of water-less vehicle care products and an innovative vehicle protection fluid which significantly reduces emissions in diesel engines in the commercial road transport, mining and manufacturing sector.

With the SDGs providing a framework, the studies of the past five years equipped my colleagues and I to find economic opportunities in promoting sustainability. To that extent, in 2019, I founded a think tank based in New York, which promotes Developmental Diplomacy and large-scale capacity building to support the SDGs in developing countries.

TABLE OF CONTENTS

TABLE OF TABLES

Table of Figures

CHAPTER ONE

1 INTRODUCTION, PROBLEM STATEMENT AND DEMARCATION OF STUDY.

The stone age did not end because the world ran out of stones, and the oil age will not end because we run out of oil (Friedman, 2000).

1.1 INTRODUCTION AND BACKGROUND

The history of the oil market has been marked, since its inception, by a succession of booms and busts, each one leading to a similar psychological climax and to flawed political decisions (Salameh, 2014). In a single generation, humanity experienced the energy crisis of 1973 and the after-effects of a dramatic oil countershock of 1986. The oil collapse of 1998-99 that gave rise to the idea of oil as just another commodity and the sharp price increases following Hurricane Katrina's devastation in the Gulf of Mexico exacerbated this crisis (Salameh, 2013). The world is experiencing the last global oil boom.

Founded in 1960, the role of OPEC was to coordinate the petroleum policies of its oil-producing members, providing member states with technical and economic aid (Salameh, 2004). The United States Federal Government, a key customer accounted for 20 per cent of consumption in 2010 (Magueri, 2011). Not executing its role correctly, OPEC's influence on the market has been widely criticised (Salameh, 2013). With almost 80 per cent of the crude oil reserves and nearly half of the natural gas reserves in the world, within its member countries, the organisation exercises considerable power, with Saudi Arabia, being the largest producer dominates the organisation, with the jockeying for power between Iran and Saudi Arabia (EIA, 2014; Magueri, 2011; Salameh, 2014; Wall Street Journal 2013; Zibakalam, 2014).

1.1.1 The History of Oil Prices Since 2008

In June 2000 *'The Telegraph'* published an interview with Saudi Oil Minister, wherein Minister Yamani articulated trepidation regarding the future of the kingdom:

Thirty years from now, there is no problem with oil. The oil will be left in the ground. The Stone Age came to an end not because we had a lack of stones, and the oil age will come to an end not because we have a lack of oil (Brandreth, 2000).

Being Saudi, Yamani was aware of the devastating effect that the end of oil, would have on the Kingdom's economy, admitting to serious economic difficulties ahead. A week later, the Yamani interview was reprinted in an Australian newspaper *'The Age',* saying that the Saudis and OPEC countries should bear the following in mind:

The stone age did not end because they ran out of stones. People invented alternative tools. Moreover, the oil age will not end because of a shortage of oil, but because we drive the price up so far, so fast, we stimulate alternatives (The Age, 2000).

This particular quote resounded in the oil and gas industry, and started to have a global impact. The world was seeking alternatives, and appeared to have found solutions in shale oil and gas, solar, wind, biomass and hydro-powered technologies.

The International Energy Agency, (IEA) maintains that the U.S., will be the largest oil producer in the world in 2020, overtaking Saudi Arabia and Russia (IEA, 2011). France's 4th Quarter 2018 Gas Projections, presented at Columbia University, illustrated a spike in gas projection for the first time, projecting that in 2023, gas would be the clear leader (IEA, 2018). In 2010, the world watched U.S. news on shale with cynicism. By 2012, oil gurus and experts, amidst an outcry from the environmentalists, started to spin a positive story, justified by higher than anticipated volumes of shale, an increase in jobs and the growth of supplier companies.

The U.S. Geological Survey (USGS, 2008) in its 2008 assessment of the Bakken Reserves, assumed a recovery rate lower than 2 per cent implying an estimated 3 to 4.0 billion barrels of undiscovered, technically recoverable, oil reserves (IEA, 2013) Jackson & Poreda 2014; Vengosh 2013; USGS Report, 2013). The USGS (2013) revised the number again to an estimated mean of 7.4 billion barrels of oil, a two-fold increase in five years. The IEA meeting, in association with S&P Platts, along with the academic experts in New York, presented the latest gas forecast for five years 2018 to 2023 (IEA, 2018).

This forecast illustrates that gas emerges as the most substantial growing component of the oil and gas sector. The highest demand comes from China, as China continues domestic expansion and global industrialisation. With this in mind, the panel of experts elaborated on what the world should be preparing for, in anticipation of another oil shock in 2023.

The United States (U.S.) is predicted to be the largest oil producer by 2020, and energy self-sufficient by 2030 (Magueri, 2013; Salameh 2013). Some may call it a game-changer, shifting the power away from fuel, while others say that the era of peak oil is now over (Salameh, 2013). Magueri (2010) argues that the pessimists are wrong, pointing out that the world is facing neither a problem of oil scarcity, nor an up-coming oil ransom by forces hostile to the West, further purporting that bad political decisions driven by a distorted view of current energy problems, can doom the world economy to a gloomy oil future (Magueri, 2014).

The expansion of hydraulic fracturing from Montana to Texas to Pennsylvania raised U.S. oil production from 5.6 million barrels a day in 2010, to 10.4 million (Trading Economics, 2018). Further output is expected to keep increasing in annual leaps of 1 million barrels-plus for years to come (IEA, 2011) Maugeri, 2013; Trading Economics 2018). The increased production in the U.S., led to the glut in the market, and this led to calls for OPEC to cut production (Salameh, 2013).

In what has been termed as a historic decision, OPEC did not intervene in the market in November 2014 (Salameh, 2015) Saudi Arabia, refused to cut its production for the sole benefit of U.S. market share within OPEC, and compromise the overall OPEC oil policy. In Berlin, on March 2015, at the German-Arab Friendship Association, the Saudi Oil Minister, Al-Naimi (2015) stated that fair pricing for crude, would be around $70 per barrel. To provide world energy market stability, the Saudi Kingdom has emerged as the pre-eminent, reliable and stable supplier within OPEC, by investing heavily, over the decades in storage facilities (Lee, 2014; Salameh, 2014).

In an effort to avoid civil conflict, at the time of the Arab-spring uprising, the Kingdom invested an unprecedented $630bn in social welfare and building projects. With the decline of oil revenues, The Kingdom was hurting (Lee, 2014). In 2015, Salameh (2015), an oil and energy consultant to the World Bank, U.K., held the view that OPEC acted irresponsibly, by not cutting back production to avoid a glut. Salameh’s (2015) view was vindicated with a further drop in price, as all markets were taking strain. The shale producers in the U.S. were also negatively affected (Salameh, 2015). The shale producers needed prices of $72 – $80/barrel to break-even (Forbes, 2015; IEA, 2015; Salameh, 2015)

In late 2015, the drop-in oil prices posed a significant challenge to the hydraulic fracturing operators. Oil producers, Wall Street analysts and most industry experts, claimed that the setback would be brief and minor (EIA 2015; Forbes, 2015; Salameh, 2015). Salameh (2015) agreed that the market would rebound and recoup by the first half of 2015, and achieving $70/barrel was feasible, but it would not be suitable for the Russian, Iranian, and Arab Gulf economies in order to recover. Salameh (2015), further suggested that $100 - $110/barrel would satisfy these producers, enabling further investment into production capacity, which would be good for the world economy as a whole (Salameh, 2015). However, oil is still missing the target, with the oil price still hovering at USD 69.80 (Bloomberg, 2019; IEA, 2019; Trading Economics, 2019).

1.2 PRELIMINARY LITERATURE REVIEW

Examining the global impact of the U.S. shale successes, this research unravels the pitfalls of the industry to date, and attempts to balance the debate between socio-economic impacts and environment protection of unconventional oil and gas (UOG) extraction.

1.2.1 Climate Change

Climate change, being a measurable reality, is primarily as a result of the rising concentrations of human-induced cumulative emissions of long-lived greenhouse gases (GHG) in the atmosphere since the industrial revolution in the mid-1800s (Baumgartner and Korhenen, 2010; Becker, 2006; Christen, 2016). Shale, a widely accepted cleaner-burning fuel is not only an economic game-changer for the world, but it is also an essential enabler towards a lower-carbon future. This section takes a look at some developing markets and the various responses to climate management. Attempting to emulate U.S. success for energy security, China is in the early stages of a hydraulic fracturing revolution (Source Watch, 2014; Yu, 2014). According to reports, China is the world’s largest energy consumer and aims to produce 30 billion cubic meters of UOG per year, as indicated in China’s Twelfth, Five Year Plan (The Diplomat, 2012, IEA, 2018).

India is the third largest energy consumer in the world and faces serious energy insecurities. Eighty per cent of India's hydrocarbon requirement is imported. The basins of Cambay, Assam-Arakan, Gondawana, KG onshore, Cauvery onshore, and Indo Gangetic have been identified as possibly having UOG potential (Bagla, 2008; IEA, 2007). According to Bagla (2008), the Indian government’s response on UOG extraction is slow. However, India’s transition to a lower-carbon society in recent years is laudable, shutting down many coal plants and cancelling planned new plants. As a new world leader in wind and solar technologies, India has already abandoned significant investments already made in new coal plants in favour of wind and solar, after witnessing the very successful yields of these two technologies (Bagla, 2008).

After India, Brazil is the next leader in wind technologies in the world. Brazil possesses significant extractible shale reserves (Curitiba in English, 2013, De Almeida, 2009). However, Brazil’s current priority lies in its 60 per cent biomass production for the nation, as well as wind technology. However, given that shale projects take years to develop, a Brazilian shale industry could not begin viably until the early 2020s at the earliest (De Almeida, 2009).

Nigeria, despite extreme resistance from the environmentalists after the Shell debacle, continues with oil drilling. Ghana, another crude producer and OPEC member, does not favour UOG extraction. At one stage. Ghana catered for as much as twenty-five per cent of U.S. oil consumption. Kenya has newly discovered oil in Turkana, but a decrease in oil prices has proven to be a negative factor in this activity (IEA, 2015). Hydraulic fracturing has not begun in Angola, an OPEC member state, even though the country is suffering from a loss of U.S. revenue and possesses substantial extractable shale reserves (IEA, 2015).

Realising vulnerabilities to climate change, South Africa, joined the other 190 countries and assented to the Paris Agreement of 2015. The country has committed cooperative action and adaptation to the unavoidable adverse impacts of climate change. South Africa stated its goal to remain committed to working with other parties in the Nationally Determined Contributions (NDC) (2014), ensuring that temperature increases are kept well below 2° Celsius, above pre-industrial levels. South Africa further included a revision of the temperature goal to below 1.5° Celsius, in the light of emerging science (IPPC, 2001; Swain, 2012; Paris Agreement, 2015, Talus, 2016; Van Asselt, 2017; UEF Class Lecture: Climate Change Law, 2018).

The realisation of this goal is the essential starting point for the NDC (2014). Earlier mitigation means fewer unavoidable impacts, lessens the requirements for adaptation investments (Swain, 2012, Van Asselt, 2015). Near zero emissions of CO2 and other GHGs are needed, in the second half of the century to avoid even more significant impacts that are beyond adaptation capability (Talus; 2016; Van Asselt, 2015).

South Africa, as a developing country, is also faced with the triple challenge of the elimination of poverty, reducing unemployment and eradicating inequality (Mboweni, 2018). Improved primary education, a developed health care system, new social welfare infrastructure and other basic human needs, require energy in order to develop (Talus, 2016; Van Asselt, 2015). The South African energy model is dominated by coal, with a fleet of old and inefficient power plants reaching the end of the design life-cycle (Burton, Lott & Rennekamp, 2016). The country is also reliant on a significant proportion of its liquid fuels being generated from coal (CEF, 2018; IGAS 2018). Climate change is a megatrend which influences the energy sector. Chapter Three is dedicated to an in-depth analysis of environmental impacts of UOG extraction.

1.2.2 Global Shale

The U.S. shale exploration moved quickly from being an *ad hoc* operation, to being a strategic operation. This research extensively references the report of the authors Fakir and Davies (2016) on the learnings from the U.S., being the first UOG extraction market, for the adoption of new regulations and the development of institutions, noting also the pitfalls of the early years of the exploration (Fakir and Davies, 2016). Other developed markets, with significant reserves, have responded to the UOG opportunity and this research studies the motivation in these markets to explore or ban the exploration. Maugeri (2012), using the imagery of military activity, illustrates the different strategies of oil drilling and hydraulic fracturing used in shale exploration. Maugeri (2012) elaborates that oil drilling is equivalent to traditional armies, which need a comprehensive plan, a long time to be deployed, with plenty of personnel moving accordingly. UOG extraction is more like guerrilla groups needing to operate on a micro-scale, with multiple micro-objectives, agilely taking advantage of time and the opportunity, to reduce costs where-ever possible. The following U.S. shale critical success factors are worth mentioning.

Firstly, in the U.S., a troika relationship of state, the private sector and academia was rapidly established (Maugeri, 2012). The main success factor is attributed to land ownership laws in the U.S., whereby the landowner owns the mineral rights below ground. U.S. land-owners derive a benefit from leasing property, by extracting optimum value and the federal government benefits from the taxes on the optimum use of the property (Maugeri, 2010; Salameh, 2013). The phenomenon provides a positive, collaborative tempo between developers and landlords in U.S. shale exploration, with government playing the role of the regulator and collecting the tax revenue.

In return, The U.S. government focuses on providing infrastructural support, as well as investing in research and development (R&D) in support of the industry. Institutions developed to perform functions on behalf of the government (Esterhuyse and Glazewski, 2016 Fakir, 2015, Jackson, 2017). With regards to the finance, Federal Government also assisted in subsidies, incentives and tax relief, aligning strategies to banking and other financial institutions. A well-developed financial sector, well acquainted with dealing with the volatility of the oil and gas industry had already existed in the U.S. and which readily provided funding for small entrepreneurs, boosting the small entrepreneur sector (Fakir, 2015; Maugeri, 2013; Salameh 2013; Wakeford, 2016, Wall Street Journal, 2013).

Capacity is another success factor which exists in the U.S. oil industry. Oil exploration experts, manufacturers of original equipment (OEM), as well as supply and service providers, were all in place and were regulated by the American Petroleum Institute (API), before unconventional oil and gas (UOG) extraction commenced. The API instituted and extended influence and power to implement the new regulations, which were enacted by the Federal Government. The API is the largest oil and natural gas industry body, claiming to represent about 650 corporations involved in production, refinement, distribution, as well as many other aspects of the petroleum industry. The API spreads its influence across the globe, where the institution endorses standardization and quality of products and services (API, 2019)

As new markets look to emulate the U.S. success story, Maugeri (2013), a well-known oil and gas expert, ex-chairman of ENI Italy, turned academic at Harvard, maintains that the U.S. success will stay in the U.S. and provides plausible reasons for justifying this belief. Years later, despite significant success in the UK, Australia and China, a similar view is held by Palti-Guzman, an expert participating in this research (Maugeri, 2013; Palti-Guzman; 2018, personal interview at *IEA'S Gas 2018 Foru*m, Columbia University, New York, 5 November 2018; Warner, 2010). Maugeri (2013) cites technical competence, latest research and development (R&D), the supply and support of original equipment manufacturers, which may still be lacking in new UOG markets, as plausible reasons for this claim. Furthermore, the U.S. possesses 60 per cent of the global availability of drilling rigs within its territory, of which 95 per cent can mechanically perform horizontal drilling (Jackson, 2015; Maugeri, 2012; Vengosh et al, 2013).

1.2.3 Socio-economic Impacts of UOG Extraction on Ground and Surface Water

A report by the Royal Academy of Engineering in the United Kingdom (U.K.) concluded that risks can be managed through a properly implemented and enforced regulatory framework (Mackay and Stone, 2013). The report, which draws on global shale findings, concludes that the rate of well-failure is low, if the correct standards are followed. The same view of well-failure is not held by the South African authors, Avenant, Watson, Esterhuyse and Seaman, who focused a study on surface water systems in the Karoo, Book Chapter 11, in Esterhuyse and Glazewski, (2016). Esterhuyse, De Lange and Glazeswki, Book Chapter 10 in Esterhuyse and Glazewski (2016), maintain that the American case does not include extensive baseline data for cross-referencing, as even though contamination has occurred, the source could be pin-pointed to well design and construction. A similar view is shared by the American authors, Down, Armes and Jackson (2013).

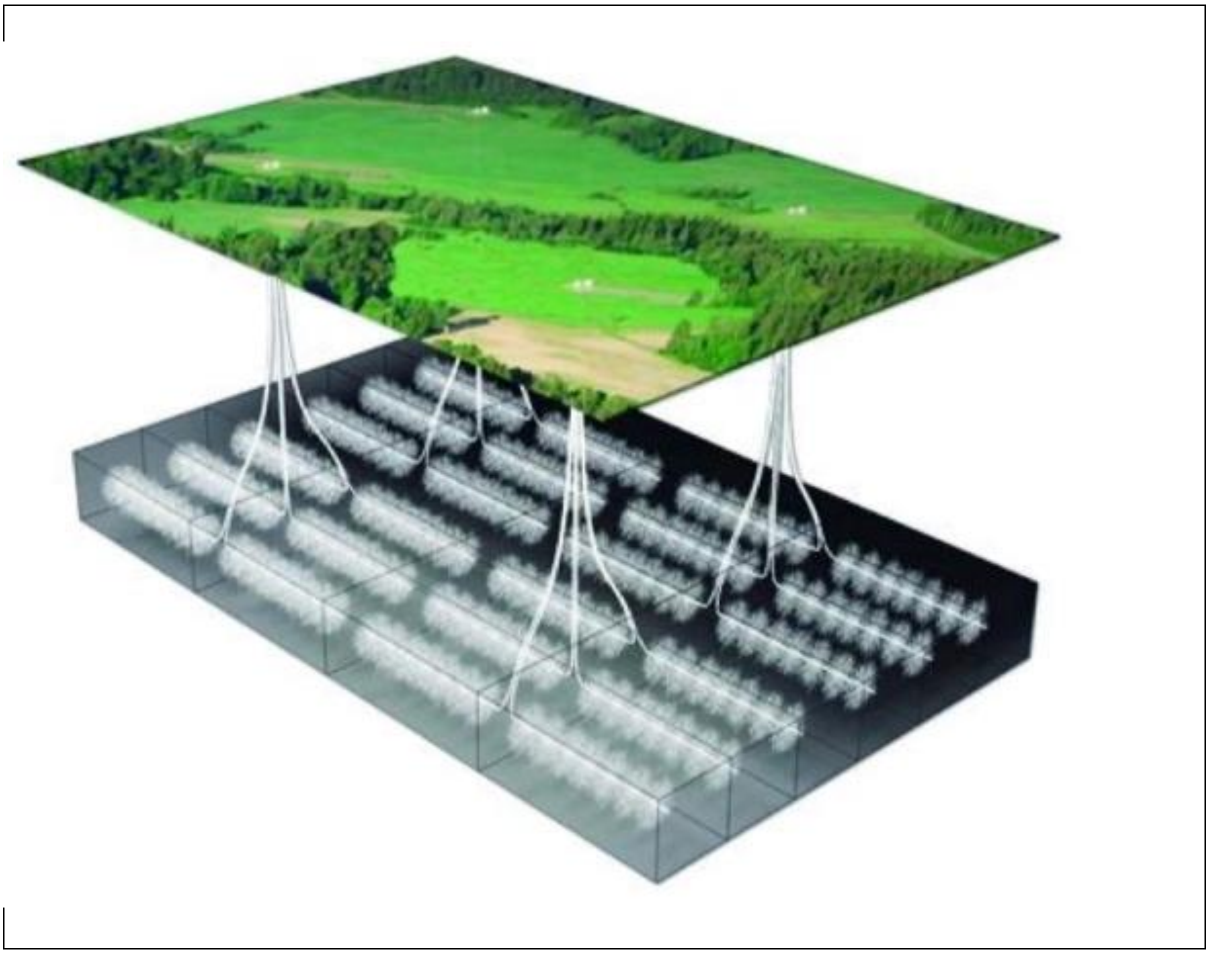
The contamination of water and harm to the environment, is reported to have occurred at surface level (Avenant *et al,* 2016; Down *et a*l, 2013; Esterhuyse *et al*, 2016). Based on these arguments, the socio-economic impacts of the UOG extraction is mainly attributed to the water, given the extensive quantity of water, that is used in this extraction. The following three factors are critical to this study and the impacts are manifested across the three research questions.

Firstly, the process poses risks to the groundwater, in particular as the water quality may be affected by contamination through seepage (UK Water Policy Brief, 2016 Avenant *et al,* 2016). The second impact is that of the quantity of water that is required for the extraction, as a single well could use ten to twenty million litres of water (Esterhuyse *et al,* 2016). The third impact is the management of waste water as in the report presented by the authors Chopra, Sharma and Marfurt (2013). The water filled with gas, has a high concentration of salinity and reduced amounts of radioactive material (NORM), which is extruded back to the surface, which could contaminate surface water. The illustration presented by Lewis (2016) in Figure 1.2, is useful to under the impact of the extraction on the hydrology of the Karoo. There is also the problem of safely treating this water, due to the high content of toxins and the overall safer disposal (Avenant *et al,* 2016). Socio-economic impacts are elaborated in greater detail, in Chapter Three.

The benefits of shale gas, as a cleaner-burning fuel, is widely accepted by the scientific community *(*De Wit 2011; Vengosh et al, 2013*)*. A recent report by the authors Darrah, Vengosh and Schwartz (2018) conclude that after years of the exploration, the debate on the benefits of shale should be settled (Darrah *et al*, 2018). The carbon footprint of shale gas extraction is likely to be in the range of 200–253g of CO2e per kWh of chemical energy, making the overall carbon footprint of shale gas comparable to gas extracted from conventional sources (199–207g CO2e/kWh(e), and lower than the carbon footprint of liquefied natural gas (233– 270g CO2e/kWh(e) (Chopra *et al,* 2013). When shale gas is used for electricity generation, its carbon footprint is likely to be in the range of 423–535g CO2e/kWh(e), which is significantly lower than the carbon footprint of coal at 837–1130 g CO2e/kWh(e) *(*ASSAf Report, 2017; Enercom, 2017*;* De Wit, 2011; MacKay & Stone, 2013; Vengosh*,* 2013*)*

Hydraulic fracturing involves drilling down vertically more than two kilometres, then laterally outwards for as much as three kilometres (De Wit, 2011). The gap between the lining of the borehole that has been drilled and the surrounding rock is then sealed with concrete. The well casing is perforated to allow fracking fluid to get into the rock and gas to escape (Fakir, 2015; Glazewski & Esterhuyse, 2016, Scholes, Scholes & Lucas et al., 2015). Figure 1.1 refers to the underground drilling in hydraulic fracturing.

Figure 1.1: Underground Drilling in the United Kingdom

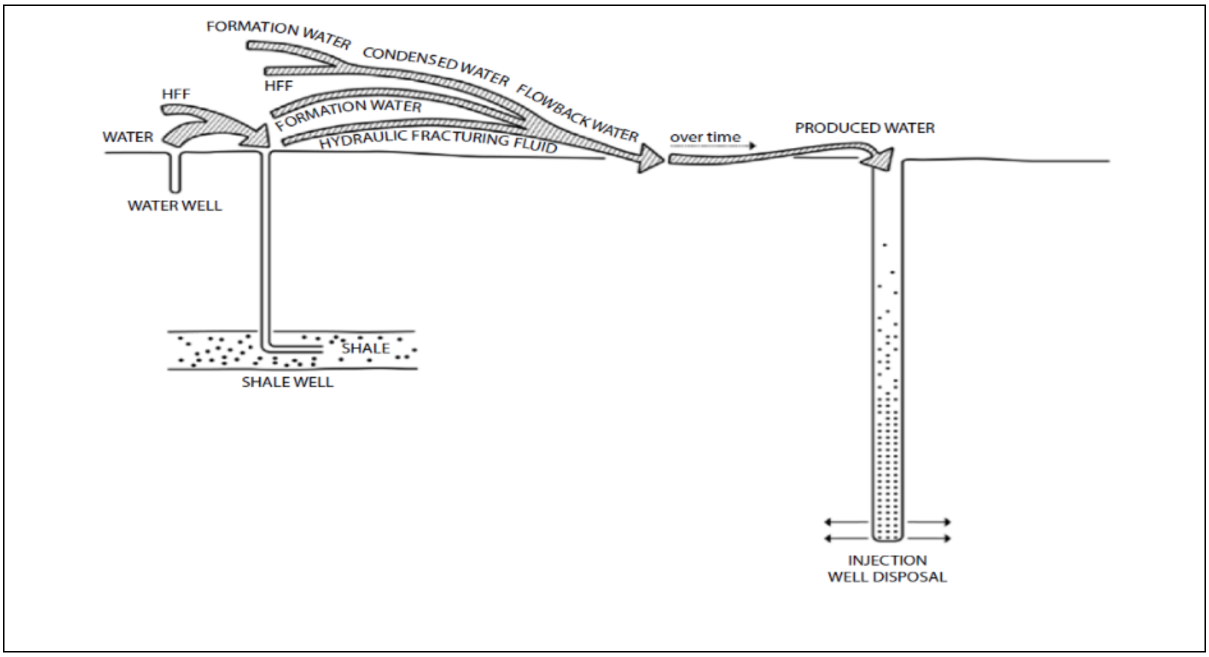


(Source: Royal Report, United Kingdom 2019)

In a typical well, up to 10 million litres of proppants, which is a combination of water containing sand, lubricating fluids and other additives, are pumped into the borehole under extremely high pressure (personal interview with Esterhuyse, 2019). This process opens cracks in the shale for up to almost 50 metres. The cracks are kept open by the sand particles. When the pressure is released, the shale gas escapes. A well-head is installed to capture the released gas, and once this happens, the drilling and hydraulic fracturing equipment are removed (De Wit, 2011).

Kleynhans, Thirion and Moolman (2005) broadly define the area of exploration into the Nama Karoo (level 1 eco-region 26); Great Karoo (level 1 eco-region 1); and the Drought Corridor (level 1 eco-region 18). River eco-regional typing categorises river ecosystems according to physical features, such as rainfall, geology, physiography and ecological features such as natural vegetation (Chopra *et al*, 2013, Kleynhans *et al,* 2005). The researcher examined these details as a background for the reasons of interconnectivity and to assess how the fracking regulations protect these important distinguishing features, all of which are impacted upon by water. Figure 1.2 refers to the extraction processes and technique.

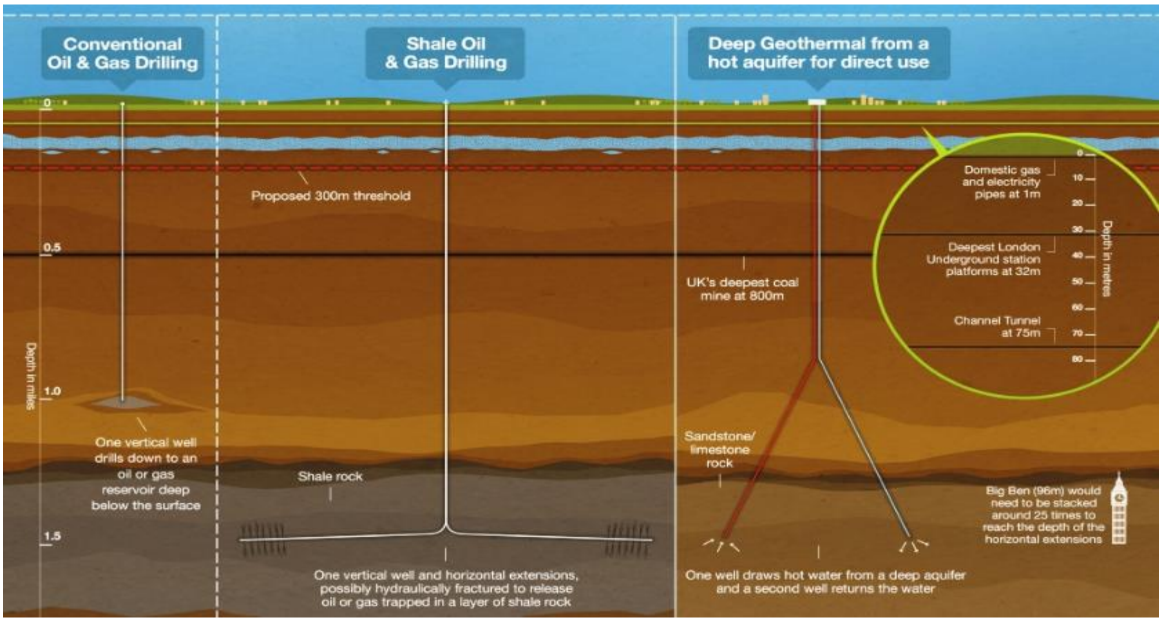
Figure 1.2: UOG Extraction Process and Technique



(Source: Lewis, 2016, p. 250)

Figure 1.3 below, provides a graphical description of three types of common drilling methods used by the oil and gas sector. The diagram depicts the depth of the exploration and the distance away from aquifers. It is important to note that all three techniques bypass the aquifers. The risks in hydraulic fracturing is the toxicity of the fracking fluids when injected and the subsequent higher level of toxicity in the waste water containing the shale gas, before it is extracted at the well-head level (Atangana and Van Tonder, 2014).

Figure 1.3: Three Types of Gas Drilling Processes



(Source: Economist Intelligence Unit, 2011)

This research strongly references the joint research conducted by the Ivy League universities, which was headed by Professors Jackson (2013) of Stanford University and Vengosh (2013) of Duke University. The findings of this collaboration, along with other authors are published in the Vengosh et al, (2014) report. In a subsequent, advanced programme at Stanford University, San Francisco, California, Jackson (2019), continues this research programme, focusing on the chemical content of the air and water and methane leakage, in the fracking areas. Methane leakage is a new core focus area of research and a serious concern of the scientists and global environmental groups, in light of the Trump administration further relaxing air pollution laws (Jackson, personal interview at Stanford, June 2017; Jackson, 2018).

Lastly, Maugeri (2013) explains further that geography plays a vital role, as the shale plays are found in the less dense parts of the rural areas in the U.S, thereby limiting potential risks to humans (Magueri, 2013). The Karoo in South Africa shares this critical similarity. The Eastern and Western Cape of South Africa is water stressed and which was a chief concern of Maugeri (2014) when the researcher first confronted him with the South Africa case.

1.2.4 Shale Economics

Maugeri (2013) continues further that quick deployment of market operations are critical and that the life-cycle of the shale well is a crucial driver in shale economics (Fakir, 2015). Shale oil drilling is different from conventional drilling which operates on extremely long cycles (Asseez, 1969). Typically, the amount of crude oil that is produced declines by between 2 and 5 per cent per year (Hedden *et al*, 2012; Maugeri, 2013). Output falls gradually, and wells typically keep pumping for 20 years or longer (Hedden *et al*, 2012; Maugeri, 2013). Ten-year-old wells often have variable costs of just \$20 to \$30 a barrel, allowing developers to produce at prices of \$60 to \$80 (Hedden *et al*., 2012 Maugeri, 2012; Salameh, 2013).

In the case of hydraulic fracturing, shale wells enjoy a short life. In the Bakken region, namely in Montana and North Dakota, a well that starts out pumping 1,000 barrels a day will decline to just 280 barrels by year two, illustrating a shrinkage of 72 per cent (Salameh, 2013). By year three, half of the reserves of that well will be depleted and annual production will fall to a trickle (EIA, 2013; Hedden *et al*., 2011; Maugeri, 2013; Salameh, 2014; Vengosh et al, 2013). To generate constant or increasing revenue, producers need to drill new wells, since the existing wells span a mere half-life by industry standards (Hedden *et a*l., 2011).

1.3 PROBLEM STATEMENT

Murthi (2019), an advocate for the human right to water, puts forth that three types of problems that exists in the world of environmentalism (Winkler, 2018). In the context of UOG extraction in the Karoo, specifically, where the use of water is ethically indefensible, there is the problem of accountability and capacity inertia. Capacity inertia exists within the area of policy-making, as well as in the implementation by the private sector. In a recent report on shale policy development, the authors, Esterhuyse, Avenant, Redelinghuys and Kijko, (2018), extol the concerns regarding data inertia in policy-making in the Karoo extraction (Esterhuyse *et al,* 2018). Murthi (2019), De Wit (2015) and Green (2016) also mentions scientific data inertia, as baseline studies and other local research and development (R&D) is lacking (De Wit; 2015; Green, 2016; Murthi, 2019).

The IEA (2013) indicators place the Karoo as having the fifth largest reserves of UOG. These reserves are more specifically located in the rural towns of Graaff-Reinet and Jansenville of the Sarah Baartman Municipality. The Sarah Baartman Municipality, in a severely water-stressed region known as the Karoo, is situated in the Eastern Cape region in South Africa. South Africa is dependent on coal and emits the sixth highest level of carbon in the world, at 451 million tons per annum (Credible Carbon, 2012; Du Toit, 2016). Minister Mantashe (2018), incoming minister of Energy and Minerals, in a personal interview at a mining conference in October, 2019 stated that South Africa would continue to mine coal reserves for the next 450 years. The minister had just published the Independent Power Producers Act (IPP), (2019), a framework which contextualizes the role of renewable energy which had been pending since 2012 (IPP, 2019). The minister, in alignment with the local experts, reiterated that the country would investigate all forms of energy, in an effort to gain energy security (Brooks, 2013; Esterhuyse *et al,* 2014; Fakir, 2014). This would include UOG extraction and nuclear energy (Wakeford, 2016).

South Africa's fossil fuel products are imported at high costs, driven primarily by the acute fluctuations in foreign exchange, which negatively impact upon the mining, construction, manufacturing, commercial road transport and agricultural sectors. In need of a game-changing, economic catalyst, South Africa could see accelerated growth in the immediate short-term, and open a new way forward in the years towards 2055 (Bryson, 2004; Cilliers, 2008). The game-changer of shale gas, would allow time for the active development and implementation of other renewables, which would further ensure the reduction of greenhouse gas emissions (Brooks, 2013; Bernstein and House, 2006; Mantashe, 2019). If elements of the U.S. success in UOG could be replicated in South Africa, then South Africa could be well on its way to achieving energy security and indeed pave the way to a prosperous future (Shabangu, 2012; Kramer, 2016; Mboweni, 2018; SAOGA, 2018). However, as pointed out by Murthi (2019), severe information and process gaps which must be addressed, in the short term if the balance is achieved between environmental and economic advancement issues.

A first problem that manifests on many levels in the UOG sector, particularly in relation to the socio-economic impacts of water and which impacts on the human right to water, is the lack of South African, Karoo-specific, UOG research (De Wit, 2010, 2015; Green, 2016; Murthi, 2019). South African UOG-specific literature flourished between 2012 to 2016 and then substantially decreased, as confidence levels in the exploration diminished. The state-commissioned Strategic Environmental Assessment (SEA) (2016), was a desktop survey, which merely collated the insights to that date referencing global data. A pilot shale exploration which started in 2012, was not concluded due to the exhaustion of funds midway during the exploration, which leaves the Karoo still debating on the extractive reserves (Council of GeoSciences, 2018; SAOGA, 2018).

The U.S. being the first market to explore these resources, is extensively but not selectively referenced by policy-makers, which points to capacity inertia, which are broadly referenced (Murthi, 2019). Green (2016) raises the following query:

The collection of data in the United States has been impaired by the widespread use of non-disclosure agreements, which were signed between oil companies and plaintiffs, in respect to hydraulic fracturing, and by the compromised records of the various institutions tasked with environmental protection and has been exposed in critical environmental audits (Green, 2016 p.376).

In the many cases of such incidences, litigators were unable to prove damage, as there was the absence of baseline samples and information. South African policy-makers have based decisions on the Vengosh *et al,* (2014) report, and a few visits to the U.S. shale fields. These engagements have been arranged under the influence of UOG developers, and by the chemical companies, who will provide the raw materials and additives which will be used in the exploration (IGAS, 2018; Jackson, 2018 SAOGA, 2018). With a relatively insignificant investment in local shale research and development, (R&D) rough drilling of a pilot exploration, no national pool of scientific instruments, nor extensive baseline data on which to compare future findings, South Africa policy-makers are tasked to make critical, national decisions regarding UOG extraction in the Karoo (De Wit, 2011; Fakir, 2015). This results in the data and capacity inertia, that is extolled by Murthi (2019), which is apparent, not only in UOG extraction, but also in many other business sectors and which adversely affect the environment.

The second problem is the lack of scientific and technological capacity and was mainly written about by De Wit (2010). Only the largest exploration companies in South Africa have 3D seismic equipment and the funds to operate such equipment (De Wit, 2010). There is no national pool of instruments to monitor seismic pulses related to hydraulic fracturing. There is also a significant lack of academically trained geophysicists, to use instruments and interpret the data (De Wit, 2010; Fakir, 2014; Scholes, Scholes & Lucas 2015). However, individual pockets of critical data exist, such as the shale samples extracted by SOEKOR in the 1960s. These samples are managed by PASA. Work is already underway to build on this platform of knowledge, which was made possible by a government grant to the AEON Institute, part of the Nelson Mandela University, headed by De Witt (2019) (Fakir, 2014; Scholes et al., 2015).

The third problem is the lack of finance, which results in South African academics and research institutions not being able to carry out sufficient investigation, at the cutting edge of this rapidly evolving exploration. Empirical data to evaluate the severe externalities of the shale project is lacking (De Wit, 2011). In South Africa, hydraulic fracturing is a new exploration technique and there is much room for improvement in the understanding of the exploration, as confirmed in the WWF Technical Report on Shale, 2015 (Fakir, 2015).

The fourth problem is the lack of legal and financial policy frameworks. The previous minister of minerals and energy, Radebe (2018), stated in November 2018, on the eve of awarding of licences, that shale regulations which is currently set out in the mining Act, would be enacted separately (BusinessTech, 2018). On 4 July 2019, The Supreme Court of Appeal, (SCA) pronounced the shale regulations which were promulgated in 2015, to be invalid, stating that it was outside the mandate of the minister of mining to promulgate these laws under the Mining Act. This court ruling leaves the UOG extraction in the Karoo, South Africa in limbo. This important discussion continues in Chapter Three.

The fifth problem is the government's dependence on foreign direct investment (FDI) for UOG extraction. Given the heritage of the oil and gas sector since 1901, U.S. financial institutions became well-versed in funding new projects in the oil and gas sector. South African lending institutions, possessing no appetite for the oil and gas sector, remain unconvinced of the viability of shale exploration in the Karoo, South Africa (Investec, 2015).

The sixth problem deals with the issue of water and is the slow development of infrastructural provision, on the part of government. At a technical presentation at the Nelson Mandela University, in June 2015, De Wit (2015) warned against the slow pace of infrastructural development (Fakir, 2015; De Wit, 2015; Scholes *et al*., 2015). To date there has been no further development. In the current shale regulations, the source of water, the central issue in the UOG discourse, remains unclarified. Under the license agreement, water is classified under infrastructure. UOG extraction uses water as raw material, coupled with sand and other toxic chemicals, which is referred to as proppants. A single well could use between ten to twenty million liters of water. This gives rise to another infrastructural problem of the management of the roads. Approximate 500 trucks per day are expected on the roads of the Karoo (De Wit, 2011; Hedden *et al.,* 2012). The next important infrastructural issue is the building of power stations and grid pipelines, as there is not a single meter of gas pipeline in the Karoo (Esterhuyse and Glazewski, 2016). The gas could be required to be piped to larger power stations. It is, therefore, expected that shale gas would power large industries, lessening a significant burden on the grid (Esterhuyse & Glazewski, 2016).

The seventh, and last, critical problem is the absence of good governance. The term ‘governance’, as commonly used, incorporates all aspects of governmental activity, its economic policies and legislative and regulatory framework (Adendorff, 2014). Concerning organisations, good governance refers to independent organisations, which provide quality outcomes for the people, who are involved with such organisations, fostering participative, decision-making processes (Adendorff, 2014; Ostrom 2009).

Repeatedly, the South African government has been criticised for interference in the energy sector. This interfering behaviour which is referred to as political economy will be elaborated in Chapter 4 in the review of the subsidies. A subsidy is considered as any support rendered to an entity by a government (Burton *et al*, 2019). The slowness of the government to react as a regulator, is a problem, which has frustrated foreign investors, leading Shell, the main developer, to exit the UOG operation in South Africa. The lack of a solid regulatory framework is currently evidenced in environmental and economic governance, whereby protection for the environment is a severe gap and commercial expectations of UOG developers are not met. Shell stated the following:

Should attractive commercial terms be put in place and the Karoo project competes favourably within Shell's global UOG and oil portfolio, Shell will continue the on-going consultation with government [and] industry about the long-term opportunities of UOG extraction and the regulations that will govern this industry (Business Day, 2015).

On a socio-economic level, good governance is critical in avoiding the resource curse (Abiodun and Oyeniyi, 2010; Addy, 1998; Berman, 2006). The resource curse is a phenomenon witnessed in countries possessing vast reserves of natural resources, yet which remain economically under-developed (Lawson-Remer & Greenstein,2012). Africa could be prosperous, if good governance was practiced in dealing with mining, oil, and gas companies. Maximum disclosure, anti-corruption rules and economic policies promoting diversified economies are encouraged, while the dependence on resource rents is discouraged (Lawson-Remer & Greenstein, 2012). Transparency International in 2014, surveyed 170 countries and placed South Africa in 67th position amongst the most corrupt countries. Columbia, Norway, Mexico and individual OPEC nations provide excellent examples of effective governance in this sector (Transparency International, 2014)

1.4 RESEARCH METHODOLOGY

Causal Layered Analysis (CLA), a Future Studies methodology, has been used through this research to develop four scenarios. In the assessment of the global drivers for change, as put forth by Inayatullah (2017), six indicators are highlighted:

- The transition from non-renewable to renewable energy.
- The development of a One nation-state driven by global collective mandates such as climate change mandates and targets.
- The growing emancipation of women in the world, moving from patriarchal to gender partnerships.
- A move away from 500 years of capitalism which has led to inequality.
- Hierarchical nodes of knowledge moving to peer-to-peer information sharing.

- The discovery of one dimension of the personality, in which individuals can experience personal bliss and well-being.

The researcher undertook an exploratory study of the literature relevant to this research topic. Given the strong ecological angle of the subject matter, the scenarios were guided by the advice of the Carpenter, Bennett and Peterson (2006). The authors provided a special expose on scenarios for ecosystem services. Exploratory studies are a valuable means of finding out what is happening, developing new insights, asking questions and assessing phenomena in a new light (Bood and Postma, 1998; Bremmer and Keat, 2009). Using an inductive approach, qualitative data were collected using a range of future studies techniques such as the futures triangle, emerging issues template, the Sarkar game as well as back-casting and visioning. Inductive approaches, such as participation, offer a more flexible methodology that permits alternative explanations of what is happening, including the following:

- Identifying the focal objectives and questions: five subsidiary research questions have been devised.
- Identifying and grasping fundamental global driving forces: global megatrends were identified.
- Identifying four possible wild cards.
- Uncovering the constant, pre-determined and critically uncertain, fundamental global driving forces.
- Selecting key local factors.
- Selecting plausible storylines.
- Giving memorable names to scenarios that were developed and fleshed out using compelling narrative.
- Identifying the probable implications of the different scenarios for the Republic of South Africa, paying specific attention to the Karoo as the primary case study.
- Cross-checking for internal consistency and significant differences and testing the policies against the scenarios.
- Setting a vision for the Republic of South Africa based on specific shale pilot exploration in the Karoo.

- Identifying leading indicators and change navigation factors in order to establish a surprise-free and contextually-aligned set of practical recommendations that apply to a developing world context for the Republic of South Africa.

Interviews with experts provided the backbone of the inquiry. The first round of interviews was conducted with experts in the field of future studies. Several experts from around the globe were contacted. The questions ranged from futures techniques and climate change to spirituality in futures studies (Carpenter *et al,* 2006; personal interview with Markley, 2015). The next group consisted of a varied number of international oil and gas experts and shale experts from America, South African scientists working in the field of UOG research and South Africa academics focused on the field of UOG research. The third group included 20 experts from the fossil fuels, coal and renewable energy sectors in South Africa, and who were interviewed about fossil fuel subsidy reform. The fourth group included the Presidency and policy-makers. The fifth group included the international and South African environmental groups. The sixth group consisted of the large commercial farmers and the business community of the Sarah Baartman community.

A presentation was made before The Executive Committee (EXCO) of the Sarah Baartman Municipality. The researcher requested, and was granted, permission to conduct focus group research, involving the youth of Graaff-Reinet and Jansensville. The venues were provided and the respondents were recruited by the municipality. Finally, a workshop, sponsored by the BRICS Academic Forum, South African Energy Cluster, was conducted in Cape Town to address the requirements for capacity building, which will support the upcoming UOG extraction in the area.

The New Real-Time Delphi Method was used to gather data in the initial stage of the data collection, but was abandoned in favour of other less biased, data gathering methods. Reviewing the data that had been harvested by Econometrics (2012) on behalf of the developer, Shell, it was decided that, given the lack of awareness of critical public information such as water and earthquake activity, it would be futile to conduct the New Real-Time Delphi method with the public. The New Real-Time Delphi method has been used in the U.S. This method has been highly criticised and has drawn higher levels of negativity when applied to the UOG sector in the town of Williston, when the first efforts of public engagement commenced.

The sorted data provided vital insights which were then analysed using the six pillars approach of Causal Layered Analyses (CLA), and which ultimately led to the development of four scenarios. The objective of this research, through the scenario–building process, evaluates how the lives of the inhabitants of the Karoo and the rest of South Africa, could be advanced, to join other more evolved markets towards attaining economic prosperity in harmony with nature.

1.5 PURPOSE OF THE STUDY

The discovery of UOG in America has proved to be an economic game-changer and the same is expected in the South African case. The research sets out to examine how this will happen and what will be the subsequent impact on the environment, economy and civil society. South Africa’s energy futures could still be coal-dominant, but employing clean-coal technologies and there will be an increasing mix of gas and renewable energy (CEF, 2017; IGAS, 2017; SAOGA, 2017). Therefore, if South Africa decides to explore all of these resources, the nation could see an ‘economic-game-changer’ in the energy in the foreseeable future (Shabangu, 2012).

This research examined the megatrends which start with the need for global economic growth which is required due to increasing growth of the global population (Carpenter et al, 2006). Increased economic growth sees an increase in the demand for energy. Increased energy demand results in higher GHG emission levels which result in climate risks and impacts upon the health of humans. The megatrends give rise to a myriad of drivers, which change the global energy sector, resulting in the world looking for other lower-emissions alternatives, other than crude products. Therefore, the age of oil does not come to an end because fossil fuel reserves are exhausted, but it is due to the fact, that externalities, such as the megatrend manifestations as the result of fossil fuel combustion, impact adversely on the lives of humans and the planet.

Given the uncertainties of a hyper-turbulent, global future, it is difficult, perhaps even unwise, to forecast and plan for a single, homogeneous future (Inayatullah, 2015). Coupled with the megatrends and the drivers of change, wildcards can be expected to manifest throughout the years towards 2055. The coal-dominated energy system requires a distinct move towards a multi-faceted, sustainable energy approach, which addresses the benefits of technological innovation, oil shocks, climate risks and civil unrest (Escudero, 2016).

Concerns around the socio-economic impacts on water, the increased level of GHG emissions and the increased occurrence of earthquakes and tremors, are the main reasons for the global controversy surrounding UOG extraction. This research examines the various markets where UOG extraction is banned, listing the reasons why governments have banned this exploration, within the context of individual economic options. The research then examines the markets which seem fit for exploration, such as South Africa, which is severely challenged in establishing energy security. The issue of water in UOG extraction is a critical problem. Water as a basic, fundamental, human legal right, is globally acknowledged (De Albuquerque, 2016; Hellier, 2018, Murthi, 2019). The violation of this right in UOG extraction, can be attributed directly to the three main socio-economic issues of water. These are the water quality which can be reduced through this exploration, the massive quantities of water that are used in the exploration and the management of the toxic waste-water, and which have adverse impacts on the surface and ground water, manifesting heavily on the flora and fauna of the Karoo.

The research then examines, the significant social, economic, technical and legal challenges, which delay the readiness for the country to start exploration. South Africa's social problems are analysed more deeply by considering the acute levels of poverty and unemployment, which can be worsened by a resource curse. This research on the social regional economic level, examines how the country could learn from development policies in other markets which have been presented with similar resource opportunities. Technological advancement can provide many benefits, as well as challenges, if capacity building is excluded from the masterplan. It is for this reason, that the research lists technological breakthroughs as a wildcard. The UOG extraction faces critical legal issues, as to date the legal basis which underpins this controversial exploration is still under scrutiny.

These critical factors, listed above, must be carefully analysed and evaluated before exploitation of the resources starts (ASSAF, 2016; Esterhuyse & Glazewski, 2016;

SEA, 2016). The research, therefore, through the use of the classic futures-based techniques, mainly, the ‘Six Pillars of CLA’, provides for four scenarios which demonstrate the economic viability of the UOG project and the degree to which the exploration could potentially change the lives of all South Africans, in the years leading up to 2055. Each scenario provides a set of options and alternatives which could positively or adversely affect the economy of the Karoo, South Africa, towards 2055.

1.6 RESEARCH QUESTIONS

UOG extraction has been an emotive topic sparking wide-scale protest action around the world and which has led to moratoria in many jurisdictions around the globe resulting in partial and complete bans in many countries (Glazewski and Esterhuyse, 2016). The research established a platform of knowledge from the desktop scan of the global literature on shale and the new-found place of gas in the energy spectrum. At first, the researcher contacted the various international and South African shale experts to verify the perceived knowledge gaps in the body of knowledge, five years ago. When key insights emerged, the research questions were framed. Questions around accountability, data and capacity inertia, lack of evidence-based scientific information and baseline data, as well as the apathy and slowness of the government to react to critical issues, have been raised (De Wit, 2011; Fakir, 2015). This research embarked on an extensive review of the legal frameworks under international law.

Firstly, climate change law and policy frameworks which support the sustainable developments goals (SDGs), under the UNFCCC (1992) banner were examined in order to provide the over-arching environmental and economic framework of this research. Secondly, World Trade Organisation (WTO) (1995) commercial laws, examining the legitimate expectation clause and most favored nation clause (MFN) were examined in the commercial context, under which the international oil companies (IOC) will operate in South Africa (Chhabra, 2014; Laing, 2013). Linked to this legal discourse of *lex petrolea,* which refers to the growing discipline of petroleum law, the study presents a review of the current license offerings to developers by the South African government and makes recommendations that the South African government may consider (Talus, 2016; Oil Contracts, 2015).

The South African current energy landscape is of a complex and multi-dimensional nature which is dominated by the coal industry (Ingle and Atkinson, 2015). The UOG extraction inadvertently, is influenced and driven by various inter-related, planetary mandates of climatic change, and which has now become more vigilant in monitoring the emissions of the fossil fuel sector. The South African UOG extraction is subject to the geographical restrictions of the Karoo typography. There are economic and social considerations which affect humans as well as the potential extinction of wildlife, given noise and water contamination (Jarvie, 2015).

The role of the state is to manage opportunities for foreign direct investment and to provide a conducive environment for trade (Ramaphosa, 2018). The role of the financial service providers is to provide finance for the South African local developers and entrepreneurs, specifically in the area of finance for cleaner, energy technologies and renewables. These are two critical areas of finance, which are to examined by this research. In providing a holistic examination of the UOG extraction problem, this research tests the readiness of the South African economy to undertake the opportunistic UOG extraction, and poses three main research questions.

1.6.1 Planet: The Safety Question

Firstly, this research considers the environment and asks the question if fracking is safe in the Karoo, South Africa. This research objective was to accurately assess all the risk factors in relation to humans, flora and fauna and the impact on water, air and below-the-ground seismic activity. Given the dire socio-economic impacts of water, in a severely-challenged, water-stressed area, the research questions, as to whether water usage in UOG extraction in the Karoo, is ethically defensible.

1.6.2 Profit: The Economic Question

Secondly, this research questions the economic benefit and asks the question as to what extent UOG extraction is and can be a game-changer in the South African economy? In doing so, this research puts forth a rudimentary numbers-based model, to ascertain in monetary value, the eventual net gain to the current GDP. This model provides a timeframe on which the economy could plan. Therefore, linked to this question are the agreements that the government would sign with developers. This research questions the validity of the current licence agreements, which are in an advanced draft form and are being discussed with developers. The further objective is to understand the trickle-down and trickle-across impacts on society.

1.6.3 People: The Social Question

Thirdly, while priority is given to the environment (planet), people are also important in this discourse and this research elaborates the question of many South African authors, in effect, for whom exactly is the exploration an economic game-changer? (Glazewski *et al*., 2016). This research examines the right of citizens to water in respect to the UOG extraction of the Karoo and the potential of a looming resource curse.

Table 1.1: Main Research Questions and Objectives

POSSIBLE HYDRAULIC FRACTURING FUTURES FOR SOUTH AFRICA TOWARDS 2055					
Planet		**Profit**		**People**	
Question	Objective	Question	Objective	Question	Objective
Is fracking safe in the Karoo, South Africa?	Understand the risk factors and how these may be mitigated.	What is the extent to which UOG extraction will be a veritable game-changer for the South African?	Demonstrate in numeric terms the extractive value of the new sector, against current GDP and other main economic sectors.	To whom will the exploration be an economic game-changer and what are the timeframes in which these will be realised.	Demonstrate in numeric terms the contribution to the current annual GDP of South Africa towards 2055.
Is water usage in UOG extraction in the Karoo, ethically defensible?	Understand to what extent is the human right to water, violated by the socio-economic impacts.	To what extent is the appropriateness of the current petroleum contract, and what are the other possible options?	Evaluate licence agreements against other modern-day petroleum contracts?	What are the rights of the people in respect to the environmental concerns which have been initiated in the UOG discourse?	Understand the legal rights of the people of the Karoo, South Africa, in respect of the environmental aspects of the exploration viewed against the principles of Sustainable development.
Emerging megatrends which impact upon the UOG discussion in the Karoo, South Africa					
Climate Risks, Water Contamination, Methane Leakage and Seismic Activity		Urbanisation Economic Development		Education and Health Civil Unrest	

(Researcher's Construction, 2015)

1.6.4 Research Objectives and Subsidiary Research Questions

The objectives of this research were to examine the environmental, political and economic issues as well as the social and legislative issues around the energy sector, which emanated from the sixties. Certain business practices were carried into the post-apartheid era, with the new black ‘elite' investors, who continued the practices of the past. Linked to this issue, is the state's support of Eskom, resulting in the subsidiary coal supply chain now being in the hands on the new investors (CEF, 2018; IGAS, 2018). Therefore, given a broad research topic, the main questions are de-constructed into the following subsidiary research questions.

Table 1.2: Defining the Subsidiary Research Questions

Scenario	Research Questions
SRQ1	Economic. Political Economy: To what extent is coal dominant, and why? Who are the actors and institutions who are the current benefactors?
SRQ2	Economic. State Support and Subsidies: What has been the historic nature of subsidies and general support offered to Eskom and the supply chain? How did contracts attract investors? How did the State support SASOL in the initial setup? What is the continued setup to SASOL? In light of climate change and emissions, are fossil fuel and coal companies being penalised for the defaults? How have these subsidies and/or support affected the prices of electricity from RE companies? What is the current level of support of the State to the development of cleaner fuels and RE?
SRQ3	Legal. Legislation: What is the current state of inadequacies of the current legislative frameworks, providing commentary on UOG extraction first and then on renewable energy? What are the current types of petroleum contracts that are being discussed with developers and can one suggest reasons for these contract choices?
SRQ4	Economic. Green Financing: What are the challenges faced in accessing finance for a shale-related project and RE projects in SA?
SRQ5	Legal. Legitimate Expectation Clause: To what extent is the LE Clause under WTO Principles recognised and implemented in SA?

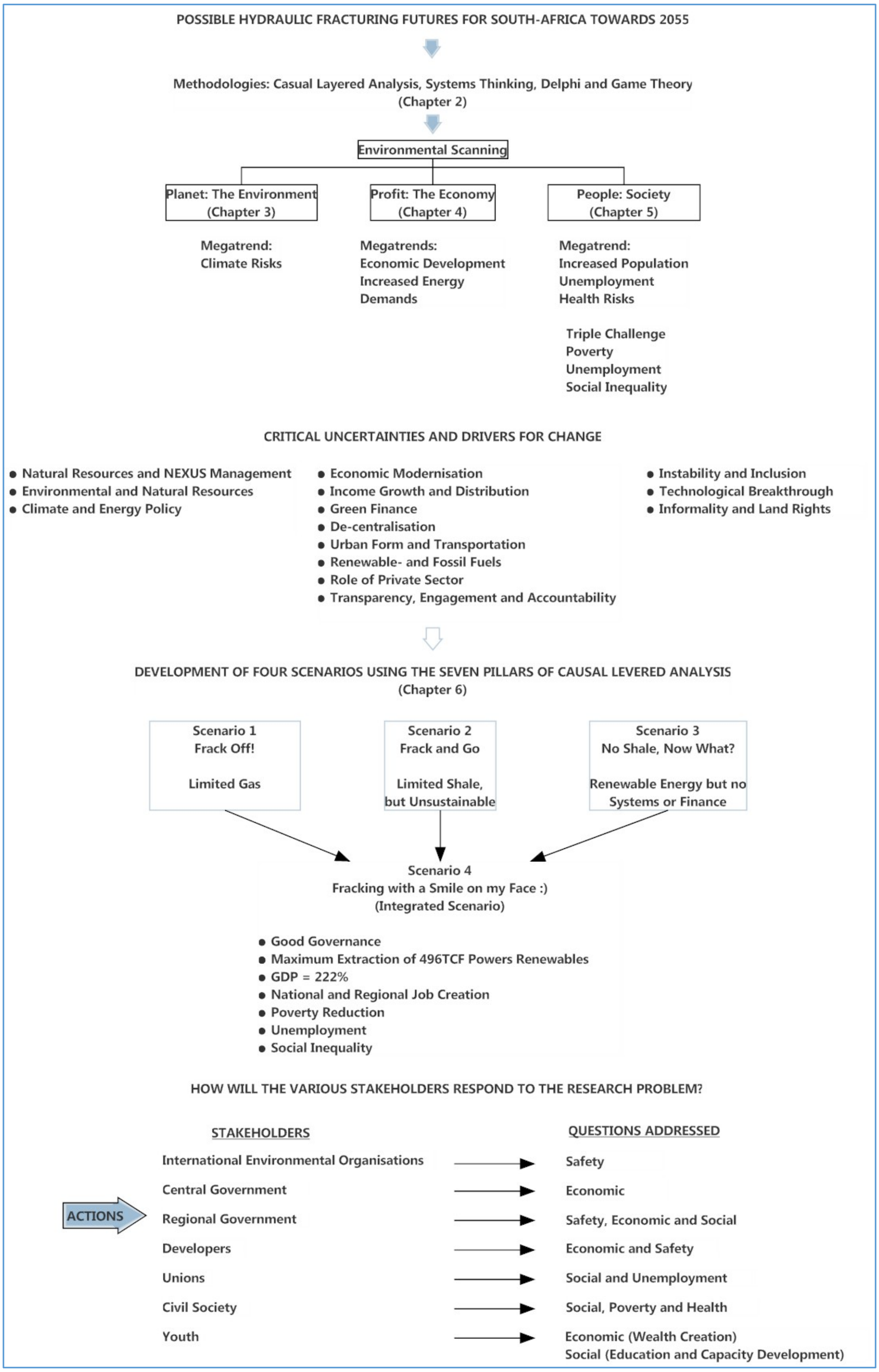
Scenario	Research Questions
SRQ6	Legal. Land expropriation without compensation and the nationalising of mines: What is the impact of this discourse on the Karoo Farmlands? To what extent would State look to amend the Constitution and what would be the timeline?
SRQ7	Environment. Climate Change and NDC to Paris Agreement: How aware are institutions, policymakers and the industry of the overarching climate change discourse and how do these feed into SA's NDC?
SRQ8	Environment. Policy and Regulation: What measures should be improved once the State has finalised the legal frameworks for mining and petroleum and which will protect the environment during all phases of the exploration?

(Source: Researcher's Construction, 2015)

1.7 CONCEPTUAL FRAMEWORK

The conceptual framework below indicates the key drivers for change and how this research is governed.

Figure 1.4: Conceptual **Framework**



Source: Researcher's Construction, 2015)

1.8 BENEFITS OF THIS RESEARCH

It is widely recognised and accepted that many developing countries still need to develop economically. In order to attain a balance while achieving the 17 Sustainable Development Goals (SDGs) this accelerated rate of development requires cheaper and cleaner energy (Talus, 2017). To date there has been no holistic study on this topic and which examines the exploration of the three research questions from an unbiased viewpoint, treating the discourses of environmental protection, the development of the economy and the triple social challenges which face South Africa.

The use of the CLA methodology enables this research to provide the audiences with four sets of options in scenario format. South African can then choose the appropriate set which will lead towards the development of an effective energy policy, which will support UOG extraction first, and which, thereafter, will enable a swift transition towards renewable energy futures. This research is structured into three parts. The first part focuses on the environmental impacts of hydraulic fracturing, and the second part provides a rudimentary business case to assess if the exploration could be an economic game-changer while the third part analyses to what extent the exploration could lead to more desirable futures for the inhabitants of the Karoo in South Africa. These discourses are elaborated in Chapters Three, Four and Five. respectively.

1.9 RESEARCH METHODOLOGY FRAMEWORK

The sections below outline the research framework using the six pillars of futures studies as outlined by Inayatullah (2007).

Based on the findings of this research, different possible futures for the UOG extraction 2055 were developed. These futures are grouped into four scenarios, which illustrate how conditions for UOG extraction in the Karoo, South Africa will play out towards 2055. South Africans are familiar with the ‘High Road’ which led to a political settlement, and the ‘Low Road' of confrontation which would lead to a civil war and a wasteland and which were presented by Ilbury and Sunter (2009). Sunter (1986) of Shell, South Africa, was influenced by associates like Wack (1997) and Newland (1971) in the early eighties, who also worked at the Shell Oil Company. The ‘high road and low road scenarios’ have become memorable names in South African homes. The naming and attaching memorability to scenarios is a critical art which will be explored in this research, applying the rigor of futures-based techniques.

According to many authors, shale scenarios are influenced by factors which may include population growth, consumption patterns, economic development, climate change, natural resources, innovation and technology and the energy policy (Glazewski & Esterhuyse, 2016, Glazewski & Du Toit 2016; Hedden & Cilliers, 2014; Hedden, *et al*, 2012, Jackson, 2000). While a theory of the future is useful, a conceptual framework for understanding the future is essential. To assist in the design of this framework, the Six Pillars approach to futures studies has been applied throughout the study. The following section presents a description of each pillar or step in this research process.

1.9.1 CLA and the six pillars of Futures Studies

CLA is a theory and methodology developed by Sohail Inayatullah in 1991 as a proven tool used for "deepening the future" (Holloway, 2019, p. 88). The following table provides a framework of the tools of CLA, which is used in developing foresight in organisations. This research has selected a few of these tools. The tools carry the direct influence of earlier thinkers that influenced Inayatullah in the formation of CLA. The most notable are: Johan Vincent Galtung (1987), who is noted for the systemic and multi-disciplinary study of the conditions which can lead to peace, for the developing of the structures and the layers, Michel Foucault (1926 – 1984), in terms of post-structuralism and Prabhat Ranjan Sarkar (1921 – 1990) or Shrii Anandamurti, the Spiritual leader, philosopher, yogi, author, cult–leader, poet, composer and linguist, also in terms of the layers (Holdaway, 2019). The four layers may be summarised as follows; the first layer having a data and empirical focus; the second, a social science causative focus; the third a discourse focus; and the last layer having a narrative focus (Holdaway, 2019). De Simone (2004) provides further detail: as presented in Table 1.3.

Layer 1 - The Litany: what are the 'soundbites' we are being exposed to?

Layer 2 - Social causes: surface level interpretation of what is happening.

Layer 3 - The worldview: uncovering meaning as it has been constructed.

Layer 4 - Myth and metaphor: deep story that fuels or blinds the vision (De Simone, 2004, p.486).

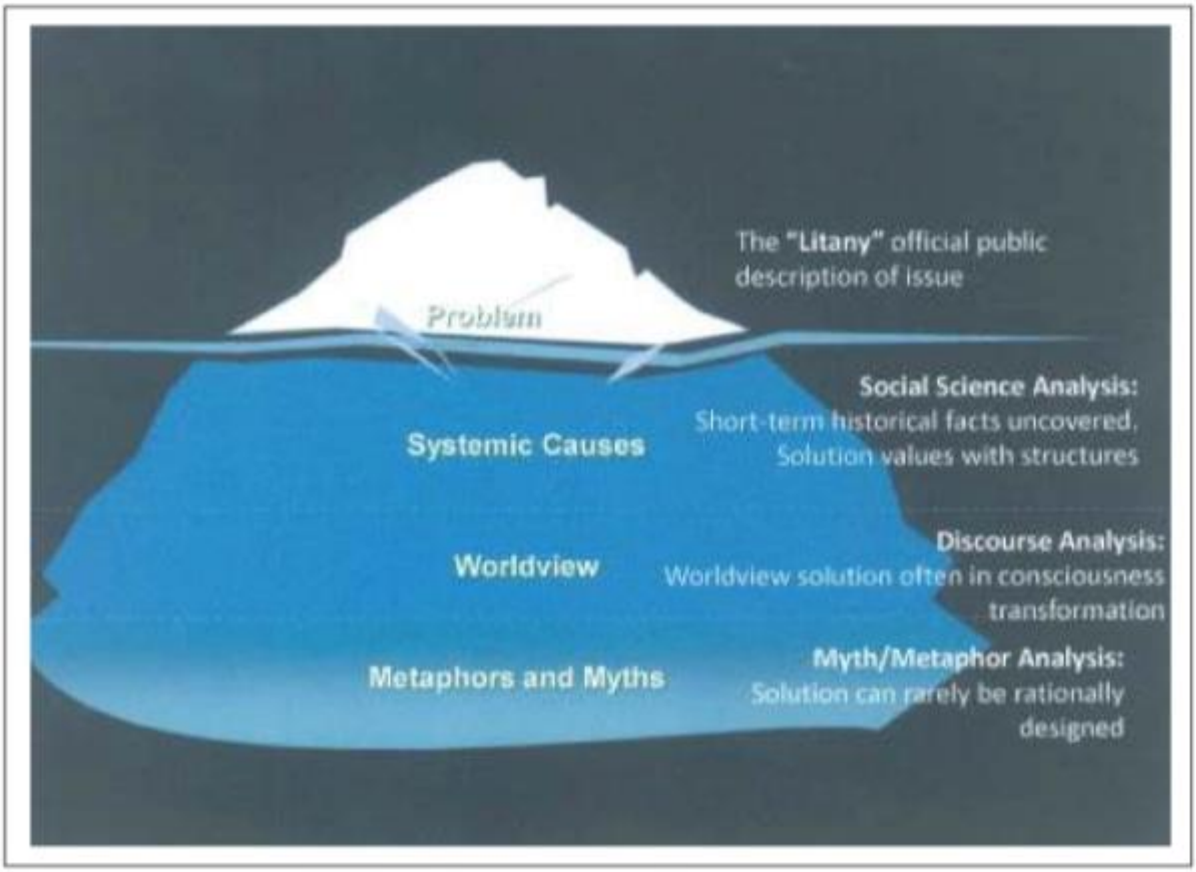
Table 1.3: The Four Layers of Causal Layered Analysis

Layer One: Litany
• What do you see here? • What is happening? • How would you express the image as, say, a news article headline? • What are the reasons for this choice of image?
Layer Two: Systemic
• What are some of the social, political, and economic factors relating to the problem, issue or strength that you have identified? • How does this relate to you? • Why does this problem, issue or strength exist? • If it a problem or issue, what can be done about it? • If it is a strength, how can it be further improved? • How might you go about making change?
Layer Three: Worldview
• What values are expressed in the image? • What is your perspective or viewpoint? • Describe any fears or hopes that you might have. • Are there other perspectives or viewpoints that you are aware of? • What aspects of the image especially resonates with you?
Layer Four: Myth/Metaphor
• What story can you share to further illustrate the image you have chosen?

(Source: Researcher's Construction, adapted from Inayatullah, 2015)

CLA draws largely from “post-structuralism, macro-history, post-colonial multicultural theory” (Inayatullah, 2004. p. 1) Figure 1.5. refers to the graphic representation of the layers.

Figure 1.5: Graphic Representation of the Layers



(Source: Inayatullah, 2015)

1.9.1.1 Pillar One: Mapping the Future

Mapping begins the process of understanding the future (Inayatullah, 2007). The past, present and the future are scanned, which leads to the basic landscape of the future being outlined. It can be likened to visiting a new city and consulting a map and plotting the various navigation points (Inayatullah, 2017 in YouTube). According to Inayatullah (2017) understanding history is crucial. Maps ask the following questions; Where have we been? Where are we today? Where are we going? The process brings in the much-needed quantitative data, as the process collates qualitative and quantitative data for the other pillars (Inayatullah, 2007).

During the mapping phase, an in-depth analysis was conducted to identify the different drivers that affect the road to shale development and the related needs for the establishment of a well-flourishing sector which takes into account the actions and behaviours of actors and institutions. Different possible combinations of these factors were analysed, which then became the basis for the possible futures of UOG extraction in the region. The methodology that was applied is the ‘Futures Triangle’, during which phase, the interaction between the following three forces was analysed:

- The image of the future of UOG as a cleaner burning fuel that ‘pulls’ all energy policymakers, the suppliers to the industry, the developers and the buyers/consumers of energy into the context of external forces forward towards the future.
- The ‘pushes’ of the present that will have a profound influence on the future of the UOG extraction of the Karoo, South Africa.
- The ‘weights’ or ‘barriers to change’ related to each of these future images were also examined as these could be forces that are out of the planner’s control.

The future of the UOG extraction was thus mapped through the above three dimensions. The second step was then to develop plausible futures by analysing the interaction between these three forces. According to Inayatullah (2008), these three forces can also be incorporated into specific shale strategies. The classic method that was used in this pillar was the futures triangle (Inayatullah, 2007).

1.9.1.2 Pillar Two: Anticipating the Future

During the second pillar, the information that was collected in the first phase was interpreted by applying the method of emerging-issue analysis. The emerging-issue analysis in this research has been useful in questioning the motivation behind the comments of certain individual respondents in the youth focus groups.

According to Inayatullah (2007), emerging issues should be provocative, and controversial, stimulating debate, further stating that if there is immediate agreement, it is most likely not an emerging issue but a trend”. Inayatullah (2007) maintains that emerging issues guide all processes that have patterns which often follow the ‘s-curve’, which can be divided into the phases of ‘emerging’, ‘trend’ and ‘problem’ (Inayatullah, 2007, 2008). At the emerging level, there is little or no quantitative data. At a trend level, there is quantitative data but is often debated and contested. At the problem level, one finds that the issue has emerged, where problems manifest with strong emotions as in the case of UOG extraction, based on the substantial volume of quantitative data. In this pillar, the trend analysis may also be used (Inayatullah, 2007).

The key focus of this pillar was to identify possible trends and disruptions, "to search for the seeds of change and to identify these seeds before sprouting" (Inayatullah, 2007, p. 200) as they might have a significant effect on the UOG extraction of the Karoo, in South Africa in the future. The pro-active identification of these issues would allow all involved in the upcoming shale exploration to respond pro-actively to these emerging challenges, with the added benefit of triggering a search for new opportunities. Inayatullah (2007) favours this particular method as it disturbs conventional categories of the future and also has a predictive dimension (Inayatullah, 2007).

The process of a formal environmental scanning exercise to identify all the emerging issues is also proposed by Albright (2004). According to the author, such an exercise would assist decision-makers in the energy sector and, more notably, in the shale sector in order to focus the respective business strategies on action plans for those external forces that can threaten future financing operations. However, it also provides the various actors and institutions with an opportunity to utilise emerging issues to the best advantage. The classic methods that were used in this pillar are emerging-issues analysis and macro-futures (Inayatullah, 2007).

1.9.1.3 Pillar Three: Timing the Future or Macro-history

This phase involves the search for the grand patterns of change, with a key focus on establishing the sources of change. Inayatullah (2007), cites macro historians such as Khaldun, Sarkar, Sorokin, Galtung, Toynbee and Eisler to help understand how the future may turn out. This research uses the Sarkar Game to enact the emotions of the youth respondents in the focus groups, which normally would not be probed if the setting was merely around the table and this researcher behind the one-way window. The identification of the sources of change towards UOG extraction in the Karoo, South Africa was also guided by the following three main sources, as described by Inayatullah (2013a p.20).

- Change, which originates from how policymakers see the future of the UOG extraction of the Karoo, in South Africa.
- Institutional change, which is usually achieved through taxation, legislation or incentives.
- Change comes from the use of new technologies and new innovative techniques which have been improved after challenges from environmental externalities. For example, the use of the gura bean which comes from a small village in Pakistan is turned into gura powder which provides the essential raw material for the new fracking gel. This gel is gentler to the earth during the fracking process.

The classic methods that were used in this pillar understood the grand patterns of change, macro-history and macro-futures (Inayatullah, 2007).

1.9.1.4 Pillar Four: Deepening the Future

During this phase, this research attempted to deepen the understanding of the future of the UOG extraction in the Karoo, South Africa by applying the method of causal layered analysis (CLA), which had been developed as a way of opening up spaces for alternate futures (Ramos, 2015). By applying the method, according to Inayatullah (2013), this phase of this research attempted to integrate the following four levels of understanding of the exploration:

- The 'litany', or the day-to-day future interrogated the commonly accepted understanding of UOG extraction in the current global context and the future thereof, paying specific attention to the concerns of the academic, scientific, and business fraternities, using mainly interviews based on the peer-reviewed literature as well as general interviews. For civil society, more interactive methods, and the de-construction of complex issues into meaningful soundbites which allowed the respondents to articulate 'day-to-day' concerns.
- The 'systemic', which is a deeper level of understanding that focuses on the multi-faceted nature of UOG extraction, as a new energy source and balances the positive and negatives aspects of the exploration. Based on the hypothesis that UOG extraction could be a conduit to renewable energy, the

country's energy policy was examined to evaluate the plausibility of this theory to be manifested.

- The 'culture, or the worldview', the bigger picture or cognitive understanding of how the exploration is constituted focused on the current capacity of the nation and the barriers which face UOG extraction. From the legal standpoint water, which is considered a raw material in the extraction, is not ethically defensible. The socio-economic impacts of water could potentially violate the human right to water, thus providing the cloud of controversy around UOG extraction in the Karoo, South Africa.
- The 'myth or metaphor', or the deep, unconscious story, which, amongst other aspects, unveils the underlying tensions between the civil society, environmentalists and developers, developers and policymakers and civil society and the State.

The water, food and energy nexus compound the analysis in this phase which incorporates the application of system-thinking methodologies. According to Senge (1990) systems thinking can assist in understanding broader concepts of the energy policy of South Africa and the role that gas will play as set out in the National Development Plan (NDP) 2030 and the future towards 2055. In the broader context, coal, being a dominant commodity in the mix, is examined. The Minister and policymakers, who were interviewed, as respondents in the 'expert panels', remain keen on coal, given the country's abundant resources (CEF, 2018; Mantashe, 2019).

Executives at the CEF, refer to the R&D that the State should explore to enhance the current understanding of 'cleaner coal' technologies in order to optimise this abundance in a more climate-responsible manner (CEF, 2018). As early as 2003, the State projected that the future of energy would have to include gas, but it remained unclear if this referred to shale gas at that stage. Whilst it was clarified by Mantashe (2019), the minister explicitly mentioned that UOG extraction was definitely part of the energy future of the country (CEF, 2018; IGas, 2018).

1.9.1.5 Pillar Five: Creating Alternative Futures

Referring to scenarios, Inayatullah (2007) postulated that:

Scenarios are “a tool par excellence” of future studies which open up the present, contour the range of uncertainty, reduce risks, offer alternatives, create more flexible organisations and mind-sets, and even better, scenarios predict (Inayatullah, 2007. p.15).

During this phase, scenario planning is used to broaden the future by creating alternatives to different possible futures towards a cleaner fuels’ society. Various authors also support the use of scenario planning as a method to forecast possible futures for a complex problem such as upcoming UOG extraction in the Karoo, South Africa (Adendorff, 2015; Inayatullah, 2013a; Oberholser, 2014; Ramos, 2015; World Future Society, 2004). According to Swanson *et al*. (2014), scenario planning is especially suited to take a long-term view, when insight is required on different plausible futures. In this regard, Raskin, Monks, Ribeiro, Van Vuuren & Zurek (2005,) describe scenarios as:

> …plausible, challenging and relevant stories about how the future might unfold, which can be told in both words and numbers. Scenarios are about envisioning future pathways and accounting for critical uncertainties (Raskin *et al,* 2005, p.46)

The key benefits of scenarios are that scenarios can prepare the actors and institutions for more than just one outcome (Bishop & Strong, 2010). Scenarios can assist decision-makers to understand what might happen as the result of a decision, one makes (Oberholster, 2014; World Future Society, 2004). Inayatullah (2015), provides a detailed explanation of four models of scenario writing.

The first is the multi-variable, which is developed from the implementation of the futures triangle and the emerging-issues assessment. The second technique uses the double variable method, which was developed by Galtung (1997). Inayatullah (2015) mentions that this method is preferred for strategy development but stresses that its weakness is that no outlier scenario is developed. The third scenario was developed by Dator (2007), which articulates the following scenario types: continued growth, collapse, steady state and the transformational. The fourth scenario type, as proposed by Schwartz (2007) of the Global Business Network, is explained as follows:

- The preferred futures that are collectively desired.
- The disowned, or the world that is disregarded, or is unable to negotiate as forces are out of control.
- The integrated or the world, in which owned and disowned, are united in a complex fashion.
- The outlier, or the future outside of these categories.

Inayatullah (2018) in a recent internet video recording, suggests that “the role of the futurist is dependent on helping governments in anticipating new problems by identifying emerging issues and developing new solutions”. The futurist is, therefore, responsible for how tools may be used, as there are similarities, yet critical differences between the various scenario writing styles (Tariq interview with Inayatullah, 2019).

1.9.1.6 Pillar Six: Transforming the Landscape

In this last phase, the future hones into the preferred future for UOG extraction in the Karoo, in South Africa. Three processes categorise this phase: ‘visualisation’, ‘back-casting’ and ‘next actions’. The desired future is referred to in this research as ‘actioned-oriented’ initiatives. According to Inayatullah (2013), it is also especially helpful when win-win solutions are needed in cases where there is a conflict between visions of the preferred future for such controversial exploration (Inayatullah, 2013).

Furthermore, Inayatullah (2013) recommends the use of participation by all of the stakeholders. Participation as a formal and structured method, was one of the key methodologies used in this research in order to understand the issues at the grassroots level and the issues of civil society. There is then the technique or process of questioning, and Inayatullah (2015) recommends six basic futures questions that are recommended to assist in constructing the future (Inayatullah, 2013; 2015).

Whilst the research lists the tools and techniques which have been developed over the years by the authors, selected tools and techniques have been used in this research. Within the CLA framework, together with the pillars, the authors with the feedback of other futurists have developed specific questions which assist in questioning the future and guides researchers, providing solutions with the futures-based thinking.

- What do you think the future with UOG looks like?
- Which future of risk factors are all shale stakeholders afraid of?
- What are the hidden assumptions of the predicted future of UOG extraction in the Karoo?
- What are some financing alternatives or lack thereof, to the predicted future of the exploration?
- What is the preferred or ideal future for UOG as part of the energy mix?
- What must be done now to get to the preferred future for UOG to be part of the energy futures of South Africa?

The questions were used in the discussions with the various stakeholders and frame the all three chapters of the environmental scan, Chapter Three, Chapter Four and Chapter Five. Given the vastness of the research subject matter, the environmental scan covers the environment discourse, the economic discourse and the social discourse in Chapters Three, Four, Five, respectively. A uniformed set of questions is asked in the introduction of each chapter, and is followed by the same structure in the data gathering process. The questions are useful and guide researchers, using futures-based methods to ask the appropriate questions. Chapter Six, distils and prepares all the data for scenario development. the responses to these questions over the three discourses are linked to the Futures Triangle.

1.10 DEFINITION OF THIS RESEARCH BOUNDARIES

Shale gas deposits are available in many parts of South Africa, but the sweet-spots are mainly found in the Karoo, South Africa. This research is limited to UOG extraction in the Karoo, South Africa.

1.10.1 UOG Extraction

The scope of this research on UOG extraction in the Karoo, South Africa refers to all hydraulic fracturing taking place in the case study of the Karoo, South Africa. This research covers the examination of the impact of all the drilling techniques, the use of raw materials, (such as proppants and hydraulic fracturing fluids), the use of transportation and the levels of GHG emission during the exploration. On the environment-specific issues, this research examines, noise and environmental pollution, the contamination of water above the ground and the aquifers, seismic activity and methane leakage. On economic-specific issues, this research examines three critical elements which influence the economic discussion.

- Firstly, the historic subsidies that have been offered to the fossil-fuels sector, are examined and the research evaluates to what extent the shale and renewables sectors may claim similar advantages.
- Secondly, this research also examines the various petroleum contracts, and evaluates the appropriateness of the current ‘license agreements’, versus the other more innovative and modern petroleum contracts, which have developed with the body of *lex petrolea*, in other countries in the recent times
- Thirdly, this research investigates all social issues concerning poverty alleviation, unemployment and inequality. The research in this section tackles the possibility of a resource curse, which is recently evident, after UOG extraction in Williston, Texas and in Detroit, U.S., which resulted in the gross violation of human rights to water.

All of the above three discourses have legal implications. The research pays particular attention to Climate Change Law, Energy Law, (which tracked the development in EU Law and Policy; *Lex Petrolea*, and WTO Principles (1985), International law with particular reference to the human right to water, international water law and South African domestic water law. This research then examines the current shale regulations in Chapter Three and seeks to examine further what amendments are required to cater for new developing concerns around the socio-economic impact of water. The socio-economic impact of water, takes into account, the ethical use of water, the vast amount of the water that is used in UOG extraction, the quality of water after usage and the management of waste back water (Glazewski & Esterhuyse, 2016 p.3). All of these factors have specific legal impacts, which influence the human right to water of the inhabitants of the Karoo, South Africa.

1.10.2 Economic Policy, Climate Policy and Energy Policy

All countries are on a quest to be energy sufficient and less reliant on Arab and OPEC member countries as energy need doubles over the next two decades. (Lee, 2014; Maugeri, 2012; Salameh, 2013). Poorer households which cannot afford alternatives will either have to absorb higher electricity costs or live with a reduced quality of life (Fakir, 2015). Solid regulatory frameworks, together with strict policy implementation is required for the effective governance of the country.

1.10.3 Climate Action and Sustainable Development

The effects of global warming itself are also forcing the world to look at alternative energy sources which are kinder to the planet. However, the development of renewable energy and the communication of its importance is slow (WEF, Global Risks 2015). In this research, shale is viewed as bridging the gap towards the largescale implementation of other renewables, such as solar and wind technologies.

1.10.4 Futures Studies

The CLA methodology has been selected as the main methodological framework. CLA provides many options that South Africans may evaluate and choose. The three main discourses of the environmental safety, economic viability and the problems within the Triple Challenge, are manifested over the forty years of the study. As a result, this research can provide information for policy-makers who have the ability to influence strategic decision-making for civil society and developers. For civil society, the research may also to be able to paint a picture, through memorable story-lines which have been articulated by the various stakeholders, using an inductive approach. To graphically represent the findings of this research, scenario art has been used as an effective tool to break down barriers in the minds of civil society.

Scenarios are defined by Inayatullah (2007, p.15) as “a tool par excellence”. The four types of scenario writing are presented, and which enables the futurist to understand the background of the various approaches. The understanding of these approaches is important, so that futurists and researchers, when advising governments and policy-makers, may exercise a certain degree of latitude in the modifying of the methods, yet may remain within an academic framework.

1.11 THESIS STRUCTURE: OVERVIEW OF CHAPTERS

This research consists of the following nine chapters:

1.11.1 Chapter One: Introduction, Problem Statement and Demarcation of the Study

This chapter serves as a general orientation to development of the UOG storyline and also provides a brief explanation of futures studies as an approach which directs the research. The chapter also presents the purpose, objectives and research questions and how the future study methodologies and techniques will be applied. Key megatrends and wildcards are defined, which paint the broad picture for the reader, whilst the critical drivers for are discussed in detailed, in the environmental scanning sector, focusing on separate discourses in Chapters Three, Four and Five. The research questions are defined and the conceptual framework outlines the format of the research.

1.11.2 Chapter Two: Research Methodology

Chapter Two focuses on the research design and the methodology of the study, which has been selected to address this research problem. The purpose of futures studies, as well as a motivation in favour of the application of futures study methodologies in UOG extraction, is also presented. The relevant techniques related to each pillar are introduced in Chapter One, but the research in this chapter continues to present and discuss the rigorous structured approach, that will be followed towards the development of the four scenarios, answering the primary and secondary research questions. The research fieldwork which has been explained in detail, which manifests the breadth of the subject matter that has been covered over the past five years. The research also covers, when necessary, the specific interventions which have been taken to develop a critical understanding of climate change, international environmental legal concepts, international commercial agreements and well as human rights.

1.11.3 Chapter Three: The Safety of UOG Extraction in South Africa

This chapter forms part of a detailed environmental scan of the UOG extraction in the Karoo, South Africa. The UNFCCC environmental framework forms the backdrop of the related safety issues which provide the data to answer RQ1, which relates to environment safety within the UOG extraction. This chapter starts by examining the markets which have banned the explorations and the reasons for such action as well as markets in which hydraulic fracturing has been permitted to be undertaken within set parameters. The megatrend of climate risks governs this environment. The scale and patterns, the relevance to energy and the implications are discussed. It is assumed that climate risks will increase in severity in the future. South Africa, a country which is not responsible for the problem, yet needs to develop resilience against this undeniable problem of the future.

1.11.4 Chapter Four: The Economic Impacts of UOG Extraction in the Karoo, South Africa

Three megatrends govern this economic discourse; urban population growth, economic growth and rising energy demand. The scale and patterns, the relevance to energy and the implications are discussed. It is assumed that urban populations will grow until 2055, and that the population of the working age will increase. It is further assumed that the GDP for urban and rural cities will also grow. Through de-centralisation of services, rural cities may grow faster that current urban cities and South Africa must plan accordingly. Total energy demand is expected to double by 2040.

The two-pronged focus of this chapter determines if, monetarily, shale is an economic game-changer, and also whether the future of shale gas presents a pathway to renewable energy. The research sets forth the economic support that the South African government, must put into place to support the UOG sector. To set legitimate parameters, the research conducts an in-depth investigation, into the fossil fuel subsidies which have been afforded to Eskom and SASOL.

A strong regulatory and policy framework is mandatory for this exploration. The research in this chapter, scans the global shale markets, reviewing the promulgation of legislation that is required to make implementation possible. International commercial law provides for various provisions, which protect civil society and foreign investors. Modern petroleum contracts and the recent applications in other markets are discussed and evaluated, against the current license agreements which are likely to be imminently awarded to developers. The horizons (exploration; production; the lifespan of the wells collectively; and ultimately, the years of hydraulic fracturing in the

Karoo) are motivated. The timeframe for the up-skilling of human resources and transformation management, as well as the support industries is recommended.

1.11.5 Chapter Five: Extractive Companies and Society

In this chapter, this research examines the impact of the Triple Challenge of poverty, unemployment and social inequality that faces South Africa. Through the various research techniques, this chapter provides insights into the hearts and minds of the Karoo civil society, thereby identifying the critical uncertainties facing these individuals and the drivers for change in order to attain a full, balanced and prosperous future.

Two megatrends which govern this social discourse are health and education. The scale and patterns, the relevance to energy and the implications are discussed. It is assumed that continuous improvements in both sectors will generally prevail, leading to the accelerated emergence of the black middle-class, demanding and affording better technological services. There will still be the poor, who will then be challenged by technological breakthroughs and South Africa must prepare, in order to leave no-one behind.

1.11.6 Chapter Six: Scenario development

Given the vast enquiry of the environmental scan, spanning over three large discourses, a chapter has been dedicated to the distilling of the data for scenario development. Inayatullah's (2015) 'five futures questions' and the 'futures triangle' are used. This chapter also pays specific attention to the change drivers which may have the same themes but varied implications over the three discourses.

1.11.7 Chapter Seven: Scenarios

This chapter presents alternative and plausible futures for hydraulic fracturing for South Africa towards 2055. Key definitions regarding scenarios and scenario planning, the purpose, as well as the value in development planning, are presented. The chapter also provides an argument in support of scenario planning as a tool to create alternative futures for UOG extraction in the Karoo, South Africa. A detailed description of the steps and stages in the development of scenarios is also presented to illustrate to the reader, the rigour that has been maintained throughout this academic study.

Four scenarios are described, supported by scenario art and video footage of the respondents in the focus groups.

1.11.8 Chapter Eight: Transforming the Current Landscapes and Creating the Preferred Future of UOG Extraction in the Karoo, South Africa.

In this chapter, this research presents a summary of the findings and recommendations for all stakeholders. This research concludes by pointing towards tested examples of sustainable communities (current, living examples from around the world), both for those wanting to maintain the current lifestyle in the Karoo and for the 'city slickers' who would opt for new world cities, such as Masdar, just outside Abu Dhabi. As witnessed in Williston, North Dakota, similar to the days of the 'gold rush', modern communities will develop and there will be a need for modern conveniences like good private schools, shopping areas, and recreational facilities, services which are consumed by upper-income households but currently unavailable in small towns. The Masdar example enables the reader to contextualise the seemingly far-fetched view of this researcher, bringing the reader's mindset into proximity with what is achievable in 2055.

1.11.9 Chapter Nine: Reflections and Conclusions

This chapter concludes with a final review of this research's questions and objectives. These research findings were interpreted against the background of the original research problem and this research objective. This chapter also discusses certain limitations of this research with specific recommendations for future research efforts.

1.11.10 Conclusion

The various chapters, of this multi-disciplinary work, traverse the natural sciences of the IPCC, which informs the climate change agenda, social science, which includes the rule of law, economics and the humanities. All are interconnected and the Water, Energy, Food nexus, is the modern, "wicked problem" within Senge's (1999) systems thinking approach. The main jurisdiction that falls under the spotlight, is by default, U.S. market, given the game-changing successes and it being the first market to boldly, embark on this extraction. The U.S, has a heritage of oil and gas exploration, which has its origins in the early 1900s. Over time, specific laws, relevant to oil and gas exploration have been amended and specific institutions have evolved, as new oil and gas options were discovered. Not all the UOG pitfalls have been documented and Green (2016) pointed out serious shortcoming in U.S. scientific literature. Therefore, policy-makers in South Africa, need to 'look before they leap', and should heed De Wit's (2010) early warnings that government should carry out local assessments based on local geological, sociological and economic factors, before any extraction may begin (De Wit, 2010).

CHAPTER TWO

2 RESEARCH METHODOLOGY

2.1 INTRODUCTION

The stone age did not end because the world ran out of stones, and the oil age will not end because we run out of oil, (Hubert, 1999).

Hubert, a scientist from Shell, a company not new to foresight, sparked the discourse that led to the cleaner fuels which the industry and the world now regard as commonplace. Through a scientific investigation into fuel cells, which generate clean energy from hydrogen, Hubert (1999) discovered by default and submitted that cleaner fuels would replace coal powered stations. Hubert's (1999) work, therefore started to impact on society. Hubert's discovery in the light of climate action caused organisations to use foresight to investigate lower-carbon futures.

At this early stage of modern FS, organisations remained confused about strategic planning and futures studies. Inayutullah (2015) offers explanations which distinguished planning and future studies. Planning intends to control and close the future, whereas the future studies approach provides various outcomes which are committed to authentic, alternative futures, adopting a more participatory approach. The participatory approach encompassing the views of all stakeholders and resulting in action-oriented approaches, is termed as 'creating the future'. Chapter One explained the research problem and determined the scope and parameters of this study.

At the commencement of this research, a panel of shale experts were identified. Shale experts from the U.S., were interviewed to understand the evolution of UOG extraction the future prediction of the contribution of shale to the U.S. economy. The most notable experts were Jackson (2019) and Maugeri (2015). At the beginning of the research Maugeri (2015) was requested to join the panel of experts. The author, a Harvard academic and shale expert articulated concern pertaining to the source of water for the hydraulic fracturing process. Two years later, the researcher travelled to Stanford University and interviewed Jackson (2017), one of the authors of the Vengosh et al, (2013) report, to verify most of the findings to date and to gain new insights on the subject of methane leakage.

Examining the shale situation in South Africa, aspects of CLA have been used to assess the current situation regarding hydraulic fracturing, covering environmental, legal, political and social factors. This chapter includes an explanation of how futures methodologies, scenario planning and this research process has evolved during the period of the research. The ethics and values of futures studies were reviewed and debated to ensure the setting of parameters for responsible recommendations and scenario building.

2.2 ORIENTATION AND SCOPING

The success of humankind is manifested in the advances in technology and economic developments. Social and cultural polarisations as well as the reduction in biodiversity have arisen as consequences. The escalating impact on the environment has created a new set of problems in the current comprehension of wicked problems (Slaughter, 2010). While there is growing confidence in the role of futures studies, the discipline needs to remain modest and aware of its limitations (Slaughter, 2010). Slaughter's (2005) thinking was moulded years earlier and a knowledge base of futures studies was conceived enabling futurists to achieve a number of ends.

- Help make futures studies more precise and more meaningful.
- Promote intercultural dialogue in dissolving systemic problems and the framing of viable futures.
- Provide new academic material for new courses in futures studies.
- Promote innovations of many kinds.
- Support the process of creating a society-wide foresight capacity.
- Constitute a gift to future generations.

Slaughter (2010) was not the only futurist pre-occupied with the growing discipline. Harold D. Lasswell (1902 -1978) struggled for more than four decades, well into the thirties, to create what is now known as Futures Studies (Bell, 1997). Lasswell's chagrins are documented by Wendell Bell (2010), who provided an exposé on the progression of approaches, adopted by the U.S. political scientist. Lasswell (1958) proposed policy sciences in 1951. The purpose of the futures studies and policy sciences was to study policy and decision-making, as policy-making necessarily relies on future anticipations.

Lasswell (1958) put forward the idea of a ‘developmental construct’ similar to the ‘image of the future’ or ‘vision’. This method of futures research was called ‘developmental analysis’ and was used to analyse social trends and future possibilities. Policy Sciences (PS) and Futures Studies (FS) were initially intertwined until distinctions were made and, by 1990, resulted in the divergence of the two fields of inquiry. After pointing out similarities, De Leon (2011) concludes that policy research is focused on the short term with some immediate policy in mind, while FS, typically deal with more extended periods. Another belief was that policy scientists are interested in implementation analysis, while futurists are not (Bell, 2003).

The primary purpose of futurists is to maintain or improve the welfare of humankind, and carry out this purpose by systematically exploring alternative futures (Bell, 2010). Futurists try to create ‘new’ alternative images of the future, through the exploration of the possible, systematic investigation of the probable and the moral evaluation of the preferable. The role of futurists is to ensure that in the discourse of sustainability, long-range planning should be encouraged in the development of new methodologies.

To some extent, ‘new voices’ in the form of women, young people and the previously disadvantaged have grown out of the techno-elite (Krawczyk, 2008; Slaughter, 2010; Lee & Shaw, 2012). As language becomes less of a barrier, new voices continue to emerge from non-westernised corners. Sarkar’s work on the future of Islamic civilisation marked the turning away from western pre-occupations to more universal ones based on a variety of other cultures (Krawczyk, 2008; Slaughter, 2010). Inayatullah (2008) explored the work of the Indian mystic, Sarkar, and used this ideology as a springboard into the approaches of other civilisations.

Commenting from FS perspectives, Indian mystic Sarkar extols the benefits of the overall well-being of the futurist and the psycho-somatic balance that is required for positive visioning of the future. Sarkar was the founder of the Ánanda Márga Pracáraka Saḿgha, an organisation which promotes the ‘path to bliss’. The researcher, who is of the Christian faith, had attended an Ánanda Márga service in Johannesburg, and began an inquiry into the socio-spiritual organisation and movement, which led to deeper understanding of the original threads of development of spirituality in FS and the overall values put forth by Sarkar. This study would later prove beneficial in anticipating outcomes of the Sarkar game, which was used, years later in this research. Leading futurists such as Markely (2015), Miller (2015), Ramos (2015) and Inayatullah (2018), extol the benefits of spirituality in FS and this trend is growing uniformly around the globe via the various international bodies for FS. It is also noteworthy, that Inayatullah notes that spiritual awareness is one of the six trends of the future (Inayatullah, 2018).

A trend of new voices in the area of spirituality, outside futures circles is also developing. Arron Wolf (2018) water expert, scientist and academic involved in the analysis of conflict resolution amongst the riparian countries of the various river basins speaks of a different method of resolving conflict (Wolf, 2018). Wolf (2018), in many interviews, speaks of rationality, which is the tone of serious discussions. Rationality in these discourses is extended to philosophies and ethics (Wolf, 2018). Wolf (2018) advocates the role of spirituality in conflict resolution and cites that two-thirds of all water-related disputes have been settled through peaceful measures. Environmental scientists increasingly recognise the need for holistic approaches to be formulated for policy development regarding the environment.

Water diplomacy is relevant to this research, and therefore this research pays attention to the various growing trends which enables new solutions to wicked problems. Wolf (2018) also goes further in looking at the direct effect of hard law, pointing out the reasons for failure due to its rigidity. Soft law mechanisms, while still providing the rule of law, provide for less ‘strict’ measures, wherein state and non-state actors behave more naturally. Belinskij (2015) also concludes that these were shortcomings of the two transboundary water conventions. The United Nations Economic Commission for Europe (UNECE), realising that previous mechanisms have not worked, commissioned new research methodologies which treat problems more holistically to deal with transboundary riparian issues in developing markets and Asian countries of the Mekong River Basin (MRB) (personal interview with Berlinskij, 2017).

A parallel thinking has been witnessed at the Kyoto-based, Future Generations Alliance Foundation (FGAF). The Foundation fosters the exploration of eastern religions and philosophy, which includes Zen insights. These efforts have not only been made to develop and establish a ‘future generations’ perspective but also to develop future generations universities, which will alter the ‘map’ of FS and produce and enrich a global futures discourse (Slaughter, 2010).

2.3 THE CONTINUED DEVELOPMENT OF FUTURES STUDIES

Slaughter (2010) categorises the evolution of FS into at least four phases, each having a distinct set of characteristics. The first phase started in America after World War II and was influenced by Hermann Kahn (1965) and Edward Cornish (1927 – 2019 in the empirical tradition, which was used to incorporate other contexts. The main contributions were formative, which led to the development of new tools and new ways of thinking and operating. While its focus was almost exclusively on changes in the external world, it developed a range of useful strategies for exploring the dynamics and possible futures of that world. The most well-known of these include trend analysis, technology assessment, forecasting and scenarios.

Systems theory, chaos theory and other sub-disciplines later developed, along with the development of modelling and computing, when more sophisticated insights were incorporated. By the mid-1980s, this line of development was in decline (Slaughter, 2010). Futures Studies developed in many places including the Soviet Union, and many Eastern European countries, and notably in Hungary. In Western Europe, namely the UK, Scandinavia, Italy, Belgium and France, a more culturally-oriented tradition became established (Slaughter, 2010). The movement was led by Robert Jungk (1994) and Eleonora Masini (2018). The trend was more open to the realms of society, culture and individual or group values. The approach was more introspective than the U.S. approach and was more interested in questions of value and meaning. Bernard de Jouvenel's *the Art of Conjecture* (1967) and Johann Galtung's (2010) peace studies, developed an activist-emancipatory focus.

The work of Jouvenel (1967) led to the art-oriented approach, which defined the Futuribles School in Paris, France. Jungk (1994) Masini (1986) and Galtung (2010) were pivotal in the formation of the World Futures Studies Federation (WFSF). Critics dismissed the European approach as anti-science and anti-technology in outlook (Burns, 2010). Anticipating possible futures in this turbulent environment calls for greater creativity, skills, insight and understanding. Leaders are required to consider a whole range of new opportunities and possibilities and data more than ever must be more accurate (Burns, 2010).

Geldenhuys (2006) highlights the fact that traditional methods for forecasting may have become outdated, due to the new ‘turbulent context'. Researchers urge a more flexible planning approach which considers a broader range of possible future scenarios as opposed to current forecast efforts (Geldenhuys, 2006; Veldsman, 2002; Weeks, 1990). Bood and Postma (1998) argue that when there is a high level of uncertainty, scenario-based planning yields more excellent value than when compared to other estimating and forecasting processes. Using this method, the signals of change can be identified much earlier. By identifying these signals, leaders can turn unexpected occurrences and situations into opportunities that can be exploited ahead of the competitors (Bood and Postma, 1998; Geldenhuys, 2006).

Geldenhuys (2006) states that scenario-based planning appears to be more aligned with the present-day business environment in this rapidly changing time. Veldsman (2002 highlights the fact that many developing world countries borrow planning practices, such as scenario-based planning from the developed world. Veldsman (2002) warns that this practice is high-risk, as this happens without testing contextual validity in the new context. Such planning can only be successful if the socio-economic structure of the particular society, its political system and ideology of the ruling power are taken into account. These factors are said to have a direct impact on the “role, processes and organisation of planning” (Geldenhuys, 2006: p.265). Political factors play a more prominent role in developing worlds. In this context, political power is always applied, along with technological and socio-cultural values. These prominent factors result in substantial differences when considering different countries.

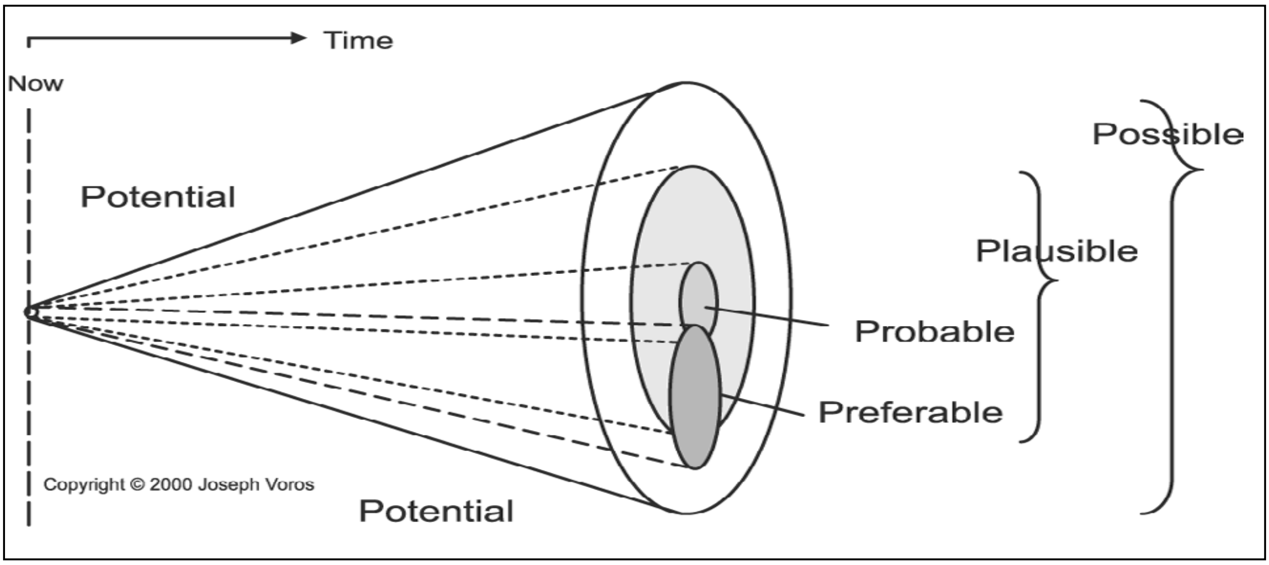
Turning towards Africa: situations in African nations, or developing worlds, differ significantly from other countries such as those in Western Europe and North America where basic concepts and techniques of planning have evolved and been developed. Thus, strategic planning concepts and techniques may not be appropriate for the African context (Conyers & Hills, 1984; Kiggundu, 1989). Inayatullah (1991) started to speak of started to speak about the six pillars approach to FS and provides a sound framework for understanding issues. What makes the six pillars approach effective and powerful, is the logical sequencing of foresight concepts, questioning and the application of strategic foresight methods. The word ‘future’, generally refers to the extrapolation of ideas and images to make sense of what is assumed about tomorrow or what might, or will, become the future for the given context (Inayatullah, 2008).

The six pillars of Clausal Layered Analysis are as follows:

- The pillar of mapping futures
- The pillar of anticipating futures
- The pillar of timing futures
- The pillar of deepening futures
- The pillar of creating alternative futures
- The pillar of transforming futures

According to Voros, 2005, the futures are possible, plausible, probable and preferable. Figure 2.1. refers to the classic foresight process.

Figure 2.1: A Foresight Process Framework



Source: Voros, J .2005.

Furthermore, according to Inayatullah, these 'futures' might be any of a number, as presented in Table 2.1.

Table 2.1: The Types of Futures

Defining the Types of Futures	
Future Type	**Description**
Default future	The often considered 'right' future, such as a vision statement, • which is assumed rhetoric and does not require questioning or • comment (Inayatullah, 2007).
Used/borrowed future	Refers to a future that is purchased or borrowed from • others and is usually based on ideas and images that have been consciously or unconsciously adopted but which were constructed by others (Inayatullah, 2007).
Disowned future	Refers to futures which are ignored within oneself or can • represent the views of others, different cultures and perspectives, outside of which there is a dominant and generally accepted version of the future (Inayatullah, 2007).
Alternative future	Traditionally futures that create flexibility through • scenarios providing a range of choices and potentially different futures. • Society generally believes that there is only one future whereas there are • many probable, possible, plausible or preferred futures (Inayatullah, 2007).
Models of social change	Refer to the understanding that where patterns of change emerge, the aim is to determine where individual influences can best change within the current structures of social change (Inayatullah, 2007).

(Source: Inayatullah, 1991)

2.3.1 The Purpose of Futures Studies

The aim of futures thinking is to disturb dominant structures (historical and present patterns) and narratives (stories) through futures thinking and questioning to invite agency for change, to investigate future ideas and images and the consequences thereof, and finally, to seek to create new possibilities and alternatives through challenging dominant ways of knowing the future (Inayatullah, 2008). Inayatullah's (2008) core thinking on futures is that futures are not singular but plural. Humans have agency (influence), which in turn can influence the future. Images of the future can move into the desired future. Images of the future can be based on historical narratives that have travelled through time and cultures.

2.3.2 Characteristics of Futures Studies

Is Futures Studies considered a science or an art? Masini (1993) characterises FS as trans-disciplinary, complex, global, normative, scientific, participative and dynamic. Krawczyk (2008) argues that a *trans-disciplinary* approach is a characteristic of many disciplines. Slaughter (2010) believes that the western/industrialised worldview based on certainty, predictability, control and instrumental rationality had become fractured and incoherent (Burns, 2010). Wendell Bell proposes three solutions to the art-science schism and the post-positivist revolt.

The first, is the recognition by Bell (2010) and Jouvenel (2010) that the futures field, by its very nature, cannot be a science (Burns, 2010). Many futurists working today, believe that Futures Studies is an art. Bell (2010) then concludes that artists, unlike scientists, are not obligated to tell the truth (Burns, 2010). Bell (2010) suggests that the art-science-schism, is an inter-generational paradigm shift, that is still in progress and that a new generation of futurists may have different orientations.

Secondly, Geldenhuys (2006) speaks of Afrocentric leadership. Niiniluoto (1990) further summarises that futures studies are seen as a branching tree with alternative possibilities and graphical, statistical, and quantitative methods and limits. The discussion to the level of problem-oriented futures, in contrast to Rivet's (1990) critical mode. Rivet's critical mode was offered to replace Niiniluoto's (1990) decision science with and action science orientation, which enables the fusion of scientific methods and which contains "conditions, counterfactuals, dispositional, theoretical speculations, creative speculations, creative formulations of hypotheses, and predictions" with the awareness of psychological, economic, cultural, and socio-political implications of forecasts.

Thirdly, Bell (2010) supports the critical realism approach which defines science as being a collection of statements which are either linguistic or numerical, regarding the nature of reality (Burns, 2010). Ogilvy (1998) also, had earlier viewed critical realism as a middle road between the empiricists and sceptics.

2.4 TYPOLOGY OF FUTURES RESEARCH METHODOLOGIES

According to numerous authors (Amara, 1991; Dreborg, 2004) are aligned to Hancock and Bezold's (1994) view that FS can fall into three categories; probable studies, possible futures and preferable futures, which in turn are based on three questions about the future; What will happen? What can happen? and How can a specific target be reached? (Hancock & Bezold, 1994). In response to these questions, there are three corresponding, classical or archetypal 'modes of thinking'; the predictive, the explorative, and the normative or visionary mode of thinking (Dreborg, 2004).

2.4.1 Dreborg's (2004) Predictive Thinking, Explorative and Normative Modes

The predictive model of thinking attempts to get an indication of what will happen, by trying to find the most likely development in the future, in order to be better prepared. The explorative mode of thinking is characterised by openness to several possible events and different developments. The strategic purpose is to be better prepared to handle emerging situations, with the idea that it is impossible to predict what will happen. The normative or visionary mode of thinking, thrives to envision how society can be designed, in a better way than at present (Dreborg, 2004).

2.4.2 Quantitative and Qualitative (objective and subjective)

Whether scenario planners use a modelling or storyline approach, the method can be categorised as quantitative, if it uses numerical information in the form of tables and graphs. If words and stories are used, the approach is qualitative. The qualitative approach adds the emotive qualities of the situation, with the disadvantage of the lack of statistics. Modelling, on the other hand, is criticised for providing only one point of view of how the future will unfold.

2.5 THE PROCESS OF STUDYING THE FUTURE

In an article published in Foresight, in 2008, Inayatullah (2008) sets forth the stages of foresight development and six basic futures questions are proposed. The Six Pillars are explained explicitly, detailing specific tools and techniques which guides new researchers to the methodology and seasoned futurists, to question the future. Some examples which may be referenced and which are used in this study, are the Futures Triangle in Pillar One, the emerging analysis in Anticipation, which is Pillar Two, the various categorisations of timing in Pillar Three, CLA, myth identification, the changing of metaphors and developing of new narratives in Pillar Four, which is known as Deepening, Scenario Development and CLA Incasting in Pillar Five. Visioning and back casting are the only techniques, used in this study, which are part of the Transforming of Landscapes in the Sixth Pillar (Inayatullah, 2008).

The future process has six foundational concepts and six pillars. This research assumes an optimistic future of the game-changing nature for UOG extraction in the Karoo, South Africa and which can be shaped by all the stakeholders such as central and regional government, developers, investors and civil society. This research focused on the uncovering and mapping of the UOG extraction. The objective was, therefore, to assist in the generation of a preferred future for sustainable energy forms in South Africa where shale gas, together with renewable energy, moves towards a lower carbon future. This research assumes that the adequate amount of extraction is required to facilitate the transition to a future of renewables based on the concept of Hubert.

2.5.1 Overview

Environmental scanning is described by Albright (2004) as the process of translating internal communication of the external information, which primarily focuses on those external issues or factors that have the potential to make a profound impact on decision-making in an organisation. Sutherland and Woodroof (2009), describe useful environmental scanning as a process consisting of using foresight to identify essential developments, having the insight to understand the implications and acting to ensure that the foresight and insight are available for use in the decision-making process. An additional objective that is highlighted by Gordon (2009) is the early identification of possible critical future developments. Kosow, and Gaßner, (2008) share similar views on futures, scenario development and analysis.

2.5.1.1 Pillar One: Mapping the Future

In the first pillar, the past, present and future are mapped, and this research in this section attempts to plot how hydraulic fracturing would be possible in the Karoo, drawing from the U.S. experience. This research conducted an in-depth environmental scan of the mining and petroleum sectors to uncover possible quantitative and qualitative drivers of change that exist. Albright (2004) proposes that operations, technology, regulatory, economic, social, and political environments be included in a comprehensive environmental scan. Sutherland and Woodroof (2009) further suggest the inclusion of a sustainable natural environment. The aim of the environmental scan in this research was to provide insight into the multi-dimensionality of energy and the shale sector. The energy sector is necessary for sustainable development and heavily depends on the inclusive and equitable economic growth of all sectors associated with the energy sector.

The environmental scan also focuses on the values, processes and systems generally associated with justice and fairness of human and non-human issues which will be impacted upon by this exploration. The primary FS tool used in this pillar is the futures triangle as described by Inayatullah (2008) and which performs the following:

- The pull of the future: The images of the future that pull energy and gas futures forward.
- The push of the present: The quantitative drivers and trends, such as demographic changes that are changing the current carbon-intensive energy landscape to a low carbon future that is lower in price but which will allow industrialisation to be fast-tracked.
- The weight of history: The barriers to changing the legacy of the coal-dominated environment.

2.5.1.2 Pillar Two: Anticipating the Future

The second pillar of futures studies is anticipating, with the analysis of emerging issues as the primary method (Inayatullah, 2003, 2015). The method, which intends to investigate the responses to emerging issues or challenges pro-actively, usually identifies the regions, where social innovation starts. This research provides an analysis of the emerging issues in the run-up to the UOG expedition, with the following key objectives, as proposed by Inayatullah (2013a):

- The identification of a trend or the possible presence of a trend;
- The identification of new possibilities and opportunities; and
- The identification of possible disruptions or wildcards, which are described by Reich et al. (2011), as low-likelihood, high-impact surprises that may reshape the trajectories of events and situations.

The identification of possible trends was further guided by the definition of Reich *et al*. (2011) The authors describe trends as factors arising from broadly generalised change and innovation, experienced by everyone and often in more or less the same contexts, insofar as they create broad parameters for shifts in attitudes, policies and business focus over periods of several years that usually have global reach (Reich *et al.* 2011). During this phase, essential questions were also asked regarding these emerging issues and which were guided by the questions proposed by Horton (1999). Responses to the following questions were, therefore, used as critical inputs in the process of foresight creation:

- What does this mean for the shale exploration of the Karoo, South Africa and its inhabitants?
- What are the implications for key stakeholders, such as developers, international and local investors, policy makers, institutions and new emerging entrepreneurs?
- What are the issues that challenge the possibility of shale exploration in the Karoo, South Africa?

2.5.1.3 Pillar Three: Timing the Future

The third pillar is about timing the future, involving the search for the grand patterns of history and for the sources of change (Inayatullah, 2013a). This research also acknowledges that the future of the UOG extraction is born from the need for a new energy source, which is a cleaner energy than the coal. It is, therefore, necessary to establish where the change comes from and to search for both patterns in change, as well as the stages and mechanisms of long-term change (Inayatullah, 2008). An added advantage of futures studies, according to Bishop and Strong (2010), is that futures studies help to classify change by source, level, horizon and rate. These authors also highlight that, fundamentally, change comes from the following two sources, with the future always being various combinations of both sources:

- Inbound change, which comes from the world around us, and over which people have little control.
- Outbound change, which is created by oneself-in an attempt to influence the world towards a preferable future.

Inayatullah (2013), highlights the following three sources of change:

- Change, which comes from how one sees the world.
- Institutional change
- Change, which comes from new technologies and which alters the way things are done.

Dator (2007) suggests that real change comes from new technologies and further argues that new technologies are the basis of social and environmental change. Changes, according to Bishop and Strong (2010), manifest at three levels, namely; the enterprise level (individuals, organisations, and communities), the immediate transactional environment (the environment one deals with regularly), and the global environment (the world).

The following patterns, adapted from Inayatullah (2008), were, therefore, also used to guide the identification of key actions which need to be taken in account to shape the future of the UOG extraction:

- The future of the South African lower-carbon energy plan and UOG extraction is linear, stage-like and would require a significant effort by all the stakeholders.
- The future of the South African lower-carbon energy plan and UOG extraction is cyclical, which recognises that there will be ups and downs.
- The future of the South African lower-carbon energy plan and UOG extraction is a spiral, with parts that are linear and cyclical parts. In this future, the past is not disowned, but rather it is integrated in a better future.

2.5.1.4 Pillar Four: Deepening the Future

The fourth pillar of futures studies concerns the deepening of the future South African energy plan with causal layered analysis (CLA), as the primary method that was applied (Inayatullah, 2015). The method can open up spaces for alternative futures, assisting this research in reconstructing the critical assumptions about the way the UOG extraction is constituted, to provide a meaningful gas contribution within the energy mix towards a lower carbon future. CLA has four dimensions or levels, namely; the litany, the systemic, the culture or worldview and the myth or metaphor. CLA does not privilege any particular level. Each level is true (at its level) and internally consistent. Also, it requires that solutions need to be found at each level, and it then seeks to integrate the different levels of understanding. The different dimensions, a description of each, and the required level of understanding of each dimension. Table 2.2. refers to the layers of CLA.

Table 2.2: CLA Framework

Dimension	Description	Required Level of Understanding
Litany	The surface. The day-to-day future or commonly accepted headlines of the way things are or should be. The endless stream of clichés, media fragments, outlandish statements and disinformation.	Interventions lead to short-term solutions, easy to grasp, packed with data.
Social/Systemic Causes	The more in-depth focus on the social, economic, and political causes of an issue, which must be dealt with historically and into the future.	Answers require interventions by efficiency experts
Culture/ Worldview	The big picture or paradigm that informs what is thought and is real or not real.	Seeking solutions from outside the framework in which the solution has been defined. Change is much harder and longer-term.
Myth or Metaphor	The narrative or the deep unconscious story, which is connected to certain unconscious principles of ordering both perceptions and descriptions.	Requires the most profound interventions and the telling of a new story. Rewiring the brain and building of new memories.

(Source: Adapted from Inayatullah, 2015. p.43)

The influence of systems theory on futures thinking, and the inherently systemic outlook is also evident in the CLA method. According to Inayatullah (2013), it is especially useful in more in-depth approaches that deal with complex, human-related problems. The incorporation of systems thinking is also supported by Peder and Bagheri (2006) and Floyd (2008). Peder and Bagheri (2006) argue that any system in which humans are involved is characterised by bounded rationality, limited certainty, limited predictability and evolutionary change. The authors, therefore, argue in favour of a more adaptive approach, characterised by constant learning and modifications of the decision rules. Systems thinking, according to Floyd (2008), allows one to communicate systemic perspective and, in doing so, it involves a process of abstracting concrete features of experiences from the direct experiences.

2.5.1.5 Pillar Five: Creating Alternative Futures

The fifth pillar of futures studies concerns the broadening of the future of UOG extraction, with scenario planning as the primary method used to provide alternative futures (Inayatullah, 2015). The method seeks to open up the present, to reduce risk, to offer alternatives and to create more flexible organisational mind-sets.

2.5.1.6 Pillar Six: Transforming the future

The last pillar of futures studies is transformation of landscapes, where the future is narrowed to the preferred and which can result from the scenarios which can be created by the process of questioning (Inayatullah, 2013). The following three transforming methods are described by Inayatullah (2013):

- Visioning: The process where the preferred future is discerned through a process of creative visualisation.
- Backcasting: The process whereby individuals are moved into the preferred future, and the vision can then be 'back-casted' to fill in the space between today (the future) and the past.
- Transcendent method: This method is used when there is a conflict between visions of the future and the focus is on finding win-win solutions, instead of compromise or withdrawal.

Before moving onto the scenario building process, the research lists the five scenario methods as put forth by Schwartz (1991):

- The multi-variable method, which is derived from the futures triangle and is used to create a range of scenarios.
- The second variable method, which identifies the two significant uncertainties and then develops scenarios based on them. This is the Galtung method.
- The articulation of scenario archetypes or perfect examples of possible futures (the 'ideal-world' for shale gas).

- The method of scenario writing in which the scenario structure is composed of four variables, namely; best case, worst case, outlier and business as usual.
- The method developed by Schwartz (1991) consists of four dimensions, namely: the preferred (the future all want), the disowned (the future people reject or are unable to negotiate), integrated (the future where the owned and the disowned are united in a sophisticated fashion); and the outlier (the future outside these categories).

2.6 THE SCENARIO-BUILDING PROCESS

In this section, this research explains the developmental process of scenarios as advocated by the doyens of futures studies.

2.6.1 The Chosen Method

The chosen method for this research was based on the eight-step scenario method proposed by Schwartz (2007), as explained in 'The art of the long view'. The method of Schwartz was then expanded through the incorporation of additional steps and stages, as proposed by Geldenhuys (2006) and Adendorff (2013) and which allows continuous reviewing of the existing strategies and ongoing learning.

2.6.2 Description of the Steps and Stages

2.6.2.1 Stage 1: Prepare

Step 1: Lay the Foundation

In the first step, the scope and objectives of the scenario-planning exercise are clarified, and the design process is developed. Critical decisions must be made regarding the participants, and in this case, all the stakeholders have been considered as well as the types of scenarios to be built, and the implementation of these scenarios which are realistic and provide possible, plausible and surprise-free energy options for South Africa, towards 2055 (Geldenhuys, 2006).

Step 2: Identification of the Focal Issue

The next step is the identification of the central or focal issue, which in this case is the cleaner energy options for South Africa, given the current economic circumstances. In this regard, Schwartz (2007) suggests one begin ‘from the inside out’, rather than ‘from the outside in’. This implies the identification of a specific issue which is then built out towards the environment. The author also proposes to identify an issue known to have a significant impact, and where there were uncertainties about its impact over time.

2.6.2.2 Stage 2: Explore and Build

Step 3: Listing of Critical Factors

The critical factors in the operating environment that influence the potential success and failures in the UOG extraction must then be listed. (Schwartz, 2007). In the case of this research, the factors related not only to the America insights that have been listed and incorporated, but also to the latest developments and key insights from the UK, Australia, Canada and China. The following questions require solutions in order to develop into the next level.

- What would decision-makers in the shale sector want to know, when making decisions regarding appropriate business strategies and product offerings for shale, as part of a basket of energy goods for South Africa, and how these would interact with each other?
- What would decision-makers in governments want to know when making decisions regarding the appropriate policies, to effectively facilitate higher levels, between the stakeholders during the exploration, as well the future supply of cleaner energy to the nation?
- What would be seen as a success or failure; would the evaluation be considered on the grounds of economic benefit or the impacts upon the environment?
- What are the considerations that will shape those outcomes?

Step 4: Listing of Crucial Driving Forces

Once the critical factors in the operating environment are listed, the next step is to list the driving forces in the macro-environment that influence the identified vital factors.

According to Schwartz (2007), forces relevant to the social, economic, market, political, environmental, and technological environments need to be considered. Some of these forces are predetermined (e.g. demographics), while some are highly uncertain (e.g. public opinion). This step is the most research-intensive step in the process of scenario development, with a critical focus on defining the driving forces and a search for significant trends. This exercise is conducted in Chapter Three, Chapter Four and Chapter Five.

Step 5: Ranking of Critical Factors and Driving Forces

During this step, the key factors and driving forces are ranked. Two criteria are proposed, namely; the degree of impact or the importance for the success of the focal issue and the degree of uncertainty regarding the identified factors and trends (Geldenhuys, 2006; Schwartz, 2007).

Step 6: Selection of Scenario Logics

The next critical step in scenario development is the identification of plausible storylines, which, according to Geldenhuys (2006), have to portray the possible futures convincingly. These storylines are based on the outcomes of particular combinations of the most important and critically uncertain key-driving forces identified in Step 5.

Step 7: Fleshing Out the Scenarios.

The next step is to construct a scenario for each of the combinations that convincingly presents a plausible storyline (Geldenhuys, 2006). In this regard, Schwartz (2007) also suggests that the storylines be based on those issues that are important to the focal issue, i.e. the generation of a cleaner and cheaper energy solution for South Africa towards 2055.

The fleshing out of the skeleton scenarios is then done by returning to the list of critical factors and driving forces identified in Steps Three and Four (Schwartz, 2007). The scenarios are then fleshed out in as much detail as possible by focusing on the manifestation of the megatrends and the wildcards as prevalent. (Geldenhuys, 2006; Schwartz, 2007). A critical decision in this regard is to forecast the intensity of the manifestation, using the scientific data (Schwartz, 2007). The scenarios are developed. Geldenhuys (2006) also suggests that memorable names be given to the scenarios.

2.6.2.3 Stage 3: Test

Step 8: Rehearsing the future to test the impact of the fundamental driving forces in each scenario.

In this step, the future is rehearsed by highlighting the extent to which the key factors and driving forces affect the different scenarios (Geldenhuys, 2006). In order to establish the implications of these plausible futures for decision-makers involved in the UOG extraction of the Karoo, it was also necessary to return to the focal issue identified in step two (Schwartz, 2007). Questions, such as the following, needed to be asked:

- For key stakeholders involved in UOG extraction of the Karoo, how do the required decision/s look in each scenario?
- Are the decision/s or business strategies robust across all scenarios, or do they look good in only one or two of the scenarios?

Schwartz (2007) also suggests that if the decision looks good in only one of several scenarios, then it needs to be viewed as a high-risk gamble.

2.6.2.4 Stage 4: Use and Assess

Step 9: Review the Existing Strategies and Develop New Strategies.

Geldenhuys (2006) suggests that robust strategies must be derived from each scenario. The strategies must then be compared with the more common strategies that form the core business plan for all the scenarios. The strategies differentiated by scenarios then become a series of options for the future.

2.6.2.5 Stage 5: Tract and Learn

Step 10: Selection of Leading Indicators and Signposts

Given the reality of constant change in the business environment, a company must be prepared to amend or change its strategic direction if necessary. Leading indicators and signposts must, therefore, be carefully selected to inform decision-makers on an ongoing basis, as to which scenario (or combination of scenarios) is beginning to unfold (Geldenhuys, 2006).

The added benefit of carefully selected leading indicators is that they can be used to monitor progress, or as an effective early- warning system. Schwartz (2007), however, highlights that some of these leading indicators for a given scenario can be very subtle and that it is essential to know as soon as possible, which of the different scenarios is closest to the course of history, as it unfolds.

Step 11: Maintain Ongoing Learning

Scenario-based planning, according to Geldenhuys (2006), is not a one-off exercise, but rather an ongoing process capturing ongoing business and learning, as it evolves. It is, therefore, necessary to update and apply the scenarios at regular intervals and be prepared to amend or change a chosen strategic direction if necessary.

2.7 VALUES AND ETHICS IN FUTURES STUDIES

Ogilvy put forth that teamwork is essential for moral legitimacy (Ogilvy, 2010) According to Ozbekhan (1960), business people are encouraged to work in groups, yet allow for individuals to maintain the individuality of thinking. Individuals often trying to put forward individual points of view, which are rigorously challenged by the team or senior management (Ozbekhan, 1960). A corporate policy can act as a buffer to ensure that future solutions are moral and to the benefit of humanity. Ozbekhan (1960) was one of the earliest researchers to question the role of values in FS, further pointing out the need to differentiate between what will be and what people want it to be (Ozbekhan, 1960). Two decades later, Schwarz (1991) distinguished three broad types of values underlying studies of the future (Schwarz, 1982):

- Political - which underline or condition how alternatives are outlined (Schwartz, 1992). Schwartz's view guided the examination of the shale discourse in Karoo, South Africa, in particular political economy or the state's interference in the South African energy sector (Gard and Kitson, 2016).

- Professional - which relates to how the people involved in the study of the future perceive individual roles in such a study. In this research, it appeared that "someone was missing in the room", a term used by Inayutullah (Inayatullah, 2015). Focus groups of youth using future studies methods, including the Sarkar Game, allowed for specific insights as to how the youth intended to participate as professionals in the OUG extraction for South Africa towards 2055. Respondents also identified and put forth recommendations on how assistance should be provided for individuals. Furthermore, given that the institutions for the UOG sector are not formed yet, the American Petroleum Institute (API), provided sufficient information for the practical setting up of the industry-led support for UOG extraction in South Africa and recommendations, in this research, are presented in Chapter 6.
- Paradigmatic - extolling the role of accuracy, predictability, and reproducibility.

When considering values and ethics, taking responsibility for the future cannot be omitted. Futurists are not only responsible for looking into the future and making suggestions for a desirable future but are also responsible for the consequences of such activities (Masini, 1993). Concern exists because of the absence of a code of conduct for the discipline (Bell 2003; Kidder, 1992). The concern stems from the fact that futurists are also in influential public roles such as teaching, research, publishing, consulting and advising both governments and business (Bell, 2003).

If the broad purpose of futures studies is an overall improvement in the well-being of all living beings (Adendorff, 2014; Bell, 2003), then futures research needs to have a common goal. As a result, according to Bell (2003), futurists are involved in a range of professions, such as teaching, researching, publishing, consulting and advising both governments and private organisations. Consequently, futurists are becoming increasingly responsible for the activity of looking into the future, as well as the consequences of such activities (Adendorff 2014; Ilbury and Sunter, 2009; Krawczyk, 2008).

The authors, therefore, highlight the need to also incorporate both the cultural and social values of people into future forecasts. Although the absence of a comprehensive set of ethical guidelines in future research is acknowledged (Bell, 2003), validity and accuracy in the collection and reporting of information are highlighted by Geldenhuys (2006), as two fundamental principles. The following minimum principles were enforced throughout this research:

- Whenever audio recordings were used, this researcher explained the protocol and requested permission for the recording.
- Whenever respondents asked to be anonymous, this request has been noted.

The researcher was open and attentive to new observations and discoveries, and all ethical guidelines stipulated by the university has been respected. As part of the literature review, contentious areas which led to critical recommendations were verified personally with the authors. The following may be listed:

- In Green's critique on the Vengosh *et al*. (2013) report, regarding the limitations of U.S. scientific research, the various authors were contacted to verify the areas of confusion. This investigation allowed the research to make reliable and concrete recommendations (Green, Book Chapter 18 in Esterhuyse and Glazewski, 2016).
- To verify specific claims in the Vengosh *et al*. (2014) report, the researcher travelled to Stanford University. An extensive investigation into the laboratory tests of the air quality baseline studies and methane leakage was conducted under the supervision of Professor Jackson. The causes and consequences and the impact of other fugitive gases were also examined.
- To understand to what level methane leakage is being observed, monitored and tracked in America and the impact that methane leakage could have on the planet, considering the net effect of UOG extraction in the world as new markets hasten to start exploration, the researcher interviewed mainly environmental consultants working in this growing field of research in America.

- In understanding the growing acknowledgement for the role of spirituality in Future Studies, Markley (2015), Inayutullah (2015), Adendorff (2014) and other international authors were interviewed via Skype and in personal interviews.
- The truth is presented honestly, and without bias and this is evident in the scenarios as ‘No Shale, what now?’ which focuses on solutions towards a dominance of renewable energy and the ‘Fracking with a smile on my face! ☺’, in which the study puts forth an economics-based scenario which allows the policy-makers to evaluate the various options and make the appropriate decisions.
- The participants volunteered to participate in this research.
- Potential participants were informed, as fully as possible, about the nature and purpose of this research, the rights of refusal to participate in this research and the confidential nature of responses.
- The identity of the individuals from whom information was obtained has not revealed, and confidentiality was respected.

2.8 RESEARCH DESIGN AND METHODOLOGICAL RIGOUR

Kreibich, Oertel & Wölk (2011) describe futures studies as a unique field of study. Given the pace of change and the associated high levels of uncertainty, futures studies do not pretend to have the ability to accurately forecast the future (Dator, 2007; Olsson, 2002). In Chapter Three, this research presents a rudimentary economic model which helps to quantify the size of the UOG extraction prize, as one of the leading research questions is to understand if UOG extraction of the Karoo, South Africa is an economic game-changer.

According to the World Future Society (WFS) (2004), the focus is placed on giving more clarity regarding the future, and empowering decision-makers to take advantage of any opportunities that may exist. Kreibich *et al.* (2011) also argue that there are reliable procedures in place to ensure that futures’-oriented knowledge is of high quality. In order to address possible reliability issues, the authors suggest that research efforts should not start with the assumption that research objects of futures studies can be isolated from the operating environment.

The face-to-face interviews were used to gather data from panels of experts. The panel comprised of policymakers, developers, investors, unions and institutions involved in the oil and gas sector (as the shale sector is not yet formed), the coal sector and the renewables energy sector. Each sector undertakes in-depth research, underpinned by guidelines from relevant global organisations, e.g. IRENA on renewable energy and API (U.S. office) on shale gas. Adopting this approach ensured a stable and robust platform for reliable data for further interrogation and the collation of findings.

2.9 RESEARCH METHODS

The rapidity of discontinuous change has increased dramatically in the last 20 years (Blickle & Witzki, 2008; Van Tonder, 2004; Veldsman, 2002; 2008). Deciding whether or not to change is a luxury ill-afforded by organisations. Strategic planning is an example of a management tool that might require rethinking according to Veldsman, who is even of the view that strategic planning is an outdated and non-value adding activity (Veldsman, 2008; Mintzberg, 1994). It can be argued, however, that more flexible strategic planning approaches, such as scenario planning, which take into account a more comprehensive range of possible futures, will position organisations better than current forecast efforts that depend only on a single, linearly extrapolated, strategic response (Veldsman, 2002).

2.9.1 Scenarios and the Benefits of Scenario-based Planning

Scenario-based planning serves to create stories about expected future realities and is a form of organisational storytelling (Van der Heijden, 2005). Scenario-based planning is a cognitive (or rational) way of doing strategic planning based on a mutual, intellectual understanding between actors or participants in the process (Van der Heijden, 2005). Scenario-based planning allows one to see the future world in different plausible ways, as portrayed in the stories, but it does not address how the change implied by these stories affects people emotionally.

Scenario-based planning allows emerging signals of change to be detected much earlier than conventional strategic planning. Multiple perspectives on complex events, knowledge and experience can be woven into coherent, systematic and plausible stories to construct possible futures (Bood & Postma, 1998). Nell (1999) further argues that as a management tool, an appropriately designed, scenario-based planning process seems to be more in tune with the current and future expected context which is characterised by profound, on-going, and unpredictable change.

2.9.2 Causal Layered Analysis as the Over-arching Methodological Framework

Causal Layered Analysis (CLA) is primarily a quantitative data analysis technique that adopts a qualitative approach to gathering and analysing data. CLA is a theory of knowledge and a methodology for creating more effective policies and strategies. Since the invention of CLA in the late 1980s, CLA has been used successfully by governments, corporations, international think-tanks, communities, and cities around the world (Inayutullah, 2015). HCLA works on several levels, delving more in-depth than the litany, the headline, or the level of reality determined by data to reach a systemic-level understanding of the causes for the litany. Below that level, CLA goes further, searching for a worldview or stakeholder views on issues. Finally, it explores the deepest metaphorical levels of reality (Inayutullah, 2015).

Each subsequently lower level reveals a more profound cause and broadens the understanding of causal issues and leads to more profound scenarios. More deep-seated myths are explored and new litanies based on the views of different stakeholders are examined and make it possible to see how solutions are constructed. CLA can be used to deepen our understanding of strategy (Inayutullah, 2015). Mapping reality from the viewpoints of multiple stakeholders, enables the futurist researcher to develop more robust scenarios. It helps futurists to understand current reality by providing a tool with which to dig deeper and more broadly, allowing the creation of the desired future that is robust in its implementation (Adendorff, 2013; Inayutullah, 2015).

CLA has been selected as the over-arching method as CLA is very flexible and has a welcoming input from other methodological frameworks (Holdaway, 2019). According to Kenny (2006), some researchers use CLA as a dominant methodology, in which to frame the overall study, some combine CLA with other suitable framework (Kenny, 2006); and others use CLA as one of a number of suitable analytical tools (Ramos, 2015). This research used CLA as a dominant framework and attempts to use other suitable frameworks when required. Within frameworks, such the Delphi (further explained below), even mandatory rules have been modified. CLA flexibility can be further motivated by the manner in which discourses transcend the various levels, bringing in the different epistemological positions and attempting to arrange the data on different levels forming an integrated approach. The first level has a data and an empirical approach. A good example of such an approach is breaking down the complexity of understanding TCF of gas to a barrel of oil.

In South Africa, the business communities and policymakers are more familiar with crude oil and not gas, therefore, this equivalence is necessary. The researcher then sought to investigate the equivalent of cubic feet of shale to barrels of crude oil in value. Many attempts have been made to arrive at this common understanding. A report, published by the Institute of Security Studies in South Africa, in association with the Belfer Institute at Harvard, set the formulae for the correlation of the TCF and the barrel of oil (Hedden *et al.*, 2012). This useful approach allowed for the empirical data to be effectively used in constructing the business case in Chapter Four, which answers the RQ2, Is shale gas an economical game-changer? Another example of gathering empirical date was a structured investigation of subsidies which currently favor the fossil fuel industry in South Africa. The benefit of this data is to motivate the legitimacy for such support to be afforded to the shale and renewable energy sector, not only in South Africa but also in the rest of the world.

The second level has a social science causative focus and many examples are evident when answering the social questions in Chapter Five. The third level is discourse focus and last is a narrative focus. In this last level, the researcher considered these variables when envisioning the future of Karoo communities towards 2055, taking into account the current spiritual, moral and cultural values of the inhabitants. Holdaway (2019) stresses "that unlike post-modernism, CLA does not take a relativist stance, but posits a critical meta-dimension, enabling the identification of probable, possible and preferable futures" (Holdaway 2019, p. 49).

2.9.3 Systems Thinking

A suitable framework which compliments CLA is System Thinking, which is in line with Kenny's (2006) thinking. Systems thinking is one of the significant breakthroughs in understanding the complex world of organisations in the field of systems theory (Aronson, 1998; Senge, 1990). System thinking studies systems from the perspective of the whole system, its various sub-systems and the recurring patterns in the relationships between the sub-systems. Systems theory has dramatically influenced how organisations are understood and changed. The application of this theory is called 'systems analysis' and is one of the primary tools is systems thinking.

Senge (1990) considers the theory of systems thinking in the early nineties, arguing a deep and persistent commitment to 'real learning'. Senge (1990) maintains that an open-minded approach is required by the individual or organisation, where individual faults can be recognised openly and transparently, and 'mental models' can be challenged, leading to non-obvious areas of leverage. The fundamental rationale of systems thinking is to understand how the most vexing problems, can be dealt with by giving the individual some perspective on the problems, in order to give an organisation some leverage and insight into what might be done differently (Senge, 1990).

Senge (1990) further states that the process of triangulation, is a concept requiring different people, with different points of view and seeing different parts of the system to unite and collectively see issues and situations which generally none of the parties would see if viewed in an individual capacity. The systems thinking approach guided the discussions with policymakers at SOEs such as the CEF, IGAs and PetroSA. Executives of these organisations were tasked to work across the various government ministries considering the inter-connected nature of food, energy and water resources and the impact of each with respect to sustainable development.

Aronson (1998) argues that systems thinking is a tool, that provides a researcher with a broad perspective that includes an overall view of structures, patterns and cycles in systems, rather than seeing the only specific event at a time within a system and identifying the real causes of issues in organisations. In recent forums, where sustainability is discussed at a high level, the world is encouraged to apply systems thinking approaches continually.

Systems thinking, accordingly, produced a variety of principles and tools for analysing and changing systems (Aronson, 1998; Senge 1990). Given the interconnectedness of the United Nations Sustainable Development Goals (SDG), the systems approach brings on complexities. Further to this, especially about energy, is the nexus approach, i.e. a new approach that recognises the interconnectivity of specific sectors. The Water-Energy-Food (WEF) nexus may be cited as a wicked problem with multiple layers of complexities. By mere application of the nexus thinking, which has been used throughout this research, Senge's (1990) approach has been applied.

2.9.4 The Real-Time Delphi Technique

At the research design phase, a mix of 39 methodologies were considered in the context of the stakeholder groups, which required examination for this study. The method of gathering information in real time is called the 'Real Time Delphi Study'. This technique evolved through advanced technology from the conventional Delphi Study since the usage by the Rand Corporation in the 1960s. A comparative analysis is supplied by the authors Gnatzy, Warth, Von der Gracht and Darkow (2011). The conventional Delphi Study gathered data from experts and respondents through many rounds, which historically has been time-consuming to complete (Gordon & Pease, 2006; Gnatzy *et al,* 2011). Technological advances overcome this shortcoming and the Real-Time Delphi technique collates data in real time (Gnatzy *et al,* 2011).

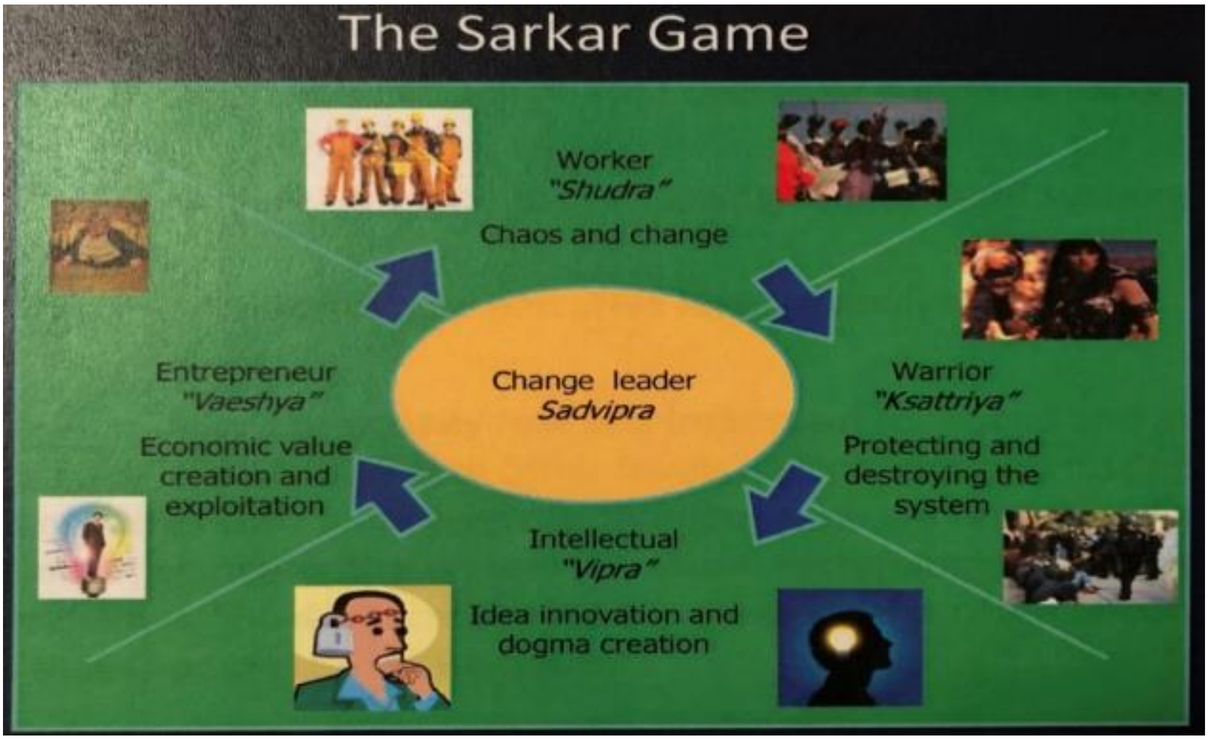
Concerning UOG extraction In Williston Texas, the Delphi Technique was used. The public was brought into a media hall and was required to answer 'yes' and 'no' questions regarding UOG extraction. The public stated that the methodology was biased as the method attempted to get only those responses that developers wanted. Understanding, similar sentiments in the Karoo context, this method was not considered for this research at the beginning of the research design. However, for the panel of experts, The New Real-Time Delphi was attempted, but became became problematic as the panel were from various disciplines. A uniformed questionnaire was less useful. This method was then abandoned in favour of one-on-one interviews, which provided on-going discussion throughout this research.

2.9.5 The Sarkar Game Used in Focus Group Workshops

In its flexibility, CLA is also underpinned by action learning and the action research enabled through CLA practice-based methods, occurring, for instance, in workshops

(Holdaway, 2019). The Sarkar Game is one of Inayatullah's (2015) preferred approaches and accordingly, it is suggested that Sarkar is more important to modern day futures studies than any other Indian thinker in this century (Inayatullah, 2015). At the Futures Workshop: Creating Alternative and Preferred Futures, conducted by Inayatullah (2015), at the Council for Scientific and Industrial Research (CSIR), the essences of the Sarkar approach elaborated. Figure 2.2 refers to The Sarkar Game. The Sarkar Game is based on, but is different from the Hindu philosophy of history and caste (Inayatullah, 2015). Further to this technique, visioning and back-casting were used to gather further insights.

Figure 2.2: Describing the Players of the Sarkar Game



(Source: Inayatullah, 2015)

The concept of the Sarkar Game was explained to the respondents who then voluntarily identified with one of the four groups. Given the poor understanding of UOG extraction amongst civil society and the negative attitudes which surfaced after the interaction with developers, it was decided as a lower priority in the research to conduct in-depth investigation into the attitudes of civil society. However, for the purposes of gathering data for the last level, it was imperative to conduct workshops with the youth of the region. A general induction on UOG extraction, was required and was confined to fifteen minutes, followed by a ten-minute question and discussion session. The ‘classical’ Delphi technique was then used with the two focus groups of 40 youth in the Karoo towns of Jansensville and Graaff-Reinet. Understanding the short-comings in the Williston case, the method was used more flexibly as seven basic questions were posed, to get an initial basic assessment of the subject matter. The technique was then modified, allowing for the ‘maybe’ answers. The respondents were encouraged to write down responses, which were probed in the following question and answer session.

This research session lasted two hours, allowing for all respondents to fully express views, hopes and ambitions regarding the UOG extraction in the region. A further hour was spent understanding the underlying issues which motivated the responses to various situations which arose in this research discussion. Whilst the artist continued the drawings for later development of scenario art, a facilitator recorded the session.

The researcher maintained an ongoing interaction with the respondents, and introduced a Coursera online course, from Duke University on energy usage. This provided a useful induction into UOG extraction for the prospective stakeholders of the community. A new curriculum on environmental law and policy is being introduced to higher learning institutions in all BRICS countries, as part of the capacity-building programme, which the researcher proposed as a policy brief and is elaborated in Chapter 7. The programme is being tested at the University of Johannesburg in January 2021.

This recording may be accessed on:

https://drive.google.com/file/d/19OYF2Sg9d1SDFSHqBhUrF6kysrjZh5UF/view

2.10 THE GATHERING AND SORTING OF DATA

The researcher is part of the BRICS Academic Forum, Energy Cluster and advises on alternative energy forms for South Africa and other BRICS countries. In the BRICS Energy Policy Brief, capacity-building was identified as the critical factor for success in the upcoming shale, wind and solar sectors. All these sectors, are encouraged to be developed in all BRICS markets. An ideas paper for capacity building was scoped and presented by the researcher at the BRICS Academic Forum 2018, and led to widespread acceptance of the concept. Deans and professors from all the BRICS countries, who were present at the BRICS Academic Forum (2018), provided input over two months. BRICS funding was approved for a workshop to localise a proposed learning curriculum, aimed at undergraduate level at tertiary institutions in all BRICS markets, after being piloted in South Africa.

Thereafter, the first step, was a capacity building workshop which was conducted in Cape Town, in July 2018. The Mayor of the Sarah Baartman Municipality attended the workshop as a full participant, together with a member of the local, regional government, the principal of the local technical college of the region and a professor of pedagogics of a South African university. Together with the principal, the academics were able to judge the content of the programme, to ascertain the strategic fit for colleges and universities and also provide input into timelines that were realistic for implementation.

While the Mayor was concerned about the content and rapid implementation, the academics were centred around the scope for 'articulation' of the programme from college to undergraduate to post-graduate level. South Africa is in urgent need of such a programme as the wind and the solar sector is rapidly gaining traction, resulting in critical skills shortages being filled by expatriate staff of the international investors. The programme allows for the first year of introductory courses, the second year of mobility in a BRICS country to gain on-the-job experience, together with online coursework. The final year is completed at a South Africa institution, where the course is adjudicated by an examination and a thesis. The programme is being considered by the Dean of the University of Johannesburg and the Director of the Wits Business School for implementation in 2021. The curriculum was shared at the BRICS Energy Summit, in August 2018, and received wide-scale acceptance with large corporations volunteering to take in interns.

The final leg of the research was the field-work in the U.S. to question the myths and concerns which arose on numerous occasions on the U.S. findings. Two extended trips to America were undertaken to verify the desktop research, focusing mainly on the feedback from the South African experts and the new technologies in the shale sector. Based on a long-standing communication with the authors of the Vengosh *et al.*, report (2013) that was highly criticised by Green (2016), the researcher travelled to Stanford University to question the work conducted in 2014-15, and had the opportunity to gain a better understanding on the latest concerns, emanating from

UOG extraction in the U.S., which is at an advanced stage. The latest concerns are around air pollution and methane leakage. The researcher, under the guidance of Professor Jackson, had the opportunity to interview the post-graduate researchers and examine the laboratory reports on air quality. This exercise aimed to interrogate the sampling and monitoring of the air in fracking areas to understand the improved technology of monitoring and managing methane leakage and other fugitive gases.

The concerns of the South Africa academics were tabled to the authors, mainly focusing on the non-disclosure clauses, which compromises U.S. scientific findings rendering the U.S. findings almost invalid for the South African case. From the discussion, it became clear that there was misunderstanding of the content of the article and the Americans pointed out that like all business ventures, the report illustrated real business challenges and was not a pilot exercise, for global shale reference. However, these interviews presented an ideal opportunity to question the U.S. academics and developers on the impact of the Trump Administration's 2018 relaxation of the air quality laws.

The IEA (Paris Office) presented the IEA Gas 5 Year Forecast at the end of October 2018 at Columbia University in New York, U.S. One of the panellists, Palti-Guzman (2018) agreed with Maugeri (2012) that U.S. UOG successes would not be replicated in the rest of the world (personal interview with Palti-Guzman, 2018). This forum allowed for interrogation of this critical and controversial discussion point, which led to the researcher summarising that this is not necessarily the case as there are still environmental gaps in the America UOG sector, namely methane emissions. The researcher further elaborated, at the forum, that China, invests extensively in R&D to ensure that shale successes can be replicated with lower risks than those experienced in the U.S. The panel was not able to answer direct questions posed by the audience regarding the excessive flaring and methane leakage and which are critical negative issues arising from UOG extraction in the United States. The forum concluded that there is a gap in the understanding of methane leakage emanating from fracking.

Recommendations to close this gap are included in Chapter Seven. The field-work continued with shale corporations and bodies such as the U.S. Petroleum Institution (API) 2018, which has initiated a separate shale department to formalise the various institutions, business structures and policies. OEM engagement and channels of marketing and sale, are being continually modified and set up as the shale sector continues to develop. Interesting insights were gathered for the setting up for South African institutions. South Africa National Standards (SANS) (2018), which is the previous South African Bureau of Standards (SABS), and which was set up in 1929, is the closest equivalent to API, which only focuses on the oil and gas sector. The closest national industry body would be the South African Oil and Gas Alliance (SAOGA). Executives of SAOGA have been activating contributors to this research. Fakir, the WWF head, based in Cape Town, is on the panel of experts as a reputed shale commentator. The legal counsel of AfriForum, the right-wing Afrikaans farmer pressure group dealing currently with the land reform issues and the nationalisation of the state's natural assets, is also regularly consulted on matters for verification.

PricewaterhouseCoopers (PwC) in the U.S. have commented extensively in that jurisdiction and for consistency the PwC, Cape Town office has been consulted on the development of the business case. This business case is presented in Chapter Four. The findings from all these interactions were evaluated, and wherever there was significant merit, due consideration was paid and comments are incorporated into the final chapter of this research.

Despite the Trump Administration's exit from the Paris Agreement of 2015, initiatives promoting sustainability, which started during the Obama Administration in 2016, have resulted in local government bylaws being promulgated. The fieldwork examined the various approaches in America, which enabled the researcher to identified programmes which could be implemented in South Africa. The following initiative was examined and the New York Schools' sustainability programme is referenced. One thousand, two hundred schools across the five boroughs of New York city, appointed a sustainability coordinator in every school between the period of 2010 – 2011. The researcher has participated as an assistant facilitator at the University of Columbia's review of the programme. The respondents were a random sample of coordinators, parents and students.

The BRICS Academic Forum sustainability programme, as described above, was presented at this forum. The programme content sparked wide-spread interest and is being modified by the professor of sustainability in charge of the New York schools' co-ordinators' research programme. The expected outcome, is to formally train the coordinators and lead to higher education accreditation. Key insights from the New York schools programme will be incorporated in the final recommendations for towns of the Karoo, South Africa. The following is the second initiative which could be recommended for cities in South Africa.

Columbia University administers a project on the greening of New York City. The researcher travelled to interview project managers. The researcher examined the findings of post-doctoral research on New York's trees in the 'greening of the city' initiative. Insights have been incorporated in the 'Fracking with a smile on my face! ☺', which illustrates that when the stresses of poverty are overcome, people are better positioned to be friendlier to the environment and sustainability becomes a more reasonable concept to understand.

In line with bottom-up approach of the Paris Agreement of 2015, the discipline of development diplomacy (DD) is gaining widespread recognition. In October and November 2018, Adams (2018) presented a series of lectures in DD at the Seaton Hall University's (SHU) School of Diplomacy. The researcher was invited to participate as discussant, making recommendations that DD should be incorporated into corporate score-cards in order to gain traction in the global marketplace.

Economic development in the Karoo could improve the living conditions. The research has investigated the new trends in sustainable living conditions, incorporating modern forms of energy. At the beginning of this research, the researcher attended a summer school at Delft Technical University of Architecture in Holland, on the retro-fitting of old European households for increased resilience. Care is required for the aged of the Karoo. This research references the case study of Singapore in the early 2000s, where the progressive Singaporean government at the time, realised that rural-urban migration could become a threat for the elders living in the countryside as Singapore started to develop economically and prosper. The foresight of the state is unparalleled (The Economist, 2005).

The researcher in the early 2000s studied the development of the built environment of Singapore. Given the limited landmass, the Singaporean government started to construct modern apartments for young executives. Apartments were constructed in a manner in which the main quarters had adjacent 'granny-flats (The Economist, 2005). Future dwelling in the Karoo, South Africa, will acknowledge these notable points. Social aspects of the community in the Karoo, South Africa is one of the cornerstones of this research. The psychological and sociological aspects of human issues such as migrant workers, prostitution, the spread of aids and drug abuse, brought about by both poverty and wealth are discussed in the PESTLE. It was, therefore, incumbent on this research to investigate options of communal life and, therefore, this researcher from Singapore turned to Auroville. The researcher in 2005 visited the UNESCO site, in Chennai, India, and studied the interconnected living experiences between affluent westerners and the more impoverished artist communities living together in harmony. It would be misleading and irresponsible to presume that there will be no homeless, lonely and destitute people in the Karoo, South Africa towards 2055, after the exploration and examples of communities as seen in Auroville should be developed for communal living.

2.11 CONCLUSION

The current popularity of scenarios in forecasting is mainly the consequence of Wack's (1991) work as an employee of Shell Oil Company in the seventies. Scenarios can create a calculated picture of dreams (Wack, 1991; Ilbury & Sunter, 2009). The interconnectivity of the water-energy-food nexus which influences the exploration in the Karoo, the requires systems thinking approach. These areas are investigated at deeper levels, using CLA. Impacts and possible solutions were identified in consultation with experts using the various future studies methodologies for the gathering of information.

Various workshops allowed actors to plot and simulate how new economic opportunities will be realised. To ensure the growth of SMEs in the regional economic development (RED), social, and economic development (SED) programmes were considered. Health, safety, security and environmental (HSSE) frameworks as well as face-to-face interviews to delve deeper into issues that will address the building of capacity were linked to RED, SED and HSSE issues. These frameworks would allow the trickle-down and trickle-across the effect. The sum of these processes led to the storylines on which scenarios were developed.

The rule of law for UOG extraction in the Karoo must be established in consideration of protection and improvement of the environment. This research has conducted an in-depth investigation into the global legal frameworks, detailing climate change obligations of states, specific petrochemicals laws which have evolved in the U.S. as shale exploration developed, and finally, it interrogates to what extent these legal frameworks have been adopted into the South African legal system to govern the new exploration.

The UOG extraction in the Karoo, South Africa, is not just an examination of exploration for a resource; it is indeed an investigation into how the all the economic sectors of water, energy and food will co-exist. This would entail the setting up of institutions and establishing agreed rules of law, and the models of governance, in which the parties may co-exist. Apart from the operation relating to local business interaction, the oil and gas sector is categorised by international trade relations, which by nature are governed by international treaty law. Increasingly O&G policies are subject to climate change law, a new and growing part of international environmental law and which is, in turn, a part of international law.

Given these legal complexities, this research has been informed by the structured environmental law and policy courses undertaken at the University of Eastern Finland's School of Law. Hydraulic fracturing techniques, fluids and use of chemicals are subject to stringent scientific tests and assessments, as well as non-disclosure agreements (NDA) and intellectual property (IP) laws. The claims made by the U.S. scientific community regarding shale exploration have been rigorously investigated at source, wherever possible, given the concerns raised by South Africa shale commentators (Green, 2016).

Laboratory tests referenced in U.S. scientific literature have been verified on site, to ensure a clear understanding of the background to the experiments, as well as the limitations and findings. This research thus questions the validity of these American findings in the South African case in the light of Green's (2016) challenges. This research concludes along with the South Africa scientific community that the South Africa government is required to assess the extent of the game-changing opportunity and commit funds in advance to R&D. South Africa possesses no experience in hydraulic fracturing and thus should be guided by the principles of international environmental law. Given the relevance of the U.S. shale market, the U.S. laws governing the Williston, North Dakota exploration were studied. This research resumes the legal discussion in Chapter 4. A stricter adherence of the U.N. and E.U. guidelines allows for greater compliance with the international environmental goals and principles which are explicitly specified in the Brundtland Report (1987). Before any exploration can take place, a firm policy and regulatory framework based on the definition of sustainable development must be in place for public scrutiny and international environmental organisations.

Chapter Three provides an environmental scan of the challenging environmental megatrends of climate risk and associated critical uncertainties, and sets out the theoretical basis for the environment arguments in this research. Chapter Four proposes a business case to answer the economic question. Chapter Five continues the literature review and the mapping process examining the various international legal frameworks which impact on all stakeholders in UOG extraction.

CHAPTER THREE

3 THE SAFETY OF UOG EXTRACTION IN THE KAROO, SOUTH AFRICA

3.1 INTRODUCTION

Climate emergency is the Oxford Word of the Year 2019. Rule of law is one of the central themes in the research and in this chapter the rule of law pertaining to natural resources and the environment is examined. Under the global frameworks for sustainable development, the WEF nexus is examined, analysing in-depth the legal framework for water, energy and food, as enshrined by the United Nations (U.N.). The rule of law protects not only states and foreign direct investors, but also the rights of civilians. The human right to water, in relation to UOG extraction, comes under scrutiny. This research seeks, therefore, to establish how South Africa, as a U.N. member, fulfils this particular obligation. From a climate action perspective, South Africa, also a party to the 2015 Paris Agreement is committed to the stringent 2020 targets.

International law provides for citizens' acknowledgement of rights outside of domestic frameworks under the United Nations framework, which speaks sharply to specific fundamental human rights to water and sanitation and the broader definition of water affecting food (Belinskij, 2015). With that knowledge, citizens have agency to hold governments, accountable for delivering these rights. The interplay between international law and South Africa domestic law is significant and this is evidenced in the following court judgement. In the case of *Mazibuko et al., vs The Johannesburg City Council*, even though the South African government had not ratified the U.N. Water Convention of 1992 the High Court referred to water principles of this international convention. After a five-year legal battle between the court and the State, the South African courts, ruled in favour of Mazibuko based on international law (*Mazibuko et al., vs The Johannesburg City Council, 1992).*

Governed by what is now one of the most progressive constitutions in the world, South Africans are aware of human rights (Winkler, 2017). The history of Apartheid, a policy which was embedded within a legal framework, legally oppressed the majority of the population for decades. Increasingly, previously oppressed South Africans are becoming aware of human rights, and this is the result of international legal frameworks (Winkler, 2017; Griech, 2012; Berlinskij and Kotze, 2015).

The Presidency announced in March 2017, that South Africa had reversed the decision to withdraw from the International Criminal Court (ICC). The decision to withdraw, at the time in 1915, was to protect Al Bashir, the Sudanese President, wanted for trial for war crimes in Darfur, but the withdrawal was declared unconstitutional and invalid (The Times, 2017). The announcement sparked nation-wide debate, which highlighted citizens' involvement and understanding of legal matters and the understanding of the recourse to international law.

This research recognises that citizens of the Karoo, South Africa, have the right under international law, to stop the exploration if the limited surface water or the aquifers, which are allocated for drinking and sanitation, are violated during the UOG extraction of their area. Sufficient and prudent UOG extraction is necessary to ensure that enough wealth is generated, for the well-being of today's generation with adequate resources left for future generations (Brundtland Report, 1987). In this chapter, RQ1 is introduced and supported by research objective SRQ1.

The chapter, after a brief introduction, is divided into four parts, each addressing a specific aspect of the environmental problem, and concludes on the safety of hydraulic fracturing in the Karoo, South Africa. South Africa is growing at an unprecedented pace and this growth provides economic opportunities and challenges. Karoo towns, in line with the future development of African cities, face a high level of complexity and uncertainty, particularly concerning energy and climate change issues. Two important studies informed this research. The first is Future Energy Scenarios for African Cities, led by Escudero (2016), assisted by Savage and Kravva. The second is Africa's New Climate Economy: Economic Transformation and Social and Environmental Change, led by the authors Brahmbatt, (2016), assisted by Bishop, Lemma, Granoff, Godfrey and Te Velde (Brahmbatt *et al*., 2016; EUEI PDF, 2017).

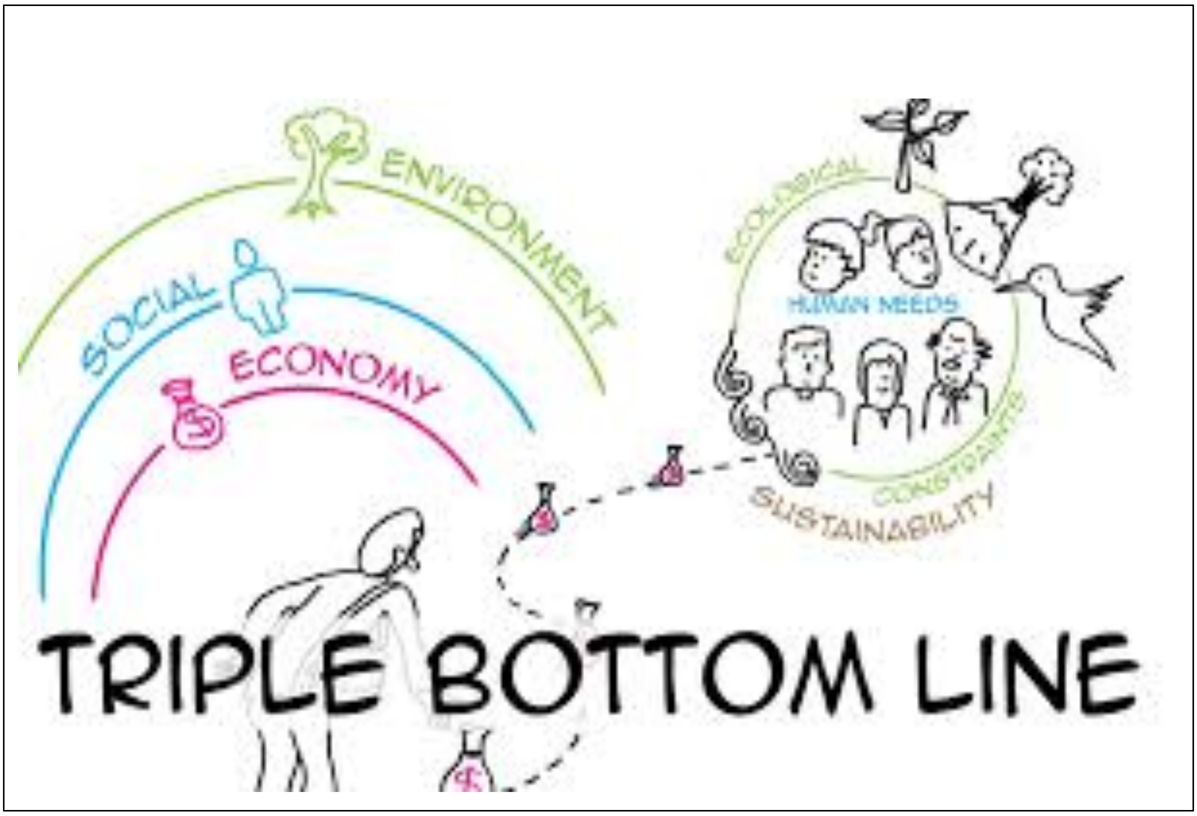
Part One of this chapter presents the findings of an environmental scan of the global oil and gas sector, tracking the booms and busts of the industry and the rise of shale gas which is a 'wildcard' that started to manifest after 2010, disrupting the oil and gas sector. Part Two of this chapter examines the safety concerns of the environmentalists and the pressure under-which the various governments, posed a partial or total ban on the exploration. Countries that have been authorised with caution by the various governments to commence hydraulic fracturing are examined, paying specific attention to how these markets modified legal frameworks, implemented policies and set up institutions to manage the new shale sector.

Drawing on the insights of the various markets, Part Three examines the readiness of the South Africa to protect and effectively govern the environment. Part Four provides a summary and the emerging issues from the safety discourse and attempts to answer the questions: What stays the same? What are the key trends? What are the main processes of change? What are the most critical problems and issues? What are the new issues in the pipeline? And, what are the sources and hope? (Inayatullah, 2015).

Growing trends have a significant effect on the subject matter of this research topic of “Possible hydraulic fracturing futures for South Africa towards 2055”. Based on the triple-bottom-line accounting principle—planet, profit, people—the research in this chapter starts to probe the answers the first of three primary research questions. The questions on the ‘planet’, presenting the environmental issue, the questions on ‘profits’, which presents the economic problem and question on ‘people', which presents the social discourse of the Triple Challenge. Figure 3.1 refers to the Triple Bottom Line by Elkington (1994).

South Africa grows organically, as well as from the annual influx of foreign immigrants, mainly from the African continent. Immigrants entering the country, settle mostly in Gauteng and the Western Cape (Esterhuyse & Glazewski 2016). The current population of South Africa is 58.8 million people (StatsSA, 2019). Governments must cater to growing populations by developing economically through large scale industrialisation, witnessing demands for energy, which result in climate risks. Crop failures caused by extreme temperatures, cause an increase in poverty levels. Health issues also increase due to air pollution and extreme temperatures. The lack of education systems, has a direct effect on employment levels. These ‘wicked-problems' raise awareness of inequality and cause civil unrest. Civil unrest is another ‘wildcard’ treated in Chapter Five of this paper, which deals with societal issues.

Figure 3.1: Illustration of the Triple Bottom-Line Principle



(Source: Cyber visual depicting Elkington's (1994) Principle)

3.2 PART ONE: MEGATREND MANIFESTATION

Climate change is the main global megatrend in this environmental discourse. This section unravels the level and rate of negative impacts which may be directly linked to global UOG extraction. The following section tracks South Africa's response i.e., the progress in the energy policy towards change to a lower-carbon future.

3.2.1 Megatrend Manifestation One: Climate risks

South Africa has articulated a commitment to addressing climate change, based on the science put forth by the science that underpins the 2015 Paris Agreement (IPCC, 2015). Scientists are now projecting further trends of marked temperature increases, rainfall variation, rising sea levels as well as an increased frequency of severe weather events (1/CP.19 and 1/CP.20 of the Conference of the Parties 21, 2015).

Increased energy demand sees higher carbon emissions from coal resulting in further climate risks. Climate change, a vast subject, governed by legal frameworks, spans across water law, food law, energy law and provides specific sectors and works hand-in-glove with the United Nations SDGs. South Africa is committed to the Paris Agreement of 2015 under decision 1/CP.19 and 1/CP.20 of the Conference of the Parties 21 (Paris Agreement, 2015).

South Africa has transitioned its international mitigation commitment from a relative deviation from ‘business-as-usual’ to an absolute peak, plateau and decline of greenhouse gas emission trajectory range (NDC, 2015). South Africa's response is influenced by the findings of the Intergovernmental Panel on Climate Change (IPCC) that warming of the climate system is unequivocal and that mitigation is better than adaptation. Therefore, for reduction, more significant efforts by all countries are needed to avoid high to very high risks of severe and possibly, irreversible global impacts (personal interview with Honkonen, 2017; Talus, 2016; Van Asselt, 2017b).

Irrespective of any adequate mitigation efforts, the IPCC (2015) also concludes that, due to the inertia and long response time-lags in the global climate system, adverse impacts of climate change are inevitable (Murthi, 2019, Seminar at Duke University, 2019). Global climate change frameworks rely on the implementation of policies and initiatives at local municipality levels (personal interview with Adams, 2019). This research examines the role of local regional government and the central government in the context of this exploration.

The Stockholm Institute (2013) estimates that 80 per cent of the emission reduction achievable in cities is not administered by governments on a national level (C40 Cities and Arup, 2015). The Institute further notes that international organisations tend to focus on the larger economies in Africa, such as South Africa and not on the other African cities (C40, 2014; C40, 2015). Cities in Africa are administering various interventions in mitigation and developing adaptation strategies for coastal towns. In South Africa there are still very few large-scale interventions, such as the clean development mechanisms of the Paris Agreement or even the existence of an emission trading scheme (ETS) (Leseka, 2016). In the climate change debate, shale contributes positively as a cleaner burning fuel. Large scale UOG extraction on a global level, sees methane leakage as a critical uncertainty which is caused mainly by poor cementing (Jackson, 2017). Flaring warms up the earth's atmosphere. Discussion with consultants throughout the fieldwork in the U.S.A. concluded that monitoring of fugitive gases and flaring is not a structured nor monitored approach in U.S. UOG extraction (IEA Conference, 2018).

The following extract from *The Guardian* summarises the effects of flaring:

Flaring excess gas is widely regarded as ecologically damaging. The burning of methane results in greenhouse gas emissions, which contributes to climate change. In the U.S., flaring is so prevalent that the light from the flames can be seen from space. Fracking companies prefer burning methane, which is the most straightforward form of disposal. Flaring is cheaper than capturing it, and using it for fuel, and it is less dangerous than allowing it to leak freely. (*Harvey, 2013*).

3.2.1.1 Sustainability

The four attributes of sustainability are environmental compatibility, the security of supply, economic efficiency and social acceptance. All attributes need to be balanced in order to reach a sustainable solution for a nation. Every nation's economy is based on a mix of energy options. South Africa's economy is based on coal. Eskom, the nation's sole supplier of electricity, through coal-fired power plants, provides for 70 per cent of energy requirements (IEA, 2014). As a signatory to both the 1999 Kyoto Protocol and the 2015 Paris Agreement, South Africa is committed to reducing emissions by 34 per cent by 2020 (NDC, 2014).

The economic aspect of sustainability requires that the supply of geo-resources be procured on a longer-term basis for the planning of storage, logistics and ensuring efficient use of available resources. This also includes a balanced mix of conventional and unconventional energy sources (ASSaF, 2017). The ecological aspect calls for the preservation of the environment. The extraction of one resource should consider its impact on the use of another resource (ASSaF, 2017). In the context of this research, shale exploration (energy) must consider the effect on water and agriculture (food), a concept with is referred to as ‘the water, energy, food’ nexus and which also extends to soil and other subsidiary factors.

The International Energy Agency (IEA) in its New Policy Scenario (2019) states that the global energy consumption will rise by 36 per cent from 2008 and 2035 (ASSaF, 2017). This translates to an increase from approximately 12 300 million tonnes of oil equivalents (Mtoe) to over 16 700 Mtoe, or 1.2 per cent per year on average. A severe challenge that such development faces, is the ability to grow with minimal pollution to the earth (ASSaF, 2017). The term ‘sustainable development’ embodies the efforts of humanity in the quest to improve economically and meet the present day's growing needs without compromising the ability of future generations to meet future needs (ASSaF, 2017; The Brundtland Report, 1987).

The South African government in the energy arena plays a singular role as regulator and this is instituted through the National Energy Regulator (NERSA). NERSA was established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act No. 40 of 2004). Its vision statement gives this aim:

…to be recognised as a world-class leader in energy regulation, by regulating the energy industry, following government laws and policies, standards and international best practices, in support of sustainable and orderly developments (NERSA, 2018).

3.2.1.2 Air Quality, Coal Dominance and Cleaner Forms of Energy

South Africa remains heavily dependent on coal, with a fleet of old and inefficient power plants that are at the end of their design life-cycle. South Africa is also reliant on a significant proportion of its liquid fuels being generated from coal, which is produced by SASOL, the former state-owned enterprise (SOE) that was privatised in 1979 (Esterhuyse & Glazewski, 2016; Gard & Kitson, 2015). The following section attempts to establish the measures that government must institute in order move to a lower-carbon future.

This section on fossil fuel subsidy reform (FFSR) in South Africa has been informed by the joint work of the researcher and the International Institute of Sustainable Development. The researcher conducted twenty interviews with energy experts and stakeholders. South Africa's fossil fuel subsidy regime sustained the production of coal for export, as well as the conversion into electricity and liquid fuels, and has led to the current dominance of the coal sector (Burton *et al.* 2019). Shaped by the need for energy security during the years of international isolation during apartheid, the current energy landscape remained intact from that era, whereby the SOEs such as the vertically integrated, monopolistic utility, Eskom, and previously owned coal-to-liquid fuels producer, SASOL, benefitted from the state subsidies (Baker 2012; Fine & Rustomjee, 1996; Marquard, 2006).

From the 1970s, the state provided a constant demand for coal through the state-owned electricity supplier, Eskom, and the coal-to-liquids (CTL) technologies through SASOL, as well as the railways and steel industries and, therefore, saw a significant reliance on fossil fuel. The Department of Energy (DoE) states that the following makes up the domestic energy mix: coal is a 65 per cent contributor to electricity and oil and gas are responsible for 25 per cent. The power sector thus provides 90 per cent for the generation of electricity, which is driven by the state-owned utility, Eskom (www.doe.gov.za, 2019).

From its inception, SASOL received significant support from the state. Aid, in its various forms, allowed for the development and the locked-in economic positions, providing a so-called 'cheaper' fuel (Burton *et al.,* 2019). The benefits are still retained by the pricing mechanism, which ensures large profits in the CTL business. Eskom has benefitted from state support and passed this on in the form of under-priced electricity (Steyn, 2001). Scrutiny into the fuels levy through discussions with the experts of the Petroleum Association of South Africa (PASA) highlighted how consumers still bear the costs of the oil and gas and coal sectors.

3.2.1.3 Origins and Benefits of Subsidies

In compliance to the INDCs, governments around the world are investigating new forms of cheaper, cleaner energy (Van Asselt, 2017b). In the fast-tracking of renewable energy in many markets, the subject of subsidies in the energy sector has become a subject of global interest (Van Asselt *et al*, 2019). In promoting renewable energy, organisations seek to establish a new legal basis and the review of subsidies in the O&G sector as an appropriate starting point. Under the mandates of the UNFCCC (1992), organisations such as IISD conduct in-depth, focused research into fossil fuel subsidies.

In light of the development of renewable energy and the support that must be rendered, the president of the WTO has admitted that the FFSR, has been a missed opportunity within the WTO (Wooders, 2019). The IISD faces many challenges in gathering data, given the political economy of the energy sector in many developing countries (Wooders, 2019). However, once data is gathered on FFSR, representations may be made to the WTO, ahead of the organisation's twelfth ministerial conference in June 2020 in Kazakhstan.

The legal basis of subsidies finds its place in the World Trade Organisation's (WTO) Agreement on Subsidies and Countervailing Measures (ASCM 229; WTO, 1985). Fossil fuel production subsidies refer specifically to production occurring in the coal, oil and gas sectors. It also provides for the broader inclusion of access, exploration and appraisal, development, extraction, preparation and transport of fossil fuel resources, plant construction and operation, distribution and decommissioning and fossil fuel generation (Burton et al., 2019; Gard & Kitson, 2015; Newell & Johnston, 2016). Production subsidies refer to state-aided support for fossil fuel production and include national subsidies and investment by state-owned enterprises (SOEs), e.g. CEF, SANEDI and PetroSA (Gard & Kitson, 2015; Burton *et al*., 2019). National subsidies would include direct spending, tax and duty exemptions and other mechanisms provided by federal and sub-national governments to support fossil fuel production.

State-owned enterprise (SOE) investment refers to a legal entity created by a government to undertake commercial activities on behalf of the state. Governments can wholly or partially-own these SOEs. Public finance is provided through institutions such as national and multilateral development banks, export credit agencies and domestic banks that are majority state-owned. All of these have legal provisions and are included in the ASCM definition (Gard & Kitson, 2015; Burton *et al*., 2019). In July 2019, the South Africa government has pledges R465 billion for an Eskom bailout (RSA, 2019).

In South Africa, the Industrial Development Corporation (IDC), The Development Bank of South Africa (DBSA) and the Public Investment Corporation (PIC) are included in this SOE category. Analysis of the IDC policy shows very little unique support for oil and gas entities, even less to the renewables sector and no consideration for the upcoming shale exploration sector. Public finance includes the provision of grants, equity, loans, guarantees and insurance by majority government-owned financial institutions for domestic and international fossil fuel production. Relief from environmental liabilities, which refers to the fossil fuel companies not being made to pay for the costs of environmental externalities, for example, mine rehabilitation or air quality, is also considered as support.

WTO Principles (1985) define the most visible form of subsidisation as a loan that qualifies as a direct transfer from government, albeit as a ‘potential' direct transfer (Burton *et al*., 2019). Fossil fuel producers can also be subsidised by the use of tax expenditures that are similar to direct transfers. Under the WTO Principles (1985), a loan would qualify as a government subsidy; an example of such would be the 2008 Subordinated Loan to Eskom.

The subordinated loan was made available to Eskom in 2008, during the time of the rolling blackouts which led to the recommissioning of Camden, Komati and Grootvlei power stations and the new construction of Medupi and Kusile, which was supposed to be fully commissioned in 2019. The years 2008 - 2011 saw a total disbursement of Treasury funds of R60 billion (Burton *et al*., 2019).

Exceptions are also seen as support. Both Eskom and SASOL received exemptions from early 2015 from compliance with the Air Quality Act (CEF, 2018). Based on the broader definition and the categorisation of these sub-sectors, quantification of subsidies is difficult. However, ZAR 213 million (USD 20 million) in the year 2013 – 2014 in state subsidies has been calculated (Gard and Kitson, 2015).

In 2014, despite its failure to meet the repayment, the utility was further assisted by the government, when R24.4 billion was written off and converted to equity (RSA, 2009). Government ‘foregone revenue’ refers to interest due, and that is not charged and which is forfeited over time. Government-provided infrastructure, is another type of subsidy. The Hydrocarbon Policy sub-programme is an excellent example whereby R4.5 billion in subsidies were transferred to Transnet between the 2010 – 2013, for the commissioning of new pipelines.

PetroSA has also benefitted in the form of government grants for personnel training and capacity building. The Central Energy Fund (CEF), which is a Schedule 2 SOE, dispensed R560.8 million in overseeing projects between 2010 – 2016, for the promotion and exploration of natural gas production. In 2013, the CEF allocated funding to the South African National Energy Development Institute (SANEDI) to a total of R182 million (Burton *et al*., 2019). SANEDI funded R&D projects in hydraulic fracturing and carbon capture and storage projects. All these measures effectively reduced the cost of producing fossil fuels to below the values that would prevail under a standard tax treatment.

Market price transfers are raised from policy interventions and provide transfers between consumers and producers. In the case of liquid fuels, producers' guaranteed returns are generated via the regulated fuel price. Table 3.1 below refers to the types of subsidies provided in South Africa. The background to subsidies and assistance rendered by the State to the actors of the energy industry, requires investigation around the relationship of the state, the various actors and the reasons that motivated and shaped these support mechanisms. The U.S. government, as referenced earlier, also provided support for the oil and gas industry, from the very early days of the 1900s, and this continues now into the shale industry.

Table 3.1: Subsidies Identified in South Africa

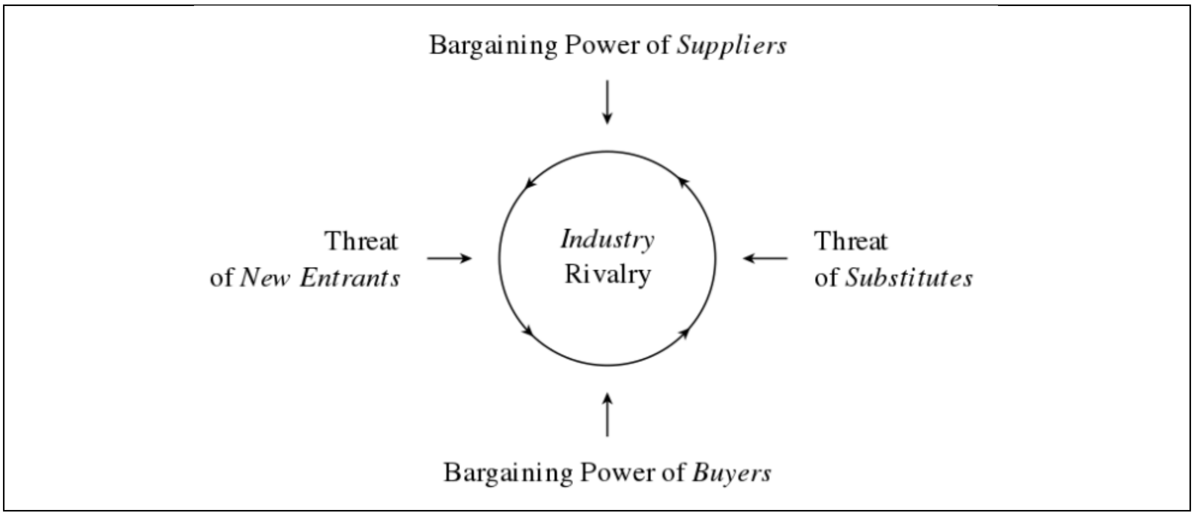
Direct transfer or potential direct transfer of funds	Government revenue foregone	Government-provided or government purchased goods or services	Income or price support, or relief from standard costs or procedures
Direct Payments	Tax expenditures: reduced tax rates, exemptions, rebates.	Under-pricing of government-provided goods or services.	Above-market rate prices for producers via government regulations or import barriers
Grants	Accelerated depreciation allowances	Government-provided infrastructure is specific to the sector.	Consumption mandates
Government loans provided at below-market rates	Reduced royalty payments		Export taxes or restrictions
Guarantees for loans, security or credit			No penalties for environmental impacts
Government spending on research and development			Zero compensation for human health hazards
Assumption of liabilities for closure and post-closure risks.			No payments in Royalties or a direct cash for the IP of CTL technology.

(Source: Researcher's Construction adapted from Burton *et al.*, 2019)

3.2.1.4 The Power of the Various Actors in Coal

Porter's Five Forces framework (1979) is an excellent tool to analyse the current state of the South African micro-environment and the political economy of the energy sector. The tool also enables this research to examine the emergence of a few black local investors and the unions which have a strong influence on maintaining the current *status quo* of coal, as the primary and dominant fuel in the South Africa energy supply. This phenomenon of power control within a privileged elite, existed during the apartheid era and continued into the new South Africa. The comfortable, ever-green contracts enjoyed by the white, local investors were transferred into the hands of the new black elite of the labour unions (Burton *et al*., 2019). Figure 3.2 below refers to the graphic representation of the Porter's Five Force Model.

Figure 3.2: Porter's Five Forces Model - 1979



(Source: Porter 1979)

In summary, the investigation into FFSR is pertinent to UOG extraction in the Karoo and all other new energy forms in South Africa. Provisions within international legal frameworks such as World Trade Organisation (WTO) (1985), may institute provisions to obligate states to provide state-aid for new energy companies pursuing lower-carbon intensive futures (Wurstenburg, 2017). FFSR expected as a key agenda item in the upcoming conference in Kazakhstan, in 2020. While support mechanisms are not currently in the place, the new shale sector, as well as the renewable energy sector, are eligible candidates to claim such support. This support will further assist in lowering the price of energy generated by new forms of modern power. The role of the WTO Rules (1985) is very pertinent to the shale exploration, given the dependence of IOCs to provide the finance and expertise for the exploration. Clauses such as "legitimate expectation" and "the most favoured nation", are important to provide assurances to the foreign and local investors. The clauses ensure that foreign investors are treated equally as the national investors.

3.2.2 The Environmental Question: Is UOG Extraction Safe Enough for the Karoo, South Africa?

3.2.2.1.1 Principles of International Environmental Law

The sources of international law as set out in Article 38 (1) of the Statute of the International Court of Justice (1945) are generally custom law and international conventions, general principles of law by civilised nations, judicial decisions and the writings of publicists, codifications and *jus cogens (*Talus, 2014). *Jus cogens* have become significant in the context of South African environmental law as South Africa is part of many international conventions. International norms and standards have been instrumental in shaping South African domestic environmental law. Environmental law draws on sources from many formal existing laws and, therefore, there exists an on-going debate as to whether international environmental law is indeed a law discipline in its own right (Glazewski, 2016).

The South African Constitution (1994) refers not only to an environmental right but also states the development of environmental law. As such, the Constitution (1994) provides a framework for the administration of domestic environmental law, allowing for specific designations in the context to national and regional competencies. These become unclear and complicated when cases straddle many regional constituencies.

The sources of South African environmental law are international law, custom law, statute law, common law and The Constitution (1994). While custom law is based on age-old customs, the courts have defined the legitimacy of these provisions, in satisfying four criteria, as referenced in the case of the Fish Hoek, Cape Town fishing community. Custom law is a law that has existed for a long time, is generally observed, is reasonable and the content is precise and clear.

The South African Constitution was enacted by the new government of 1994. African custom-law which referred to African unwritten law covers the traditional leaders and traditional belief systems. The ‘rights of the water's people’ in the Karoo, is a strong, yet intangible point which was raised by Chief Margaret (personal interview with Chief Margaret, NMU, 2015). In the context of the shale discourse, a case emerges whereby the Khoisan action group is not in favour of UOG extraction, believing that Khoisan ancestors are the ‘water’s people’, living in the waters of the Karoo, South Africa.

With the expressed commitment of addressing climate change based on the science and equity put forth by the drafters of the Paris Agreement (2015), South Africa has already observed, and is projecting, further trends of marked temperature increases, rainfall variation and rising sea levels as well as an increased frequency of severe weather events. Informed by the findings of the Intergovernmental Panel on Climate Change (IPCC) that warming of the climate system is unequivocal, further mitigation efforts by all are needed to avoid high to very high risks of severe and irreversible impacts globally.

Irrespective of any adequate mitigation efforts, the IPCC also concludes that, due to the inertia and long-response time lags in the global climate system, adverse impacts of climate change are inevitable. The following three international environmental law principles are noteworthy for this discussion on sustainable energy policy development; the combined but differentiated responsibility (CBDR) principle, the precautionary principle and the 'polluter must pay' principle

The combined but differentiated responsibility (CBDR) principle holds that developing countries have the least responsibility for the challenge of global climate change, but are the most vulnerable to its impacts and needs to adapt to the adverse effects of climate change (Honkonen, 2017). The precautionary principle puts forth that when in doubt, parties should err on the side of caution and the necessary precautions must be taken (Honkonen, 2017). The 'polluter must pay' principle, the third principle, in international environmental law, kicks in and levies punishment on the offenders (Honkonen, 2017).

South Africa, as a developing country has many pressing challenges. The elimination of poverty and eradication of inequality, employment creation, improved primary education, developed health care, social welfare systems and basic human needs which falls intrinsically into poverty alleviation, rank higher than environmental protection. To meet these poverty challenges, energy is required. In the recent national election held on the 8h May 2019, the evidence of only two political parties mentioning sustainable development and climate change, as part of election campaign manifestos, illustrates the priority of this important global mandate.

This research expands on the experiences of the global shale markets, drawing on the experiences of other shale jurisdictions based on evidence-based scientific research. Evidence-based scientific research on the geology of the Karoo, South Africa, allows this research to evaluate the safety aspects of technology and the geology of Karoo, South Africa. The analysis is structured in the following ways:

- The exploration technique
- Analysis of the socio-economic factors concerning water usage
- The rule of law that will govern the exploration

The literature on shale from all markets references the early days of U.S. shale successes and pitfalls. Successes range from general economic benefits to the U.S. economy. At the same time, a negative effect was felt on the global oil price, (Salameh, 2013; Maugeri, 2013). The socio-economic factors in UOG extraction are the water quality, water quantity and waste-water management (UK Water, Policy Brief, 2016).

Notable shale commentators around the world note the limitations of U.S. scientific literature (Green, 2016). UOG extraction for many jurisdictions, is an interim solution in the energy crisis. The authors Kijko, Kahle, Smit, and Esterhuyse (2016), question whether the economic benefits outweigh the complexities of the exploration after reviewing the exploration technique the impacts upon the environment in terms of the long-term effects on water, the potential seismic activity and the emissions of fugitive GHGs during the extraction process.

3.3 HYDRAULIC FRACTURING AND THE FEATURES OF THE TECHNIQUE

There is mounting evidence that the extractive process may release higher emissions of fugitive gases, such as methane, which is a deadlier culprit than carbon. In the U.S., there have been numerous accounts of the contamination of water at well-heads and the surface water in the early days of the exploration (Jackson, 2017). U.S. acts and laws were modified to mitigate certain circumstances resulting in a multitude of environmental regulations, both at the state and the federal level, and which have been enacted, affecting the costs associated with petroleum development and exploration. Compliance with the law requires some modification to the exploration process and production methods. These new methods may lead to an increase in the costs of production (Bohi and Toman 1996). An example of such would include the new chemical compositions in fracking fluids and which have not been used before in mining in South Africa. A recent study states that not all chemicals used in the fracking process are toxic (Glazewski *et al*., 2016).

3.3.1 U.S. Advances in Technology

The notable advances are in the shale exploration techniques and the usage of chemicals which have caused consternation amongst governments and environmentalists and the following section elaborates on the various techniques (Jackson, 2017).

3.3.1.1 Massive Hydraulic Fracturing

Massive hydraulic fracturing (MHF) was introduced into the Devonian shale plains. The earliest developer, Mitchell Energy, with the financial assistance of the DOE, applied MHF to the Barnet Shales. At this point, after experimentation, Mitchell Energy started in 1984 to use nitrogen-assisted, gelled water fracks which were 1,500-foot half-length gelled water fracks (Krupnick & Wang 2013).

These gelled waters were commonly known as a massive hydraulic frack and were used for all Barnett stimulations. Mitchell Energy, having acquired this expertise, experimented in extensive hydraulic fracking in a tight gas formation in East Central Texas (Krupnick & Wang 2013). The years 1987 to 1993, saw the use of nitrogen being eliminated from the frack design, without causing any adverse effects. Instead cheaper, lower quality fluids replaced a more expensive type as the proppant. In some areas of the Barnett, this resulted in no adverse effects (Krupnick & Wang 2013). Acid treatments in the pre-frack stage were also eliminated, with the gel content in the fracking fluid being slightly reduced with advances in technologies. This saved costs by 10 per cent which before this were between USD 350 – 450 000.00, until much later when the gel was eliminated, and slickwater fracking was introduced by Union Pacific Railroad Corporation (UPRC) (Krupnick & Wang 2013).

In summary, gel and water are carriers of proppants. The job of the proppant is to carry as much sand as possible, into the wellbore, to capture the gas. The gel possesses better properties to bring more proppant, while un-gelled water has reduced properties. The use of chemicals has been challenged by the environmentalists and this has led to the development of greener gels leading to the development of guar gum, which was then used. The history and development of guar could result in a critical success story for the Karoo, following the success of the powder being made from the bean of a relatively unknown plant grown in India and Pakistan and which has turned around the economies of rural towns in those countries. Gura can quickly turn water into a thick gel.

3.3.1.2 The Technology of Using Foam Fracture

Foam fracture is a technology whereby the wells during this technique are stimulated explosively in open-hole well-bore or by water fracks. This technique was first used by the gas shales programme, in more than fifty cost-share demonstrations in the first four years in the U.S. The introduction of the method saw foam fracture being able to reduce the volume of water compared to conventional water fracks. Since 1979, foam fracturing was the preferred method in the Devonian UOG wells. Commercial services were widely available.

The market leader, Mitchell Energy, initially experimented with foam fracture but abandoned this technique in favour of water fracks which was not only the traditional method but also the technique which continued to be used widely by other developers. The impacts of foam frack in South Africa should be thoroughly investigated in the light of potential earthquake activity. Halliburton (2018) and Schlumberger (2018) have progressed to the innovation of greener frack fluids which have a gentler effect on the environment and also minimise the use of water in a region where water is scarce.

3.3.1.3 The Technology of 3D Seismic Imaging

3 D Seismic Imaging has been a revolutionary technology for oil and gas exploration with 3-D seismic imaging measuring acoustic reflections from an energy source, thereby providing a better picture of the structure and the properties of the subsurface rocks than the predecessor 2-D imaging. It improves the ability to locate new

hydrocarbon deposits, which determine the characteristics of reservoirs for optimal development and defines the best approach for producing a reservoir.

3.3.1.4 The Technology of Micro-seisemic Fracturing Mapping

Micro-seismic fracturing mapping, with the support from DOE and GRI played an essential role in the early development of micro-seismic frack monitoring (Krupnick & Wang 2013), with the technique being different from 3-D seismic imaging as microseismic frack mapping possesses properties of being able to reveal the height, the length, the orientation and other attributes of induced fractures.

As mentioned earlier, the US Government, already steeped in a heritage of exploration and development since 1901 when oil was first discovered in Spindle-Top and Texas, had already possessed a detailed policy framework which evolved over the years with the various technological and environmental developments. However, UOG extraction was unique as it was steeped in the great controversy, before, during and after the first wells had been explored. Mitchell Energy, being one of the earliest developers faced many lawsuits and these shaped amendments to the various acts and gave rise to the multiple bodies of legal counsel, consultants and engineers who started to specialise in the field of hydraulic fracturing, hydraulic fracturing fluids, other methods and supply-chain functions (Green, 2016; Krupnick & Wang 2013).

3.3.1.5 The Development of Less Toxic Additives

Shale backwater is acknowledged as a critical problem, both in terms of storage and toxicity. However, the gura bean, has revolutionised the U.S. industry, while spurring economic development in the rural areas of India and Pakistan. This research examines the benefits of guar and the game-changing opportunities for rural communities in Chapter Five. Mitchell (1980) famously wrote that the shale companies should act responsibly (Podcast: The Energy Centre. Columbia University, 2019). Advances in technology have led to fracking fluids which possess lower toxicity levels, which contribute to better waste-water management. The development of plant-based gels has contributed to the reduced levels of harm to the earth surfaces. 3D seismic imaging and micro-seismic fracturing mapping has led to a better understanding of seismicity, as result of UOG extraction. The critical uncertainty of air quality is revisited under the megatrend of Urban Population Growth in Section 5.2.1. Climate risks is also revisited in the same section.

3.4 PART TWO: SOUTH AFRICAN SHALE LEGISLATIVE UPDATE

The Karoo, referred to as the land of great thirst, is situated approximately 1280 kilometres from Johannesburg and Cape Town (Schumpeter, 2012). America's Energy Information Agency (EIA) states that 485 trillion cubic feet of gas exists in the Karoo, South Africa, which is placed in the fifth position of the world's shale reserves. If only 10 per cent of the gas were extracted, almost R1,5 trillion will be generated and thousands of jobs will be created (De Wit, 2011, Fakir, 2015, The Twine Report 2012). America's shale success, which led to energy security and the country becoming an exporter of energy, is widely accepted (Maugeri, 2015, Palti–Gusman, 2018, Salameh, 2015). Civil society around the world remains distrustful of extractive companies given the lack of disclosure transparency (De Wit, 2010). The long-term environmental damage is evidenced in the Niger Delta and the Gulf of Mexico (De Wit, 2010).

In April 2011, the South African government imposed an eighteen-month moratorium on shale gas exploration whilst a task team, set up by the minister of environmental affairs, conducted an investigation. Chabane (2012), then minister in the Presidency, stated that "it was clearly safe" (RSA, 2012). *The Economist* commented that the report only published the summary, which also stated that keeping the moratorium in place or too stringently regulating exploration would be too costly for South Africa (Schumpeter, 2012). The socio-economic impacts of shale gas exploration on water relate to water quality, water quantity, and waste-water management (UK Water, Policy Brief, 2016). Given the overwhelming concern on the use of water, the following section examines the water issue in relation to UOG extraction.

3.4.1 Establishing the Legal Basis for Water in the Karoo of UOG Extraction

Water usage in UOG extraction requires the permission of the departments of water, the environment, and mining. This section places specific emphasis on the examination of the current fracking regulations and attempts to unravel the legal basis for UOG extraction and the overall impact on the communities of the Karoo, South Africa. The first section deals with the laws of the various departments while the second section examines the UOG regulations and how these respond to the human right to water.

3.4.2 The Legality of Water

The legal basis of the United Nations Universal Declaration of Human Rights is the United Nations Charter (1946) and the United Nations Universal Declaration of Human Rights (1948). Both are underpinned by two international treaties on human rights. These are further supported by The United Nations International Covenant on Civil and Political Rights (1976) and the United Nations International Covenant on Economic, Social and Cultural Rights (1966) (Berlinskij, 2015; GWP, 2009). The human rights consideration, when making the final critical decisions, points out the differences between civil and political rights and which are considered ‘first generation’ rights on the one hand, and the socio-economic rights or the ‘second generation’ rights. These rights then obligate the State to supply certain goods such as education, health and housing on the other (Glazewski, 2016).

The South African Bill of Rights of 1994 states that the environment should be protected for the present and future generations through reasonable legislative means and other measures that prevent pollution and other ecological degradation, the promotion of conservation and the advancement of sustainable development while promoting justifiable economic and social development (Glazewski, 1994b). The section uses the international legal provisions in the development of a context for the argument on water usage relative to the fracking in the Karoo, South Africa and the possible actions which could be within the context of legality and the rights of the citizens.

3.4.2.1 National Water Act, No. 36 of 1998

The enactment of the National Water Act, No. 36 of 1998 (NWA) (hereafter referred to The Water Act), is the general act that governs water affairs in South Africa. The NWA which provides the effect to the constitutional right, to the access of water for all citizens. The NWA provides a broad definition of water. Water is referred to as “water resources” which encompasses the whole hydrological cycle. The hydrological cycle consists of water courses, surface water, estuary or aquifers, or any other collection methods for underground water. Aquifers are defined as “a geological formation which has structures or textures, that hold water or permit appreciable water movement through these structures’’ (Section 1 (1) (i)).

The NWA must be read in conjunction with the Water Services Act, No. 108 of 1997, as these two sets of legislation have separate bearings regarding the laws and services under these acts, for example, wastewater management falls under the WSA. The promulgation of the NWA repealed a myriad of other acts regarding water and was controlled by the Department of Water Affairs and Forestry. The Zuma Administration (2007-2018) separated the forestry department from the water department which led to the forestry department being merged into the Department of Agriculture and Forestry. This move attempted not only to streamline water affairs, but sought to harmonise the Department of Water Affairs with the Department of Environmental Affairs.

The NWA, therefore, sets out to redress the past imbalances regarding water allocation, while respecting the constitutional right to property and the public environmental interest (Soltau,1999). The NWA is further informed by the South African Bill of Rights, which is contained in the Constitution (1994), under the section: *Health care, food, water and social security*, The Bill sets forth that everyone has the right to:

> (a)(b)(c) provides for sufficient food and water*,* (S27 (1), The Constitution 1994)

The NWA further states that:

The state must take reasonable legislative and other measures within its available sources, to achieve the progressive realisation of each of these rights *(*S27 (2) (b). The Constitution 1994).

The NWA gives effect to the constitutional right of access to water *(*S27 (2) (b) The Constitution 1994). The WSA provides the practical effect to the constitutional right, which sets the framework for water supply for drinking and sanitation and with which municipalities must comply *(*S27 (2) (b) The Constitution 1994). Administered by the Department of Water Affairs and the minister of water, the two acts must bear in mind the environmental provisions, which are outlined in the National Environmental Management Act (NEMA), No. 107 of 1998, the Environmental Conservational Act (NCA), No. 73 of 1989, and the Mountain Catchment Areas Act (MCAA), No. 63 of 1970. Other mineral and agricultural legislation governing water pollution and other environmental factors must also be borne in mind (Esterhuyse et al, 2016). The NWA clearly states that the government is the owner of the water and prioritises socio-economic and environmental needs (Esterhuyse et al, 2016). The act aims:

…to ensure that the nation's water resources are protected, used, developed, conserved, managed and contro*lled (Section (2)*(B).

3.4.2.2 National Environmental Management Act, No. 107 of 1998 (NEMA)

The Department of Environmental Affairs (DEA) administers NEMA, as well as a set of laws dealing with waste management, air quality, biodiversity, and the protection of certain areas, affects the NWA, and provides the guidelines for practical water usage. NEMA is supported by the NCA, the MCAA, as well as the mining and agricultural acts. The authors of the Esterhuyse et al. report applaud the robustness of environmental legislature, yet argue that this legislature leads to prolonged legal decision making as it straddles the various ministries across the nine provincial local governments (Esterhuyse et al, 2016).

3.4.2.3 Mineral and Petroleum Resources Development Act, No.28 of 2015 (MPRDA)

The MPRDA was promulgated under the stewardship of the minister of mineral resources. The mandate of the minister covers all matters regarding mining, but environmental issues are controlled by the One Environmental System (OES). The mining minister would remain the competent person of the OES. This was the start of the confusion which would lead to a complex problem. OES was a progressive move and should, from the start, fall under the stewardship of the minister of environmental affairs.

The hydraulic fracturing regulations were enacted under the MPRDA in 2015 by Minister Zwane, Minister of Minerals and Energy, 2015-2016. At that time, this promulgation was considered to be *ultra vires* (referring to outside powers of the minister of minerals) and was discussed in the Esterhuyse et al. report, which was published in 2016 (personal interview with Glazewski, 2016). Concerns from civil society and pressure groups led to three court appearances, which added to confusion and delays regarding UOG extraction in South Africa. Pressure groups used these court processes, as a delaying tactic and government was preoccupied with the nuclear advancement under the Zuma government. These delays frustrated the license holders and Shell threatened to withdraw from the exploration (Shell Company Report, 2016). The Supreme Court of Appeal (SCA), in July 2019, ruled against the minister and the shale regulations requires further review.

3.4.2.4 One Environment System (OES) 2014

At first, mining was excluded in the NEMA. Environmental affairs for mining was set under the MPRDA. This alone resulted in fragmentation of environmental affairs, which manifested negatively in high costs for applications as studies and activities were duplicated. The OES was set up in 2008 and water and sanitation joined the agreement in 2012. Further inclusions were the National Environmental Management Waste Act (NEMWA) and the National Environmental Air Quality Act (NEMAQA). The OES came into effect on 8 December 2014. The OES stipulates that mining activities are subject to an environmental authorisation process in terms of NEMA, and that the minister of environmental affairs prescribes the environmental legislative framework. It is also the appeal authority in mining-related environmental authorisations. The minister of mineral resources is the designated competent authority for environmental authorisation and for the issuing of waste management licences.

The minister of water and sanitation issues water licences in mining and this forms the link to UOG extraction. However, normal mining activities in South Africa require water as an infrastructural provision whereas UOG extraction requires water as a raw material. The water licences for mining and UOG are still not published and therefore, implementation cannot take place (Avenant *et al*, 2016). The minister of mineral resources appoints environmental mineral resource inspectors (EMRI) and bestows on them all the powers of an environmental management inspector. The EMRIs then enforce environmental laws related to mining. The role of the EMRI is not defined in the UOG activities. The minister of water and sanitation issues water use licences related to mining activities and will be responsible for stipulating water usage guidelines pertaining to the hydrological cycle (Esterhuyse and Glazewski, 2016).

3.5 DEVELOPMENT OF THE UOG REGULATIONS IN SOUTH AFRICA

There has been growing tension between the Department of Minerals and Energy (DMR) and the Department of Environmental Affairs (DEA) over respective mandates governing the environmental issues with a view that mining impacts are enacted under the MPRDA (Esterhuyse et al., 2016). This debate originated during the UOG discussions which highlighted UOG impacts on water and the environment. In 2012, The Department of Water and Sanitation became involved in OES.

Firstly, the ministers of all the departments agreed that environmental affairs pertaining to each department should be managed through the OES. Secondly, UOG, unlike any other extractive technique requiring vast volumes of water, is subject to NWA considerations. Given the environmental impacts of UOG, it requires approval from the Department of Environmental Affairs. After the lifting of the moratorium in 2012, the minister of environmental affairs established an inter-departmental team to address the interconnectivity of the three departments' decision-making processes. The result was an agreement reached by the ministers of the environment, water and sanitation, and mining. The manifestation of the agreement was that any UOG decisions would go through the OES. The IPIC could play a significant role in solving many administrative issues, given the following functions:

- Appeals and Legislative Amendments: Acts, regulations and appeals can be streamlined.
- Enforcement: Laws can be enforced and monitored which is critical for acceptance of UOG extraction.
- Co-ordinated timeframes: Harmonisation
- Capacity: Develop capacity
- Communication: Develop a comprehensive communication strategy of processes.

Until late 2018, the hydraulic fracturing regulations were to be enacted under the MPRDA (2008). Between 2012 and 2017, the industry had repeatedly called for the hydraulic fracturing regulations to be separated from the mining act. Despite this agreement, the minister of the DMR promulgated the fracking regulations in 2015, which were challenged in the Pretoria High Court, where the court ruled in favour of the minister. The matter was again challenged in Grahamstown, where the Supreme Court of Appeal, on the 4 July 2019, held that the implementation of the OES divested the minister of the right to make these regulations, as it was *ultra vires* (personal interview with Glazewski, 2016) Minister Radebe, at the deadline of the promised final draft for licences which were to be issued to license holders for public commentary, announced that the decision had been taken to separate the hydraulic fracturing regulations from the MPRDA. Minister Radebe gave no indication of when the separation and the new enactment would take place (Esterhuyse and Glazewski, 2018; personal interview with the CEO of South African Oil and Gas Alliance 2017, 2019)

3.6 UOG REGULATIONS AS CURRENTLY SET OUT IN THE MPRDA (2008)

Before the research goes into detail of each of the shale regulations, a broad outline of the regulations within the MPRDA is given. The Final Fracking Regulations under MPRDA, 3 June 2015 (Regulation Gazette No. 10444. Pretoria) is used for this commentary. Located under *General Provisions,* the regulations start at Chapter 6, which is an introductory chapter providing for the various definitions and terms and notably, the term ‘water balance’ is not defined.

Chapter 7, pertains to the Environmental Impact Assessment (EIA), which deals with assessments of conditions below ground, water resource monitoring, the assessment of seismicity and the outlining of seismicity in relation to water pumping activity (Regulation 84 and 85).

Chapter 8 details Well Design and Construction, which is devoted to the technical and safety standards. These require compliance to well-risk identification and assessment, well design and standards, conductor casing, surface casing, intermediate casing, production casing, centralisers, cement requirements, comparative tests, formulation pressure integrity tests and blowout prevention pressure testing. Regulations exist for each of the elements, given that safety precautions are vital for the exploration.

Chapter 9 provides for the last ten regulations entitled Operations and Management, and which are central to the exploration, implementation and monitoring of UOG. Each action is governed by a specific regulation setting out the specific details relating to the processes of use and compliance of drilling fluids, the use of air, water and mud (otherwise known as proppants), hydraulic fracturing equipment, mechanical integrity tests and monitoring, water quality, hydraulic fracturing fluids and legal disclosure, the management of flow-back and produced fluids, as well as the transportation of fluids and fluids storage. Further regulations on water management, water balance, and protection of water resources about the aquifers are also provided in Chapter 9. The chapter closes with the final three regulations on air quality management dealing with fugitive emissions, fugitive dust, and noise control.

Chapter 10, under the title of Well suspension and De-commissioning, regulates decommissioning and closure of the wells. The regulations detail well suspension, suspended well integrity management, and well decommissioning. The authors of the Esterhuyse et al. report (2016) state, that some of the regulations are *ultra vires,* which means that these are beyond the powers of the minister of mineral resources as these powers intrude on the mandates of the other departments (personal interview with Glazewski, 2016). In the case of UOG extraction, given the vast amount of water used for the exploration and the socio-economic impact on the nations, water affairs in UOG extraction should be under the control of the of the minister of water affairs.

The research now attempts to flesh out the details of the main regulations that govern water usage in UOG extraction. This allows for specific commentary on the individual socio-economic impacts on water quality, water quantity, and wastewater management. The objective would be to ascertain if all the nuances within each impact is provided for.

3.7 UOG REGULATIONS AND SOCIO-ECONOMIC IMPACTS OF WATER

Section 3.2.1. discussed the megatrend of climate change which relates to the Karoo, being the land of great thirst and the effects of de-forestation. Air quality comes under the radar after the reports from the Guardian on the excessive flaring in the UOG extraction process. Within this section is the sub-section on effects of a coal-dominated energy system and the effects on air quality. The following section focuses on the water, energy food nexus. The food discussion is critical to the Karoo debate as currently, the area is categorised by the agricultural sector and the most intense resistance comes from the large, white commercial farmers. the legal basis for the socio-economic impacts of the water. Biodiversity and ecological protection is central to the UOG debate and in the case of Germany and France, the costs of environmental damages outweighed the economic benefits of the extraction. In the past, water and air pollution were the main priorities. Recent reviews have also placed the stop light on the effect of the flora and the fauna (Robbins, 2013). The Karoo is home to the Riverine Rabbit, an endangered species. The research in the following section goes into the analysis of the current regulations to assess to what extent the rule of law covers these important externalities.

3.7.1 Regulation 88 (i): Environmental Impact Assessment (EIA).

As with any hazardous operation in any sector, EIAs are obligatory. The EIA covers all aspects of the shale hydrology, seeking out the risk factors of each stage from drilling to fracking, drawback, and de-commissioning. This regulation details water monitoring, obligating the license holder to provide a hydro-census. This hydro-census must be conducted by an independent specialist. It is noteworthy that the NWA refers to 'water resources' and not just water alone. These regulations mandate the role of PASA, CSIR and The Academy of Sciences to play a neutral role and inform the government, as data inertia is a critical challenge in the understanding of surface and ground water (Avenant *et al*, 2016; Esterhuyse et al, 2016; Green, 2016). This progresses on De Wit's (2010) suggestion that government should develop an independent pool of knowledge, effective tools for independent assessment of the exploration and competent human power (De Wit 2010). This approach will go far in addressing data and capacity inertia and will provide for intelligent and informed decision and policy-making to govern the new exploration.

3.7.2 Regulation 88 (2) and (3): Water Sampling Methodology

The setting up of a database of water sampling is mandatory and should be the task of the government. This regulation aims to govern and maintain the good quality of the water. The license holder must submit a water resources monitoring plan to the DWS and to the DMR. This forms part of the process of obtaining environmental authorisation. This report, which focuses on the methodology of water, must detail the sampling methodology. The monitoring process sets parameters, the monitoring frequency, and the reporting frequency, all of which are the key components of this sampling methodology.

3.7.3 Regulation 88 (6): Monitoring report

This regulation obligates the setting up of an environmental management programme (EMP). The rules of compliance for the EMP are detailed in the EIA, in Regulation 88 (i). This process provides a holistic 'cradle to grave' approach, in which the EIA provides an assessment of risks and externalities which may have a set of options for mitigation and risk management, an implementation plan (also in accordance with other regulations) and a monitoring report that ticks off a list of checks and balances. All these processes contribute to maintaining the existing quality of the water. The sections below are governed by regulations which enable the individual to accomplish the above-mentioned objectives that will respect and protect the good quality of the water.

3.7.4 Regulation 108–129: Management of operations.

This set of regulations is set out under the title of Operations and Management, setting out the controls that would lead to maintaining the good water quality. These regulations are found in the main part of Chapter 9 under the sub-title: Water Management. This section covers the details pertaining to the issuing of the license under the direction of the NWA and descriptions of the obligations of the license holder.

- Detailed engineering reports are required to be submitted in the application.
- The details of the hydraulic drilling programme are the main component, which must detail all phases of the exploration.
- The report is required to disclose the authorised sources of water, which is used during each phase of the exploration.
- The report is required to disclose the authorised volume of the water, which is used in each phase.

3.7.5 Management of water: Regulation 110

Chapter Nine is the most important chapter which deals with the management of water. Regulations 121–123 refer to the water balance (which is a term that is neither described nor defined). However, from the descriptors below, it is easy to work out what is being alluded to.

3.7.6 Water balance: Regulations 121–123

This section on water balance rather defines the job specification of the person(s) or maybe even a department, which are specifically mandated for this vital task. This water balance must contain the following information:

- The management of the devices and equipment to be used. This would be what De Wit (2010) refers to as a "national pool of scientific instruments" (De Wit 2011. p. 6).
- All data from the water flow
- The tracking will ensure records of all water abstracted, received, consumed, transported and discharged.
- This will ensure that at least 90 per cent of the water used in the exploration will be monitored. This is information could monitor how much is used during the drill phase and the fracking phase and could lead to more efficient use of water.
- The remaining 10 per cent must also be accounted for (Regulation 121(1)(a)-(g). specially Regulation 121 (1)(e)).

3.7.7 Operators and Good housekeeping: Regulations 121 – 123

This regulation controls the safe-keeping of inventory to avoid the problem of contamination through spillage of lubricants and diesel which must be stored in close proximity to the well pad. According to the U.K. Water Policy Brief, more contamination takes place at this level (U.K. Water Policy Brief 2016. p. 3).

- The devices and all other equipment must be well maintained.
- All devices must be easily accessible.

- Based on a maintenance programme, all equipment must regularly be serviced and checked.
- Must not cause any adverse effects.
- The rights of the existing users must be protected.

3.7.8 Regulation 122: Protection of Water Resources: Regulation 122

This regulation refers to the protection of groundwater and surface water. This regulation also provides specific, limiting information on the safe distance of the wells from existing surface and ground-water. In the case of an incident, the license holder must prepare the “necessary” remedial measures (Esterhuyse et al, 2016 p. 220).

The first part of the regulation details the following:

- The duties of the license holder
- The situation of well sites
- The regulations of water quality and testing (Regulation 122 (1).

The second part of the regulation details the situation of well sites:

- Fracking wells are not allowed to be within five kilometres, measured horizontally, from a municipal water field (Regulation 122(2).
- Fracking wells are not allowed to be within five hundred metres, measured horizontally, from a borehole (Woodford and Chevalier, 2002)
- Fracking wells are not allowed to be within five hundred metres, measured horizontally, from a riparian area.
- Fracking wells are not allowed to be within five hundred metres, measured horizontally, or 1:100-year flood-line, of a watercourse (Regulation 122(3).

The Esterhuyse et al*.* report (2016*)*, p. 220) finds these distances are insufficient and risky.

3.7.9 Regulation 122: Water Quality and Testing (Regulation 122).

This regulation is determined by the DWS rather than the DMR. According to the authors of the Esterhuyse et al. report (2016), this regulation is a redundant inclusion in the light of Regulation 110 (Esterhuyse et al, 2016) The authors also comment that these regulations fall more under the DWS, rather than the DMR.

- Stipulation of water resource monitoring
- Submission of monitoring plans for water usage
- Other water related aspects (Regulation 122)

3.7.10 Regulation 123: Water Use: Regulation 123

This regulation obligates the holder to obtain the correct permission under the NWA before exploration. The holder must indicate the supply and the source of water. Specific information must include:

- Quality and location for the base fluid for each stage of the exploration
- The water usage volume (Regulation 123 (1).

The licence holder must devise an integrated water plan (IWS) and submit it to the DWS and DMR and it shall comply with the following processes:

- Conduct and submit the results of a hydro-census.
- Provide detailed flowcharts that contain data from the computerised water balance.
- Provide a pollution prevention and impact minimisation plan (Regulation 123 (2).

3.8 U.S. LAWS REGARDING UOG

In this section, this research provides a review of U.S. fracking laws and critical insights that may be considered by the South African policy-makers, at a time when the Supreme Court of Appeal (SCA) mandated a review, in July 2019. In recent times, all companies and not only the petrochemical companies were burdened by the new laws implemented to protect the environment. Some were binding in the form of ‘hard' law, and some have softer, non-binding mechanisms such as the Paris Agreement (2015). Also included are the costs of carbon reduction and the implementation of the emission trading schemes. Both add more pressure and complexity for governments and industries in developed and developing countries.

Compliance with the laws requires certain modifications to the exploration process and production methods, investment in pollution mitigation equipment and the elimination of certain activities. These amendments, changes or modifications are costly from a time and labour point of view and always lead to an increase in the costs of production (Bohi, 1998). The following section concentrates on the primary laws which have affected petrochemical exploration and production. These laws were either modified or promulgated since 1988, just before the shale exploration, which began almost twelve months later. The single most important environmental restriction affecting petroleum exploration and development is the ban on these activities in several areas within the U.S. in areas with significant petroleum deposits, such as the Arctic National Wildlife Refuge, offshore California and the Gulf of Mexico which lies off the coast of Florida (Bohi, 1998).

Air quality being one of the main concerns of humankind, has yet not been legalised as water, which as a status as basic human right. The Clean Air Act and especially the Clean Air Act Amendments of 1990, affect petroleum exploration and development operations by controlling air contaminants from burning sources and hazardous air pollutants. Some of these emissions include emissions from mixing drilling muds, exhausts from diesel engines and boilers, transportation, emissions from gas flaring and the treatment of oil and gas as well as hydrogen sulphide emissions from drilling for, or producing, oil and gas, as well as from treatment facilities and from burning sources and hazardous air pollutants (Bohi, 1998). An essential change in the Act's amendment was the inclusion of benzene, a chemical found commonly in petroleum and which was previously exempted, but after review in 1990, the exemption was lifted, providing a useful reference to how acts became stricter and, particularly, more relevant to shale exploration (Bohi, 1998).

The Clean Water Act of 1977, regulates the discharge of pollutants into surface waters of the U.S. Some of these discharges from exploration and development include; drilling fluids, drill cuttings, produced water and blowout preventer fluid. Regulations under the Act have been tightened in recent years to reduce discharges into coastal waters (Bohi, 1998).

The Oil Pollution Act of 1990 is an extension of the Clean Waters Act dealing with spills, spills maintenance and a fund that regulates the clean-up of spills. The Act applies to storage tanks, ships and loading facilities, offshore platforms and onshore and offshore pipelines (Bohi, 1998).

The Safe Water Drinking Act of 1974, in addition to the control of water systems to serve the public, also regulates various kinds of injection wells that are associated with petroleum exploration and production. Injection wells are used to dispose of produced waters into depleted oil formations, inject water from production operations back into the producing waters and into depleted oil formations, inject water from production back into the producing zone, inject fluids for enhanced recovery and to store hydrocarbons.

The Toxic Substances and Control Act of 1977 regulates the manufacture, use and disposal of new and existing chemical substances. Substances naturally occurring in oil are exempt, such as benzene, toluene and xylene. The Resource Conservation and Recovery Act of 1976 controls the disposal of hazardous wastes and encourages the development of alternative energy (Bohi,1998).

U.S technological breakthroughs are noted and commended, and this research now examines the U.S. evidence-based research and attempts to unpack the concerns of the South Africa authors, making specific recommendations. South Africa is in need of an economic game-changer in order to face the crisis of an ever-increasing population and the fact that the U.S. economy after the 2008 financial crisis saw an economic turn-around by using a single bullet called shale, and this is worthy of further investigation and exploration for the South African case (Glazewski & Esterhuyse, 2016; Green, 2016; Maugeri, 2014; Salameh, 2013).

In an attempt to answer a core question of this research, the study dissects the findings put forth by the collaborative efforts of the leading academics and U.S. scientists who influenced the development of UOG extraction on a global level. Green (2016) alleges that the U.S. findings were flawed due to the shortcomings in the forms of the limitation of information flow and transparency in that market.

It is critical to interrogate the work of U.S. scientists, given the overall impact and influence of U.S. scientific literature and its effect on policy-makers around the world. Critical commentary is necessary, given the generalised referencing of the leading scientists and the corporate sophistry, which is commonplace in business (Green, 2016). The findings, as put forth in the Vengosh *et al.* report *(*2013) exonerate the misgivings of the U.S. gas industry, owing to the disclosure of information and confidentiality clauses (Green, 2016). However, what is accepted in the report is that a team of distinguished scientists concur that there is evidence of a significant risk to water from the hydraulic fracturing industry. This is in itself an important finding (Green, 2016). While there may be shortcomings, this research draws with caution on the various databases of U.S. shale insights.

This research in its investigation highlights an important shortcoming in the U.S. understanding and monitoring of methane. This line of enquiry was undertaken through various personal interviews in New York at the IEA Conference held at Columbia University on 7 November 2018, where many consultants and experts concluded that severe gaps existed in the understanding of methane leakage. Only since the past five years has there been a focused investigation into this area, which has been led by Corneille University.

3.9 A COMMENTARY ON UOG

The NWA set out to achieve two important functions. Firstly, The NWA prioritises drinking water, sanitation and the production of food over economic development. This is important as it provides the legal basis for the human right to water. Secondly, the NWA defines the hydrological cycles and its uses in the licences that it issues. Herein lies the first problem with regards to UOG extraction. The licences are not published yet for implementation.

The South African government is the trustee of South African water resources, with the obligation to respect, protect and fulfil the vital right of all citizens to water, which is a human right. In the review of the UOG discussion, the researcher assessed the competence of the government against this important mandate. Between the period 2008-2019, there have been many cabinet reshuffles, e.g., Ministers Shabangu (2012) Zwane (2016), Radebe (2018) and Mantashe (2019) in the DMR, with similar actions in the departments of water and environmental affairs (www.dmr.gov.za). The agreement to form the OES was a landmark achievement for South African environmental affairs. However, its implementation in the events leading up to the promulgation of the shale regulation is weak and unimpressive.

Without the water licences, the regulations have no basis. Regulation 110 remains nebulous as there is no legal basis for the source of water for UOG extraction in the Karoo. Given the role of water in UOG extraction and the effect that water bears on the decision-making in the viability of the extraction as well as, the State's custodianship of water and the vital role of the minister of water affairs, the competent person in OES should be the minister of water and not the mining minister. The SCA ruling confirms that the period of 2012-2019, after the lifting of the moratorium until when discussions started in earnest, has been a wasted opportunity for UOG extraction in South Africa. This can also be attributed to the fact that South Africa was not following an aligned energy policy, as President Zuma pursued a nuclear discussion with Russia as a back-up plan to Eskom's failure, which is currently being heard in the Zondo Commission (2019). A truly competent person should be in charge of the promulgation of the shale regulations and that the roles of the EMRI should be defined specifically in relation to UOG extraction and not be left vaguely to the mining sector at large (personal interview with Glazewski, 2017).

The descriptors within the regulations are vague. Chapter 6 has a specific section on 'definitions' which lacks clarity such as the 'water balance' or definitions that are completely omitted. Details, where-ever mentioned, such as the distances of well-pad from water sources, are lacking thorough, detailed geographic, and scientific bases as indicated in the Esterhuyse et al. report (2016). Such critical issues should never be open to interpretation as this will lead to judges having to formulate innovative solutions in order to arrive at ruling. The location of legal decisions, whether at central government level or local government, is not mentioned. There is no reference to the international environmental "precautionary principle" and the 'polluter must pay principle', which would solidify a definite position on environmental safety. The IPIC could have insisted on this inclusion as, whilst not explicit in the Constitution, these principles are recognised in the NEMA. At the very least, flora and fauna would be catered for in the UOG extractive process.

De Wit (2010) Head of the AEON Institute at the Nelson Mandela University in Port Elizabeth, South Africa, in an article titled 'The Great Shale Debate' and published in the South African Journal of Science in 2011, formally started the discourse on the shale in the Karoo, calling for the South African government to gather a national pool of scientific equipment and develop local intelligence on local shale gas exploration (De Wit, 2010). Years later, after the lifting of the moratorium and the publishing of the fracking regulations for public review, Fakir (2015), of the WWF, articulated global environmental warnings, denouncing the reliance on insights from America and other jurisdictions given the dissimilarities in South Africa's geologies amongst other factors (Fakir, 2015; WWF Report, 2015). Had these warnings been heeded, the regulations would provide greater specificity for the socio-economic impacts which were articulated in Chapter Two.

Green (2016) highlights the issue of non-disclosure clauses, which was prevalent in the U.S. dispute cases. Non-disclosure clauses prevent parties from disclosing pertinent information and it is alleged that the U.S. shale cases tended to mask the full truth in the evidence-based scientific literature (Green, 2016) There are many cases that were initially brought before the courts and which resulted in out-of-court settlements between the licence holders and members of civil society. To protect the licence holders, non-disclosure agreements were agreed upon and signed, which prevented any further investigation into the default of the licence holders. The regulation confirms that there is competence inertia with the circles of the government's policy-makers and ministries. In the various interviews with the policy-makers, the majority referred to vague findings in American shale literature and the failure to consider shale breakthroughs from other countries, such as Australia, the U.K., Canada and China, to name but a few examples.

The Academy of Science of South Africa (2018), together with the South African Oil and Gas Alliance (SAOGA) has recently further called on government for state funding for the pilot drilling of holes to correctly ascertain the extractive reserves of shale gas in the Karoo, South Africa. The petroleum contracts for UOG extraction in Karoo which were used to assist the discussion in 2012, are the current licence and royalty agreements. The use has not been re-examined to deal with the dynamic, changing energy landscape of South Africa. The regulations have many short-comings and the industry has a problem that the regulations are vague and are open to interpretation.

There are no references to the provider of water. The burden of the provision of water is not explicit in the shale regulations. The regulations do not specify if government should provide the water or should there be an obligation on the licence holder. One can only assume that regulations assume this. However, in licence agreements within the petroleum agreements, water is considered as infrastructure and is the burden of the host country and not the licence holder (Oil Contracts, 2015).

On a commercial level, there no reference to World Trade Organisation Rules (1985) which could protect the foreign companies. On such a global, environmentally sensitive topic such as UOG extraction, there are no specific references to the international environmental principles and certainly no mention of the protection of the flora and flora of the Karoo. South Africa is not ready for shale gas exploration in the near future, as the country is not ready to award licences as water licences are not published. Furthermore, current shale discussion is framed by the licence agreements, which define water as infrastructure. Lastly, the SCA ruling in July 2019 places the shale exploration in limbo. The industry expects that the shale regulations will be enacted in the new Petroleum Development Act, which is still being drafted.

3.10 WATER, SEISMIC ACTIVITY AND METHANE LEAKAGE

- The following section exposes the environmental problems associated with UOG extraction.

3.10.1 Water: Raw material or Infra-structure?

The source of water for shale exploration remains unclear. This research acknowledges that the state must provide infrastructure and that sources of raw materials are a corporate burden. Water is a critical requirement for exploration, and it is widely accepted that UOG extraction requires considerable amounts of water. With shale developers not declaring water sources, this leads to much public consternation. The current assumption is that potable water will not be used for exploration.

Saline underground water and water from the sea is acceptable for shale exploration and the infrastructure for getting this raw material to well-heads is not yet present. However, the question of who should pay for the water logistics remains answered (ASSaF, 2017; Fakir, 2015; Glazewski and Esterhuyse, 2016; Maugeri, 2013). While this research, therefore, assumes that existing water above ground and aquifers shall not be tampered with, this research points out that it is noteworthy that Section 24 of the Bill of Rights sets forth the rights of citizens regarding water and sanitation, which may be exercised by citizens in this discussion (Belinskij, 2015; Green, 2016). Furthermore, extensive, baseline studies are required to be conducted to ascertain the deep-level geological characteristics of the area (ASSaF, 2017; Glazewski and Esterhuyse, 2016; Maugeri, 2013).

In the early days of the exploration in the U.S., there had been many legal claims against the first exploration companies and which led to long-drawn out court actions (Maugeri, 2013; Jackson, 2018). The Geological Society (2012) in Germany concluded that fracking could be safe and responsible, provided that the rule of law was observed and provided that the necessary technical measures were taken, along with baseline studies and that pilot surveys were carried out (Bundesanstalt fur Geowissenschaften und Rohstoffe, 2012). Leading geoscience institutions from around the world conclude that best practice of engineering procedures, coupled with geological analysis and monitoring are vital to the safe exploration of UOG and the protection of aquifers (Hannover Declaration, of 2013). This fact has been reiterated by other leading institutions in the U.S. (ACOLA, 2015).

The cases brought in front of the courts centred around the waste-water. Otherwise known as backflow, this substance, which is a combination of proppants and fracking fluids is toxic. This toxicity also depends on the additives used in the early days of the exploration. It is noteworthy that not all additives are toxic as pointed out by Glazewski (2016). Reports have confirmed that surface water contamination around the wells has occurred in many wells in the U.S. and which has been caused by human negligence (ACOLA, 2015).

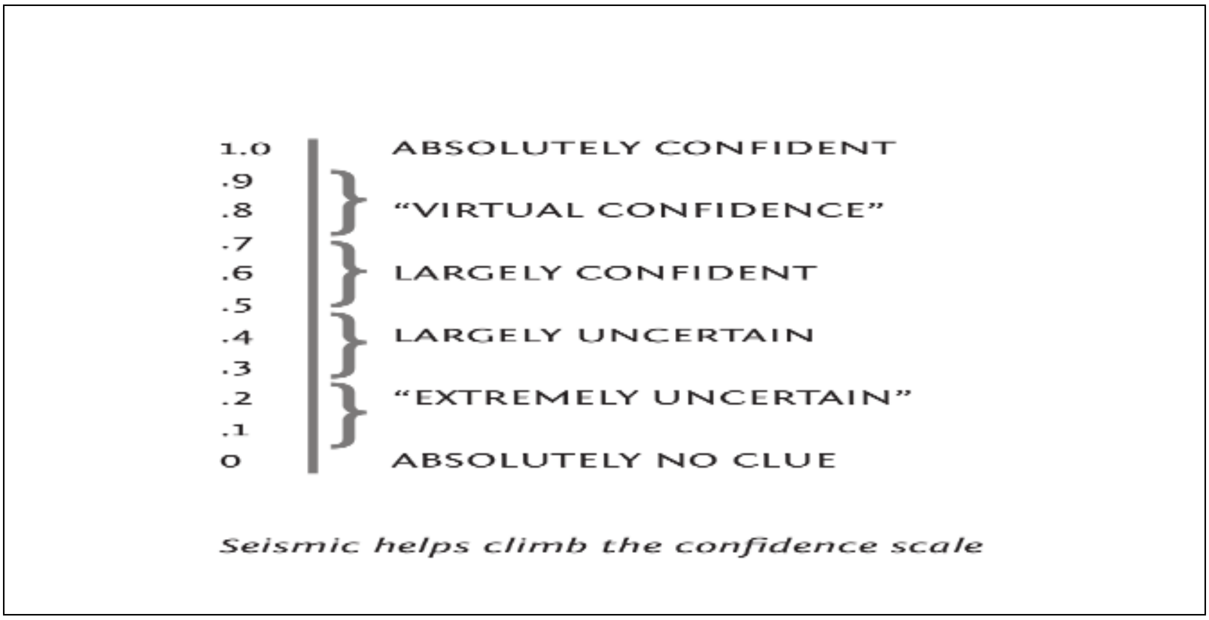
There has been no confirmed incidence of the aquifers being contaminated, or that fugitive gases have entered the pipes and taps in the U.S. and which can be directly attributed to UOG extraction. In unconfirmed reports, the methane that entered water pipes was the result of other sources and not fracking. Waste-water is highly saline and should be disposed of responsibly. (ACOLA, 2015; ASSaF, 2017). U.S. reports have concluded that there has been contamination of rivers and streams as well depletion of organisms and which again, in confirmed reports, was caused by human negligence (ACOLA, 2015; ASSaF, 2017). The academic community does point out that the issue of water contamination is not caused by the technique of hydraulic fracturing but by negligence when waste-water is extracted.

Storage of the toxic water has been problematic in all jurisdictions where UOG extraction has taken place and the industry is now investigating the option of waste-water re-usage as well as storing this water in dis-used wells. This in itself is a wicked problem as it leads to more significant uncertainty of what toxicity build-up might result in the long-term in the depths of the earth (Green, 2016). On a final note on water, this research, however, assumes that the existing groundwater and the aquifers will not be interfered with by fracking.

3.10.2 Seismic Activity

It is widely accepted that given the vast amounts of water pumped and the velocity of the pumping action, this could induce seismicity in the form of earth tremors and earthquakes, as were witnessed in Oklahoma, Irving and Lancashire (Fakir, 2015; Glazewski & Esterhuyse, 2016; Wait and Rossouw, 2017). The fact that large amounts of water are required is a concern in water-stressed areas such as the Karoo, South Africa, as well as in the rest of the Western and Eastern Cape regions of South Africa. Seismic activity related to fracking has been witnessed in Irving, USA and Lancashire, UK, and all cases were in the area of 2 - 2.5 on the Richter scale. Figure 3.3. refers the rates of risks in seismicity.

Figure 3.3: Seismic Barometer



(Source: Oil Contracts, 2015)

Lancashire has a higher density of people living in the area with the Marcellus area having a lower density, while the Karoo, where the fracking sites are located, is sparsely populated. The USGS (2018) defends that fracking is not causing most of the induced earthquakes as the technique itself does not cause the earthquakes but that the disposable waste-water is the primary cause of the recent increases in earthquakes in the central United States. According to The USGS (2018) not all wells are subject to earthquake activities. A combination of factors is required for earthquakes to occur and these are "the injection rate of the fluids, the presence of faults and the presence of pathways for the pressure of the fluid to travel from the injection points to faults" (USGS, 2018).

3.10.3 Methane Leakage and Air Quality

Methane and other GHGs emerge in this research as the most fundamental and worrisome uncertainty in the UOG extraction debate. While it is accepted that shale is cleaner burning than coal, a marked decrease in coal is seen since the recent shale exploration in the U.S. This is a good example which may be referenced, but as pointed out in the briefing document to the EU. GHGs remain an unknown entity as methane is five times deadlier than carbon. The net effect of GHGs on the environment over the entire global fracking exploration remains unknown (Jackson, 2018).

This research makes a critical case that the existing scientific research cannot fill the gaps in current knowledge. According to the report, severe shortcomings in the legal and regulatory frameworks have been noted (Glazewski, 2016; Green, 2016). Green (2016), states that the findings of the U.S. scientific analysis detailed in the Vengosh *et al*. (2014) report, lack critical evidence. This information places the South Africa research community in limbo, thereby calling for a further moratorium on the UOG extraction in the Karoo, South Africa (Green, 2018; Vengosh *et al*., 2014).

The Vengosh *et al*. (2013) report galvanised other jurisdictions such as Canada and Australia to start fracking (Glazewski & Esterhuyse, 2016). In the U.K., Australia, (Goldthau & Labelle, 2016; Strezelecki, 2014) and China, policy-makers have expressed a keen interest in shale exploration, with a positive prognosis. New moratoria were introduced in several states in the U.S. even though the so-called America shale successes as witnessed on U.S. domestic soil as late as 2018 were accompanied by reports on the exaggerated figures for employment and the side-stepping of corporate taxes by the shale companies and the growing wave of concern for methane leakage (Howarth, 2018).

While it can be argued that there are positive effects of the troika in the U.S., and of the relationship between developers, landowners and civil society that exists, there is also a downside (Green, 2016). Disagreements between developers and civil society are covered in a shroud of secrecy under the U.S. legal provisions of corporate non-closure agreements (Green, 2016). Green comments that complaints from civil society have led to compensation which was accompanied by the signing of non-disclosure agreements so that the extent of environmental impacts were not fully quantified in the U.S. case. De Wit (2011) warns in the South African Journal of Science:

South African universities are not on top of the issue either in research or teaching and that government agencies and staff, lack the necessary skills to drive serious research and investigation (De Wit, 2011 p.7).

Green (2016) further attacks the Vengosh *et al.* report, (2013) claiming that the U.S. scientific findings are not adequate to assess the South African case. De Wit (2015), together with Scholes a leading scientist in South Africa, as well as a legal environmentalist, Glazewski, (2016), concludes that government needs to conduct its independent research and not rely on developers for information. Developers currently have an advantage in the UOG discourse, possessing all the knowledge and possessing the ability to influence the country's shale fiscal policy (Fakir, 2015,) and in the words of De Wit (2011):

The lessons for the academic community – researchers and bureaucrats – are clear: do your homework well and focus on our grand challenges. The lessons for the government are clear too: provide the funds for centres of excellence where such work can be done in earnest, and do not take half measures. Shell too should be held accountable to our nation's needs and, like the energy giant Petrobras in Brazil, should be required to redistribute a more significant slice of the company's profits into educational and regulatory institutions (De Wit, 2011 p.7).

Fakir (2015), Green (2016) and Glazewski and Esterhuyse (2016) together with other notable scientists and ethnographic authors argue that whilst the U.S. is the leader in UOG extraction and has provided significant insights, the South African experience is more likely to be influenced by the paths of Canada, UK, Australia and China. From an ecological perspective, heeding the advice from non-fracking EU markets is favoured (Fakir, 2015). Based on that argument, this research now moves on to the other jurisdictions which continue in Part Three.

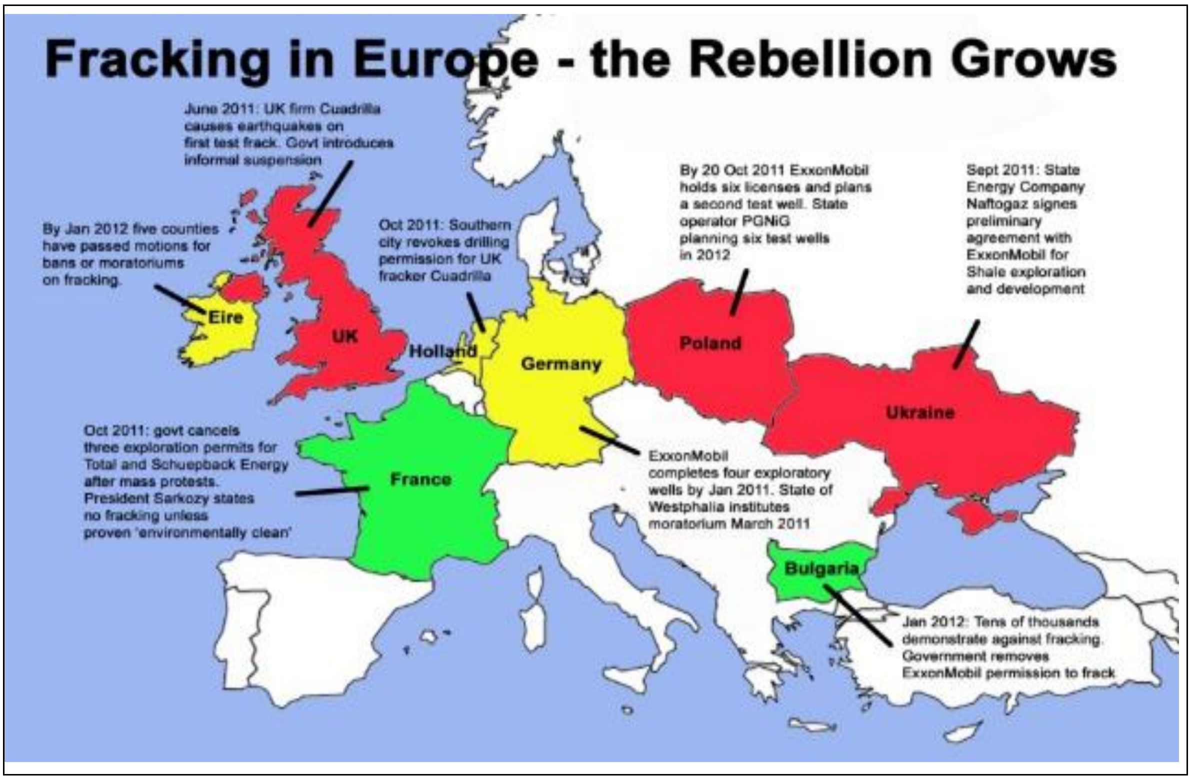
3.11 PART THREE: INSIGHTS FROM OTHER UOG JURISDICTIONS

Part Three of this research unravels the problem by investigating the opinions and decisions of other jurisdictions which have considered the shale opportunity. This research, through the examination of markets which have banned the exploration, unravels the reasons for this decision.

3.11.1 France

The total recoverable reserves (TRR) in France for UOG are estimated to be 137 TCF (U.S. EIA, 2013). France passed the law in 2011 to ban fracking, citing environmental concerns. Even though the discourse has been heavily debated in the French Parliamentary Office for Scientific and Technological Choices, and the French Academy of Sciences (2014), the ban was overturned in 2016 (Agence France-Presse, 2017). Figure 3.4 dated 2012 illustrates the current situation in Europe.

Figure 3.4: The Status of Fracking in Europe



(Source: Frack Off: Extreme Energy Action Network, 2012)

On 8 January 2016, the public protector of the administrative court of Cergy-Pontoise (Val-d'Oise) agreed with Total to uphold the appeal filed by the French oil giant against the repealing of the licence in Montelimar in 2011, and which covered more than 4000 square kilometres in the Drôme, Ardèche, Gard, Vaucluse and Herault. Bové (2012), leading the anti-UOG movement in early 2011, protested against the public opinion and considered it unlikely, pending the deliberation of the case to the end and formally requested that the government reaffirm its opposition towards UOG and oil. The court agreed with the movement and permanently revoked the licences of the company (Natural Gas World, 2013).

In 2010, the French government issued two exploration licences to Schuepbach Energy and one exploration license to Total, valid for five years. In May 2011, the government banned hydraulic fracturing based on further environmental concerns. Total (2013), unlike Schuepbach (2013) declared it would not use hydraulic fracturing but other techniques which will then be available. Environmentalists were concerned as there is no other likely method of extracting UOG in France other than by hydraulic fracturing (Natural Gas World, 2013).

For a while, it appeared that shale exploration could proceed using conventional techniques, and Total stated in September 2011 that the company would explore without the use of hydraulic fracturing (Reuters, 2011). However, a month later the government cancelled the three exploration permits issued in 2010, stating that drilling plans submitted by Shuepbach Energy and Total still included hydraulic fracturing. No exploratory drilling had been accomplished on the permits. Sarkozy (2011) stated that France would not permit hydraulic fracturing until it is proven to be environmentally clean (Frack Off: Extreme Energy Action Network, 2012).

France, in the forefront of the anti-fracking discourse, possesses extensive shale oil and gas reserves. However, shale reserves are under famous and revenue generating winelands, which could negatively impact on the French wine and tourism industry. France, a developed nuclear energy market, is moving towards renewable energy forms, as part of the EU’s aggressive push towards renewable energy (Van Asselt, 2015; Talus, 2016). The French national oil company, Total discovered gas condensate reserves in the Brulpadda prospects, Block 11B/12B in the Outeniqwa Basin, which is 175 kilometres of the south coast of South Africa. Total shares this find with Qatar Petroleum, CNR International and South African Consortium, Main Street (iol.co.za, 2019).

3.11.2 Poland

Poland’s technically recoverable resources (TRR) for UOG are estimated to be 148 TCF according to the U.S.EIA, (2013). Poland’s energy mix is 55 per cent dependant on coal (U.S. EIA, 2013). Intent on reducing its reliance on Russian gas imports, the Polish prime minister indicated that commercial production would render Poland self-sufficient in natural gas by 2035, despite the country’s poor first attempts (Goldthau and Labelle, 2016). ExxonMobil owns six licences and state-owned, PGNiG, holds 15 shale concessions. Six exploratory test wells were drilled in 2012 and finding no yield, Poland abandoned the project.

3.11.3 Ukraine

In Ukraine, the first shale-gas exploration contract was awarded to Royal Dutch Shell in September 2011. The state energy company, Naftogaz (2011) signed a preliminary agreement with ExxonMobil on shale-gas exploration and development. Energy and Coal Minister Boyko (2013) believed that exports of UOG could be possible in the following seven to ten years.

3.11.4 Germany

After Fukushima in 2011, environmental concerns saw a German plan to close down all nuclear plants by 2022. Germany, under pressure to fill that gap, faces severe challenges from active human rights and environmental groups which not only actively oppose UOG and oil but also carbon storage, geothermal energy, nuclear energy and wind turbines. Not stating a clear position on shale exploration to date and neither banning the exploration, Germany's Federal Government said that shale exploration is not on the current German agenda (De Wit, 2015). The TRR for Germany's UOG extraction is estimated to be 17 TCF (US. EIA, 2013) and 25-81 TCF, according to the German Federal Institute for Geosciences and Natural Resources (2012). Germany imports almost 70 per cent of its energy resources and the remainder is produced domestically, mostly from renewable energy sources. It is noteworthy that being a country with little sunshine, Germany boasts of having the leading solar sector in Europe. In Germany, ExxonMobil has been drilling vertical test wells since 2008 and had completed four exploratory shale wells by January 2011. Concomitantly, ExxonMobil has planned to invest $1 billion between 2011- 2016. However, the state of North-Rhine Westphalia implemented a moratorium on further shale-gas drilling in March 2011.

3.11.5 Holland

The landmark ruling against the UK developer, Cuadrilla, renewed concerns of development in Holland (Du Toit, 2016). As in Germany, similar pressure was also evident in Holland. In the southern Dutch city of Boxtel, the courts ruled that temporary planning for an exploratory borehole was invalid and that exploratory wells are by definition not temporary. If gas is discovered and the intention is to extract it. The Dutch, preferring solar and wind projects are EU leaders. (Talus, 2016).

3.11.6 Bulgaria

January 2011, saw thousands of people take to the streets of Sophia and other major cities demanding government bans on hydraulic fracturing for shale. The opposition was primarily organised on social media and forced Bulgarian MPs to vote overwhelmingly for a ban, and Bulgaria became the second European country after France to ban exploratory drilling. Table 3.2. illustrates the Top 20 shale markets in trillion cubic feet (TCF) of technically recoverable resources (TTR) and of which South Africa possesses the fifth highest TCF. None of the jurisdictions examined in the above sections appears in the list below (Georgiev, 2013).

OUG extraction caused many governments to consider the merits of the extraction, as the world investigates new forms of energy to attain energy security. The German government, remaining vehemently opposed, spurred by protests from civil society, possesses relatively small reserves, in comparison to the Top 20 list represented by Table 3.2 below.

Table 3.2: Top 20 Shale Markets by Volume

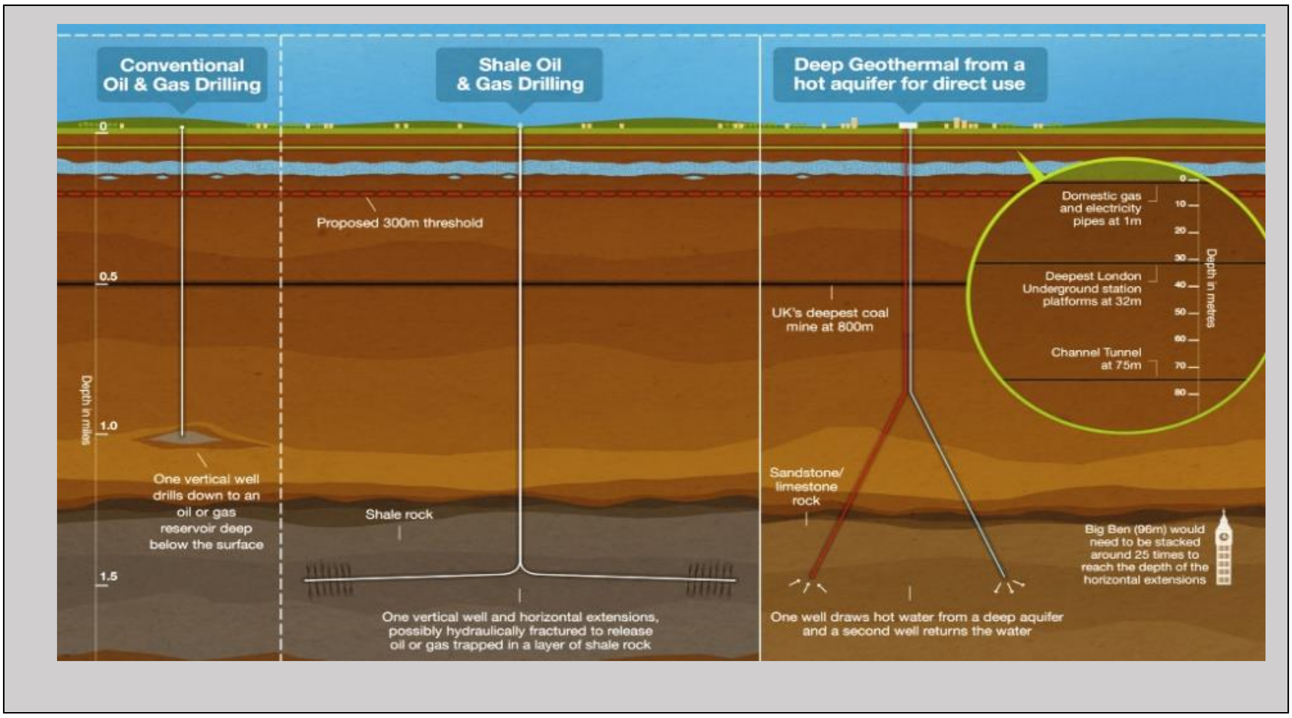
Market	TCG of TRR	Market	TCG of TRR
China	1275	Poland	187
United States	862	France	180
Argentina	774	Norway	83
Mexico	681	Chile	64
South Africa	485	India	63
Australia	396	Paraguay	62
Canada	388	Pakistan	51
Libya	290	Bolivia	48
Algeria	231	Ukraine	42
Brazil	226	Sweden	41

(Source : Economist Intelligence Unit 2011 p. 12)

3.12 MARKETS IN FAVOUR OF UOG EXTRACTION

This research, through an examination of markets which have approved the exploration, attempts to unravel the reasons for such a decision. This research presents a brief explanation of the shale exploration process before providing an analysis of the various markets which seeks similarities, success factors and the sharing of insights. Hydraulic fracturing is currently the only method of extraction for shale, even though in the French case, Total suggested other means. The insight in the following section, compares and contrasts against the U.S. shale experience and commences with the UK and U.S. comparison. Before that, this research highlights various indicators for comparison. From an extraction technology point of view, hydraulic fracturing is the only envisaged methods for the Karoo. Hydraulic fracturing involves drilling down virtually more than two kilometres, then laterally outwards for as much as three kilometres (De Wit, 2011). Figure 3.5. below, refers to the three types of gas drilling processes, providing a graphic description of the depth of the exploration and the distance away from aquifers.

Figure 3.5: Three Types of Gas Drilling Processes



(Source : Economist Intelligence Unit. 2011, p.12)

The gap between the lining of the borehole that has been drilled and the surrounding rock is then sealed with concrete (De Wit, 2011; Fakir, 2015; Glazewski & Esterhuyse, 2016; personal interviews with senior executives of CEF, and IGAS, on 23 July 2017). The well casing is perforated to allow fracking fluid to get into the rock and allow the gas that escapes to be captured. In a typical well, up to 10 million litres of water (equivalent to 65 000 house-holds usage per day), containing sand lubricating fluids and other additives are pumped into the borehole under extremely high pressures and this process opens cracks in the shale for up to almost 50 metres (De Wit, 2011). The cracks are kept open by the sand particles and when the pressure is released, the UOG then escapes. A wellhead is installed to capture the released gas, and once this happens, the drilling and hydraulic fracturing equipment are removed (De Wit, 2011).

The U.S. exploration efforts for shale as an alternative energy source transformed the U.S. economy. The town of Williston, North Dakota, is regularly referenced in such research as being the first town with massive exploration and a subject of trial and error and has been extensively covered by the global media. Devon Energy and Mitchell Energy Company were the two pioneering companies in UOG extraction in the world. Shale background information has been covered in the earlier chapters, but this section seeks to validate further U.S. shale success and the reasons why other markets have endeavoured to emulate the U.S. example (Jackson, 2018; Maugeri, 2013; ASSaF, 2017).

UOG catapulted the U.S. onto a fast track to energy independence and, to a large extent, influenced other global markets, including South Africa, to investigate the merits of the exploration. Land-ownership has contributed to the American success story, together with a few other critical factors which are further discussed in this chapter in greater detail as some insights may be incorporated into the South African case.

3.12.1 United Kingdom

Many jurisdictions intending to frack reference the U.S. case and have improved on the critical areas of uncertainty. Following certain key insights, it is noteworthy that the UK, like the U.S., has a great heritage of oil and gas extraction, followed a structured path in the UOG decision making process. The U.K. government's decisiveness on the problem, the motivation to the European Union before BREXIT, alignment to the British civil society and the decisive manner is praise-worthy. The British Geological Society's Bowland UOG study is the first in the UK to provide investors, operators and regulators with an indication of where to target future exploratory drilling (MacKay & Stone, 2013).

The Department of Energy and Climate Change (DECC) in Britain was created in 2008. In September 2013, two academics, MacKay (then DECC's Chief Scientist) and Stone concluded a report on potential greenhouse gas emissions from UK-produced UOG noting that the overall effect of UK UOG production on national emissions is likely to be relatively small if all precautionary measures and the right safeguards were in place (ASSaF, 2017; MacKay & Stone, 2013). Informed by the Mackay and Stone Report (2013) as well as the White Paper put forth by UK Water (2016), which primarily assessed the extraction from the socio-economic impacts of water, the British Government believes that UOG has the potential to provide the UK with greater energy security, growth and jobs and is encouraging safe and environmentally sound exploration to investigate this opportunity (MacKay & Stone, 2013; Gov UK, 2014).

Emissions from the production and transport of UK UOG would likely be lower than from the imported liquefied natural gas (LNG) that it would be replacing. This is another factor that needs to be accounted for when assessing the emissions of fugitive gases. Shale findings have been summarised in a document titled: Potential Greenhouse Gas Emissions Associated with UOG Extraction and Use (MacKay & Stone, 2013) which reached conclusions that fracking is safe and should be permitted. The examination of this document and the implementation of the recommendations provide insights for the shaping of the South African shale policy as similarities exist between English law and South African domestic law.

If adequately regulated, local GHG emissions from UOG extraction should represent only a small proportion of the total carbon footprint of UOG (Glazewski & Esterhuyse, 2016; MacKay & Stone, 2013; Gov. UK, 2013). Any local GHG emissions from UOG operations would fall within the non-traded sector of the UK's carbon budgets (MacKay & Stone, 2013). If the carbon budgets impose a binding constraint, any increase in emissions associated with domestic UOG operations would have to be offset by emission cuts elsewhere in the economy (MacKay & Stone, 2013). The UK possesses a strong regulatory regime for exploratory activities of over 50 years of experience in regulating the onshore oil and gas industry and can potentially apply on-site safety measures to prevent environmental contamination, mitigate seismic activity and minimise emissions (ASSaF, 2017; Gov. UK, 2013). The English debate on hydraulic fracturing considers similar issues to those in most other exploring markets; water management, minimising of water resources contamination and seismic activity related to the exploration and escape of fugitive gases (MacKay & Stone, 2013).

The UK may possess a significantly larger national pool of scientific instruments than South Africa. The UK equally boasts of greater scientific, intellectual capacity regarding oil and gas exploration. Climate change factors are at the cornerstone in the English shale discourse with local air quality laws specifying exact limits on flaring and how emissions are monitored (MacKay & Stone, 2013). Planning permission and stakeholder communications elaborate on how local issues such as visual impact, traffic movements and the natural environment are taken into account. On the technology side, well integrity and use of chemicals are governed by new legal frameworks (MacKay & Stone, 2013). The UK, after significant R&D, is a market that is ready for UOG extraction, and exploration is underway. Hydraulic fracturing in the UK has been conducted for many decades, and approximately 200 wells have been sunk without any adverse environmental impacts (MacKay & Stone, 2013; The Royal Society Report, 2012). Scientists from the British Geological Survey (BGS) have estimated that the total volume of gas in the Bowland-Hodder shale in northern England is some 1300 trillion cubic feet (MacKay & Stone, 2013).

The British Geological Society's Bowland UOG study is the first in the UK to provide investors, operators and regulators with an indication of where to target future exploratory drilling (MacKay & Stone, 2013). However, it is not possible to estimate how much UOG and oil the UK can produce until there has been some exploration and testing. In 2012, the Royal Academy of Engineering and The Royal Society reviewed the scientific and engineering evidence on shale gas. The review concluded that:

…the health, safety and environmental risks associated with hydraulic fracturing as a means to extract UOG can be managed effectively in the UK as long as operational best practices are implemented and enforced through regulation (Enercom, 2017).

The UK is well connected to the Western European gas market, so the effect of UK UOG production on gas prices is likely to be small and the principal effect of UK UOG production and use will be that it displaces imported LNG, or possibly piped gas from outside Europe (MacKay & Stone, 2013). It is, therefore, concluded that the net effect on total UK GHG emission rates is likely to be small. Long-term global temperature rises are determined not by the rates of emissions but by cumulative global emissions of carbon over time (MacKay & Stone, 2013). The production of UOG could increase global cumulative GHG emissions if fossil fuels displaced by UOG are used elsewhere. This potential issue is not specific to UOG and would apply to the exploitation of any new fossil fuel reserve.

The possible increase in cumulative emissions could be counteracted if equivalent and additional emissions-reduction measures are made somewhere in the world (MacKay & Stone, 2013). Such measures are well established in the scientific and policy literature and include; carbon capture and storage, carbon offsetting through additional reforestation or negative emissions technologies that reduce CO_2 concentrations and other measures that would lead to fossil fuel reserves and that would have been developed under 'business-as-usual' conditions, remaining in the ground. The view of the authors is that without global climate policies, new fossil fuel exploitation is likely to lead to an increase in cumulative GHG emissions and the higher risk of climate change (MacKay & Stone, 2013).

The UK Government's Chief Scientific Adviser, Sir John Beddington FRS, commissioned the Royal Society and the Royal Academy of Engineering to review the scientific and engineering evidence of the document as an independent task and to consider whether the risks associated with hydraulic fracturing as a means to extract UOG could be managed effectively in the UK (Royal Society Report, 2012). This research dwells on the subject of safety in the UK and examines how the British have arrived at critical decision-making on this issue. The research looks to the key findings of the British research regarding safety in the Royal Society Report (2012), which are set out below, and using this study as an example, this researcher has devised a shale ten-point assessment check and has constructed the following model.

Table 3.3: Shale Ten Point Assessment Check

Categorisation	Main Actions
Environmental considerations	Environment Impact Assessments Establishing baseline sampling (South Africa is in this stage) Monitoring aquifer contamination Monitoring groundwater contamination

Categorisation	Main Actions
	Monitoring seismic risk levels Monitoring methane emission levels
Categorisation	Main Actions
Technological advancements	Developing drilling technologies and fracking fluids toxicity
Legal & regulatory	Shale regulations Shale policy-making
Economics	Tracking economic viability of each well

(Source: Researcher's Construction, 2019)

Political and social factors are considered secondary in this assessment. Political factors differ vastly among the various jurisdictions and have minimal bearing on the Karoo case. The same applies to social factors.

- An Environmental Risk Assessment (ERA) should be mandatory. Every UOG operation should assess risks across the entire lifecycle of activities, from water use through to the disposal of wastes and the abandonment of wells (Glazewski and Esterhuyse, 2016.
- The health, safety and environmental risks can be managed effectively in the UK. Operational best practices must be implemented and enforced through strong regulation (Glazewski & Esterhuyse, 2016).
- Robust monitoring is vital. Monitoring should be carried out before, during and after UOG operations to detect methane and other contaminants in groundwater and potential leakages of methane and other gases into the atmosphere (Glazewski & Esterhuyse, 2016).
- Fracture propagation is an unlikely cause of contamination. The risk of fractures propagating to reach aquifers is shallow, provided that UOG extraction takes place at depths of many hundreds of metres or several kilometres (Glazewski & Esterhuyse, 2016). Even if fractures reached overlying aquifers, the necessary pressure conditions for contaminants to flow are very unlikely to be met given the UK's UOG hydrogeological environments.
- Water requirements can be managed sustainably. Water use is already regulated by the Environment Agency. Integrated operational practices, such as recycling and reusing of waste-waters where possible and would help to

minimise water requirements further. Options for disposing of wastes should be planned from the outset. Should any onshore disposal wells be necessary for the UK, the construction, regulation and siting would need further consideration (Glazewski & Esterhuyse, 2016).

- Seismic risks are low. Seismicity should be included in the ERA. Seismicity induced by hydraulic fracturing is likely to be of smaller magnitude than the UK's most significant natural seismic events induced by coal mining (Glazewski & Esterhuyse, 2016).
- Well, integrity is the highest priority. Methane leakage is the likely cause of hazards caused by faulty wells and weak cement casings. The UK's unique well examination scheme was set up so that independent, specialist experts could review the design of every offshore well. This scheme has been specially adapted and fit for purpose for onshore activities (Glazewski & Esterhuyse, 2016).
- Regulation must be fit for purpose. Attention must be paid to how risks scale up should a future UOG industry develop nationwide. Regulatory coordination and capacity must be maintained (Glazewski & Esterhuyse, 2016).
- Policymaking would benefit from further research. The carbon footprint of UOG extraction needs new research. An additional benefit would also be derived from research into the public acceptability of UOG extraction and use in the context of the UK's energy, climate and economic policies (Glazewski & Esterhuyse, 2016).

3.12.2 *Comparisons between the U.S. and the UK*

According to a study conducted by Wait and Rossouw (2013), four significant differences were pointed out in the fracking experience in the two jurisdictions. Harleman and Weber (2017) also summarise useful similarities between the two markets and provides good insights for new UOG extractive markets.

- U.S. gas reserves are much higher than the UK and, therefore, the U.S. has been able to attract more competent skilled personnel than the UK.

- The Marcellus shale is situated in rural areas with sparse populations and is less prone to the risk of small earthquakes (Fakir, 2015). Seismic activity in the UK caused delays in the drilling process. Being further away from larger cities, Marcellus shale locations saw less of a commuting of personnel from the larger cities than in Lancashire, forcing the Marcellus regions to develop a robust local supply chain. The upcoming section on the shale business case will clearly illustrate fewer jobs in Lancashire than in the rest of the UK.
- The drilling process in Marcellus areas uses vertical then horizontal drilling, whereas the UK used vertical drilling and then directional drilling, a technique which requires longer timeframes and is costlier. Landowners in the U.S. earn royalties on properties and the additional income is a boost to the rural dwellers, reducing poverty and household spending on consumables is increased. Higher employment rates mean that the State collects more taxes.
- A study conducted in 2016, by the Penn State Extension on the tax implications of the Marcellus region highlighted tax issues., in terms of corporate taxes, income tax and taxes on consumables. There is also a tax on the royalties received from leasing the properties for shale exploration (Wait and Rossouw, 2013).

Apart from the benefit of U.S. citizens being able to exploit the fullest potential of the properties under this regime, the State, in order to lower administration costs, is able to share the proceeds from exploited properties and this results in higher net fiscal benefit to the U.S. Federal Government (Wait and Rossouw, 2013; Penn State Extension; 2016).

The property regime of the U.S works well in favour of the argument that America shale successes are hard to achieve in other jurisdictions. However, in South Africa, in the light of the review of Section 25 of The Constitution regarding land expropriation, it is an appropriate time to examine the shale success attributed to U.S. property laws.

3.12.3 Canada

Canada possesses large estimated technically recoverable reserves and together with the U.S, constitutes the largest basins of the extractable resources in North America.

However, the exploration in Canada is not as advanced as in the U.S., as the approach is based on a more cautionary approach, noting the numerous potential adverse outcomes and very few positive outcomes (IEA, 2014). Regulation for fracking in Canada takes place at a provincial level in the main areas of British Columbia and Alberta. Canada is an advanced economy and has adopted a wait and learn approach and in the meanwhile invests in R&D to understand the environmental impacts before allowing the exploration to commence (IEA, 2014).

3.12.4 Australia

Geoscience Australia (2016) believes that Australia's estimated 400 trillion cubic feet of UOG which equates to all the coal seam gas and conventional onshore and offshore gas fields combined (Du Toit, 2015; ASSaF, 2017; Government of Australia, 2010). This saw the Australian government exploring coal seam gas first and when the competency had developed it then started to investigate shale opportunities. In 1900, Roma residents drilling for water struck deep gas underground. Australia's first natural gas lit Roma's streetlamps, but flickered out after just ten days. Coal-seam gas (CSG) is transforming Australia's energy market, and stimulating its robust economy (Du Toit, 2015; Economist, 2012), environmental protest movement over hydraulic fracturing but is also inflaming (Economist, 2012).

Australia's gas rush started with liquefied natural gas (LNG) from reserves under the Indian Ocean, off the north coast of Western Australia (Du Toit, 2015). Such unconventional gas was once unprofitable because it was harder to extract than from other sources. Technological advances, specifically in hydraulic fracturing, have altered that issue positively (Du Toit, 2015; Stevens, 2012). Between 2006 and 2010, production of CSG increased 22 times (Economist, 2012). GSG from coal seams now supplies about one-third of eastern Australia's gas. Knox, chairman of the Australian Petroleum Production and Exploration Association, an industry body, states that the CSG bonanza, on top of Indian Ocean gas, means Australia is likely to overtake Qatar as the world's leading LNG exporter by 2020 (Economist, 2012). Australia is now ranked fourth. On economic viability, Australia's inland coal-seam gas boom is changing its geographical face. Three consortia involving BG Group (a British company), Santos and Origin Energy, both Australian, are each building on Curtis

Island. This venture will be the world's first plants to turn gas drilled from coal seams into LNG for export. A fourth plant is planned (ASSaF, 2017; Du Toit, 2015).

Santos, pipes CSG from the Surat and Bowen basins, around Roma, to the coastal city of Gladstone about 400km away and where the resources will be liquefied for export. Asia's surging gas requirements provide the demand for Australian gas. (Du Toit, 2015; Hoontrakul, 2017). About 3,200 CSG wells have been drilled in Queensland. A report by the Senate, the federal upper house, suggests twelve times that number can be drilled thus signifying tremendous fiscal revenue (Economist, 2012). About 40 per cent of the economic benefits of the A$180 billion ($175 billion) of private investment committed to LNG projects in Australia over the next five years is linked to CSG (Economist, 2012).

Previous mining booms took place in outback regions far away from most Australian towns, sharing geology similar to the Karoo in South Africa. Shale is to be found under farmlands and beneath towns and cities in eastern Australia which is home to most of the country's denser population as per the phenomenon in the UK as well as China. Companies with exploration licences are obliged to negotiate compensation deals with landowners, but not to seek permission to drill. The value of such deals is arbitrary: perhaps A$5,000 per well from some big companies, leading to farmers complaining that the mere presence of CSG explorers on-site cuts the market value (Du Toit, 2015).

Amid calls for tighter regulation, the New South Wales state government imposed a moratorium on hydraulic fracturing until April 2013, resulting in the federal government introducing legislation for a scientific committee to report on the effects of CSG mining on water. Geoscience Australia, a government agency, estimates Australia's untapped UOG (which needs hydraulic fracturing than coal seams) could double the country's gas resources (Du Toit, 2015; Economist, 2012). Protest action in Australia is aggressive. Lock the Gate; a Queensland protest movement has spread to neighbouring New South Wales, Australia's most populous state, where CSG production is less advanced and many farmers have heeded the call to close farm gates against CSG companies (Du Toit, 2015).

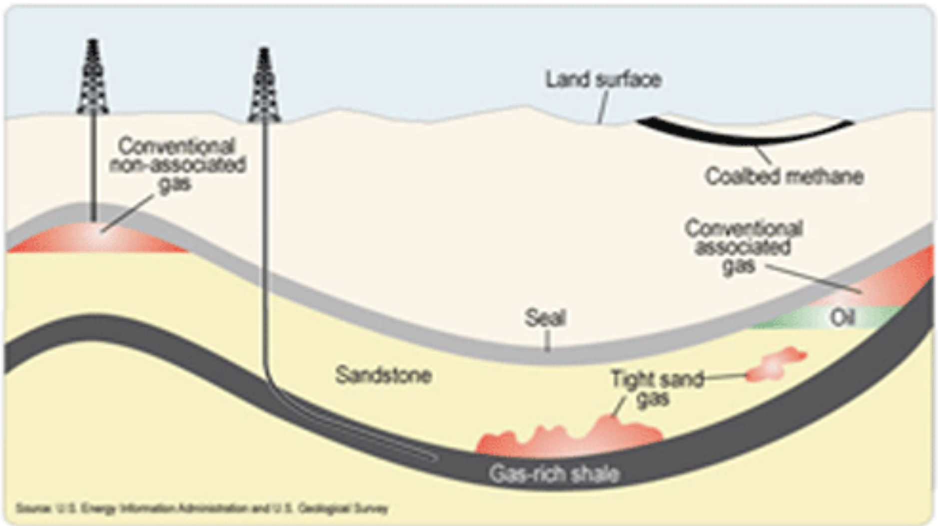
As the driest continent after Antarctica, Australians too, are preoccupied with fears of water scarcity and pollution and this has led to protest action against CSG (Du Toit, 2015). Many rural communities depend on the Great Artesian Basin for water. This is Australia's biggest groundwater reserve and lies deep under the region where hydraulic fracturing would take place. The environmentalists argue that hydraulic fracturing can contaminate adjacent groundwater that farmers and townsfolk need, a similar argument to that in the Karoo. High-quality water can be lost from aquifers as it seeps into hydraulic fracturing coal seams, and Australian scientists have yet to disprove these theories (Du Toit, 2015).

In a report published by the Queensland Water Commission (2012), it was found that water levels in 528 aquifer bores would decline because of CSG water extraction. However, gas drillers are obliged to purify the water extracted (Du Toit, 2015). On one of CSG fields north of Roma, Santos, irrigates crops with extracted coal-seam water treated by reverse osmosis, citing the 'purest drinking water on earth' (Du Toit, 2015; Economist, 2012). Sceptical farmers are not beneficiaries and landholders in Australia own only the topsoil; the state owns everything beneath, as in South Africa (Economist, 2012).

Australia also has a marine environmental problem. Gladstone harbour which lies within the World Heritage Area of the Great Barrier Reef (GBR), an area the size of Italy (Du Toit, 2015), is listed as a heritage site for its coral reefs, sea-grass habitats and rare marine species. GBR officials, worried about the impact of the harbour's rapid industrial development, called on UNESCO experts to investigate. The port at Gladstone already hosts an aluminium smelter and a coal-export terminal. The harbour also houses the seafood businesses.

Landos (2012) a veterinary scientist, was commissioned to investigate outbreaks of sickness that appeared among the harbour's abundant marine life. The Landos Report (2012) detailed how organisms examined from the harbour suffered skin ulcers, diseased fins and damaged intestines. Landos (2012) blamed toxic metals and sediment from earlier industrial pollution that had settled on the harbour bed and was being stirred up by dredging (Economist, 2012). Figure 3.6 illustrates the location of coal seam gas.

Figure 3.6: Graphic Illustrating Coal Seam Gas



(Source: Parliament of Australia Website, 2018)

Zussino (2012), the head of the Gladstone Ports Corporation, a state body, rejects this analysis (Economist, 2012). The evidence that links the outbreaks to vast freshwater flows from floods and cyclones that lashed Queensland in early 2011 was refuted. Whittingham (2012) a local wholesale seafood business owner, states that the once-thriving seafood business of the harbour has seen the halting of purchases of fish, prawns and crustaceans amounting to estimated losses to local fishermen at A$36m ($35m) a year (Economist, 2012; Du Toit, 2015).

Even though this was not the result of the gas extraction, public environmental action impacted upon gas operations. Buru Energy, started UOG extraction in Western Australia, in the Kimberley region. The exploration started with two shale-gas wells. In a statement to the Australian Stock Exchange, Buru's executive chairman, Streitberg (2015) stated that the hydraulic fracturing program was tracking positively in the preliminary results suggesting the stimulation phase has been successful (Collins, 2015).

Baru, was the first company to use hydraulic fracturing in 2010 at the Yulleroo gas field, situated 60 kilometres east of Broome but this did not attract public attention at the time. However, when Buru Energy rose to prominence with a dramatic rise and fall on the Australian stock market, as well as significant investor and political agreements, the company attracted public interest. The company also attracted protests about plans to conduct further hydraulic fracturing in the Kimberley region. The latest round of shale activity took place in Buru's Asgard and Valhalla wells, near the remote Noonkanbah Aboriginal community, which started to raise awareness of the exploration. Civil society participation saw The Yungngora Aboriginal Corporation signed an agreement for the hydraulic fracturing programme to proceed to employ up to 30 Yungngora people directly involved in the operation, the Australian Stock Exchange statement confirmed (Collins, 2015).

West Australia Greens MP, Chapple, claimed that the company only released the information publicly after environmentalists flew over the site and photographed the equipment (Collins, 2015). According to Chapple (2015), Buru Energy avoided public concerns about hydraulic fracturing in Kimberley and the company's stock exchange statement indicated no adverse environmental impacts from the fracking programme (Collins, 2015). According to the official website, the company hoped to pipe gas to Port Hedland, aiming for it to be sold to the domestic market under an offtake agreement with the Western Australian Government. Treadgold (2014) commented that Buru Energy struggled with the downturn in the global energy market, the high costs of working in the remote Kimberley region and a share price that declined by 90 per cent over three years.

On economic viability, Treadgold (2014) formally concluded that the returns envisaged would not be attained (Collins, 2015). Lower cost gas projects were already reportedly struggling around Australia, Treadgold (2014) noted that Buru Energy's chances of commercialising Kimberley gas were not promising and that producing conventional oil had better potential (Collins, 2015). Strachan (2014), an industry analyst, also confirms that commercialising gas in the Kimberley faces significant obstacles, stating that the company has started focusing on the search for more profitable oil, while trying to entice a partner to fund the more substantial challenge of turning a profit from the hydraulic fracturing for gas in the Kimberley (Collins, 2015).

The key insights from the Australian case is that government and the private sector first focused on the CSG and when the technology allowed for better exploration, OUG extraction started. Water contamination, though not a quantified result of gas extraction, caused media and civil action that caused delays in OUG extraction. However, this cautioned government and the developers to seek more environmentally friendly solutions, such the use of only water and sand as proppants, which decreases and manages many of the socio-economic impacts of UOG extraction on water resources.

3.12.5 China

China is the world's second-largest economy behind the U.S. and is also the globe's largest coal consumer and as the Chinese market begins to industrialise its demand for energy grew significantly. According to the latest IEA Five Year Gas Projection, 2018 – 2023 (2018), China outstrips all other markets in its need for gas (Xiaoliang, 2016, 2018). China is also the leading country in terms of technically recoverable shale reserve, currently estimated at 1115 TCF (Du Toit, 2016; EIA, 2018; ASSaF, 2017). According to Yang, a research analyst at the World Resources Institute (WRI), a global think-tank, the country's leaders began looking closely at UOG after seeing its success in the U.S (Yang, 2016).

The UOG industry in China is relatively new and is concentrated in Sichuan province. Experts cite the Chinese UOG extraction as being accompanied by environmental risk (C&EN, 2014; Feng, 2015). Since 2000, when the country's gas demand rose 15 per cent per year as a result of the economic boom, the government mandate has been to develop the several basins across the country. China is starting to extract its shale reserves, making gas exploration a priority in its ten-year plan (2011-2021). UOG should supply 6 per cent of China's energy requirements by 2020 (Du Toit, 2016; Xiaoliang, 2016).

Possessing limited knowledge about the technique, China has been importing skills and technology from America by encouraging domestic producers to partner strategically with U.S. counterparts. Sinopec started drilling the first of nine scheduled gas wells in Chongqing (Xiaoliang, 2016). Foreign companies continue to partner with Chinese UOG firms, bringing the expertise and experience to the nascent industry. One of the latest is the US-based well-completion pioneer, FTS International. In 2015, FTS International established a joint venture with Sinopec, called SinoFTS, to provide UOG development services in the Sichuan Basin (FTS, 2014).

UOG will primarily feed the chemical and the energy sectors. In the U.S., increased amounts of methane, a primary chemical derived from UOG has lowered the cost of

U.S. chemical and plastic companies having up to $100 billion in new investments in the petrochemical industry (Feng, 2015). China's plastics industry, on the other hand, relies primarily on oil-based naphtha as its primary feedstock. According to consulting firm McKinsey & Co., most shale wells discovered in China have been dry which means the natural gas is mostly methane and contains only low amounts of profitable, liquefiable gases such as ethane, propane, and butane (Feng, 2015).

The entry of specialised hydraulic fracturing equipment manufacturers marks a new stage of shale exploitation in China, a direction that even some environmentally conscious people say is necessary for the country (Fracking Affirmative, 2016). China's unique shale geology and water constraints has not deterred it from proceeding with hydraulic fracturing (Du Toit, 2016). In China’s southwestern Sichuan province, the discovery of that country’s first commercially viable UOG field in 2013, buoyed government hopes that China would be the next big market to discover the trapped hydrocarbons.

The lack of environmental regulation and impact studies is a problem, as reported by analysts and government officials (Xiaoliang, 2016). Natural gas imports are growing and Chinese leaders view these trends with discomfort (EIA, 2018). Against this background, China’s vast UOG resources present hope for greater energy independence. According to Chinese and U.S. estimates, China has the world’s largest UOG reserves with an estimated 31 trillion cubic metres (EIA, 2018; Xiaoliang, 2016).

China currently meets most of its energy needs through coal, with natural gas accounting for only about 5 per cent of annual energy consumption. China hopes to increase natural gas’s contribution to at least 10 per cent by 2020 (EIA, 2018; Xiaoliang, 2016). In China, environmental concerns have been heightened due to the country's unfortunate history of environmental stewardship, lack of civil rights, and an opaque energy sector dominated by two powerful, state-owned conglomerates (C&EN, 2014; Feng, 2015). For these reasons, the Chinese public have welcomed the 2017 slashing of shale output targets with relief.

The head of China’s National Energy Administration (NEA) announced that the target output by 2020 had been reduced to 30 billion cubic metres (Lelyveld, 2018). This is a different picture to the one presented by the IEA (2018) when announcing the five-year gas projections for 2018 - 2023, where China is the most aggressive user of gas with the gas demand coming mainly from the power industry (IEA, 2018). Yang (2014) and other analysts speculate that the cuts have less to do with environmental concerns than with unexpected technical challenges (Feng, 2015). Geological conditions make shale more difficult and expensive to exploit in China than in the U.S. These lowered targets do provide breathing space for environmental regulation and enforcement to catch up, according to Yuan Xu, an assistant professor at Chinese University of Hong Kong and a commentator on China's shale policies (Feng, 2015).

According to Xu, the regulatory system is relatively weak and not fully enforced in China as officials in China's county-level governments, who ostensibly oversee environmental practices in the jurisdictions, lack equipment and financial resources. (Feng, 2015). Chinese Ministry of Environmental Protection (MEP) put forth a government paper at a conference in Calgary, Alberta, in 2015 which found state regulations for UOG lacking (Feng, 2015). UOG development in China mainly reference the regulations and technical guidelines developed for conventional resources (Tong, 2015; Zhou, 2015; Li, 2015; Feng, 2015). According to Feng (2015) Chinese policies, "do not fully consider the specific environmental issues brought by this new mineral resource" (Feng, 2015 p.34). The authorities have "yet to consider environmental protection, ecological and human health impacts" when selecting sites for shale development. No research has been conducted on pollution levels from China's shale developments (Feng, 2015 p. 34).

Some products of hydraulic fracturing, including methane, are not regulated in China. The safe disposal of wastewater from fracking, is currently not regulated in China (C&EN, 2015). Water pumped during drilling is circulated back to the surface as salty water. Yang (2015) notes that according to Chinese regulation, this waste is not a pollutant, but rather a loophole for corporations (Feng, 2015). Hydraulic fracturing wastewater can also contain radioactive substances, heavy metals, and hydrocarbons (Feng, 2015). Yang notes that MEP has been conducting fieldwork in Sichuan province, to try to understand, and eventually manage UOG extraction in that area (Feng, 2015).

The study of the UK, Australia and China is critical to this research's examination of the level of safety of UOG fracking on a global platform. This review illustrates that the international experience with regards to hydraulic fracturing is mixed (Du Toit, 2016). The economic feasibility of these markets and the ability of the various geologies to support profitable extractions, despite the strong government intent, remains to be seen (Du Toit, 2016). This research has highlighted the main issues in consideration of UOG extraction using the technique of hydraulic fracturing. Bearing in mind, that issues play out very differently in the various geologies solidifies the argument that South Africa can consider the experiences of other markets, but it cannot make assumptions and make a decision solely on the lessons of the different markets. In cases of adverse environmental impacts, European governments have been quick to respond and the UK, The Netherlands and Denmark are strongly referenced. It is not sure what the stance of the Chinese government would be, in the case of environmental damage, reviewing the concerns of the environment outlined by Chinese environmentalists.

3.13 PART FOUR: CRITICAL UNCERTAINTIES AND DRIVERS FOR CHANGE

Sustainable development is the cornerstone of European Union economic policy. Therefore, international environmental law, climate change law and energy law perspectives, drawn mainly from experiences of the European Union, frames this discussion. This research, through examination of markets which have either banned or approved the exploration, has developed a database of environmental pitfalls and insights as well as the various legislative and policy barriers which facilitated and hindered the UOG extraction of the various jurisdictions. The critical safety drivers have been illustrated throughout this chapter.

The World Bank maintains that an over 2 degrees Celsius warming scenario, could have severe set-backs for South Africa. Climate risk in this research is considered a serious 'wildcard' which could manifest itself, in the years towards 2055, based on the choices that are made. This wildcard is the driver for change which governs the manifestation of all other adverse environmental factors. The authors, Glazewski & Esterhuyse, (2016), criticise the state for the choices that are being made and the manner in which these are being made. Green (2016), more specifically attacks the policy-makers for taking a reductionist view on fracking, stating that it is almost a foregone conclusion that the exploration will take place and that:

It would be wrong for us not to use the resources that God left with us. This is a blessing that God gives us and we need to exploit for the benefit of the people, (Shabangu, 2012),

and that

… the State would pursue that UOG option within our good environmental laws (SONA, 2014).

Murthi (2019) states that capacity inertia exists amongst policy-makers who are not well trained in the field of sustainability. In 2012, a serious debate on the water issue, was reduced to a focus on the thickness of the cement casing. This example, quoted by Green (2016) indicates a worrisome situation where policy-makers are not adequately informed of the magnitude of the pitfalls of the extraction, if administered irresponsibly (Green, 2016). Green (2016) provides a time-frame of the harmful effects of shale exploration on the environment and concludes that safety cannot be taken for granted, based on the current information.

There is no conclusive data which could accurately pinpoint the manner and behaviour of earth shifting that could take place in the earth's lower layers given the potential impact of the exploration. Furthermore, the recent, growing trend of storing toxic wastewater in the disused wells poses further unknown problems. The various authors on shale, the scientists and the industry represented by SAOGA, in the absence of a shale industry body, conclude that South Africa needs to develop a national pool of scientific instruments, conduct a pilot exploration and establish a baseline study which underpins all national shale discussions. On emissions, South Africa relies on the information and directives of the IPPC (2013).

The South African government, like the U.S. and other global governments, must provide the necessary financial resources for UOG R&D, and be less reliant on the findings of the developers. These findings have been used as negotiating tools and have been used as reference points for several critical milestones along the way since the start of the great shale debate since 2011 (ASSaF, 2017; CEF, 2018 CSIR, 2016; De Wit, 2015; Fakir, 2015; Glazewski & Esterhuyse, 2016, IGAS, 2018 SAOGA, 2018; Scholes and Lucas, 2016). Shale gas is a cleaner burning alternative to coal, a pathway to a lower carbon future and, therefore, to lower emissions. Methane, is even cleaner and burns 57 per cent cleaner than coal and has none of the sulphur content of coal (Wakeford, 2016). The IPCC found that natural gas used in CCGTs had median emissions of 469 grams of carbon dioxide per kilowatt-hour equivalent (gCO2/kWhe), while the emission factor for coal was 1001 gCO2/kWhe52. Table 3.4 refers to the IPCC emissions methodology.

Table 3.4: IPCC Emissions Methodology

Technology	Description	50^{th}percentile (gCO2/kWhe)
Hydroelectricity	reservoir	4
Wind	onshore	12
Nuclear	2^{nd} generation reactor types	16
Biomass	various	18
Solar Thermal	Parabolic Trough	22
Geothermal	Hot, dry rock	45
Solar PV	Polycrystalline silicon	46
Natural Gas	Combines cycle turbine without scrubbing	469
Coal	Various generator types without scrubbing	1001

(Source: Adapted from Moonaw *et al.,* 2011).

In this chapter, this research introduced one of the main discourses in the UOG extraction: the effect that the hydraulic fracturing technique and the resulting hazardous impacts that could be felt on the environment. This discourse attempted to answer the first research question: Is fracking safe in the Karoo, South Africa? This research assumes that water is a raw material and, as such, remains the liability of the developers. Civil society has recourse to the international legal water provisions under the United Nations frameworks. On earthquakes, further clarity will only emerge when pilot drilling for research purposes has been conducted independently by the South African government and monitored by South African scientists. However, recent earthquakes experienced in fracking areas are of low seismicity, and in the Karoo, South Africa, where fracking sweet spots have a low density of human life, this issue should be left to the discretion of the stakeholders.

On methane leakage, this research concludes that this issue is a critical and dangerous uncertainty. The issue is problematic on a case-by-case basis. However, from a global perspective and given the rate at which fracking is expected to be ramped up towards 2055, the current lack of accurate data presents an uncertain outlook for UOG extraction globally. Information disclosure is essential and civil society reserves the right to all disclosure. It is crucial to retain a balanced argument involving science, economy and the concerns of civil society. The Dutch Geological Organisation, 'Toegepast Natuurwetenschappelijk Onderzoek', (TNO) encouraged an 'Argument Map' which detailed pro and contra arguments involving energy, environment, safety, economy and politics (TNO, 2014).

The key point emerging from this discourse is that evidence-based scientific findings led by academia, must inform policy makers, the private sector and civil society. All stakeholders must be part of the decision-making process (ASSaF, 2017; CEF, 2018; De Wit, 2015; Fakir, 2015; Glazewski and Esterhuyse, 2016, IGAS, 2018; Scholes and Lucas, 2016; SAOGA, 2018). This chapter focused on Pillar One and Pillar Two of the Six-Pillar Approach of the CLA methodology, which is promoted by Inayatullah (2015). The various emerging trends and emerging challenges concerning shale exploration in the Karoo, South Africa have been noted. This environmental scan provided an overview of the global economy and then focused on the worldwide shale discourse in South Africa. This vast shale topic de-constructed the ecological issues of the various jurisdictions to provide answers to the safety question of this research. The answer to the research question on safety is a highly complex one, which relies on many factors.

While the research in the next paragraphs, proposes the consolidated measures towards a safe and successful exploration, it does also remind the reader of the main factors considered in this chapter. Firstly, the megatrend of climate risk dominates this safety discourse. Irrespective of the UOG extraction, climate risk is the order of the future. It is simply the intensity which is potentially manageable. The central theme that plagues the world is climate change management and energy management, as energy management provides other choices. It is then left to the political will and commitment of government on the choices that are made. Minister Naledi Pandor, MP, in her foreword to Climate Change: Briefings from Southern Africa, as noted by Scholes *et al,* states:

The effects (of climate change) will be felt not only by individuals, but also by industry and this will have a particularly severe impact on the global south. It is a stark reminder of the need to a more balanced and equitable global society that is free from hunger and poverty (Scholes *et al,* 2016 p. 12).

Given the xenophobia crisis in South Africa, Ramaphosa elected not to attend the Climate Change Summit held in New York, in September 2019. Minister Pandor (2020), minister of International Relations, replaced the president. Globally, 2016 recorded the warmest year, and South Africa experienced the worst drought in 30 years, with more than 2,7 million households facing water shortages across the country (Essa, 2015; Esterhuyse and Glazewski, 2016). Technological breakthroughs may see triumphs for renewable energy. The South African government is mindful and supportive of the ravages of climate change which already manifest as a severe social 'wildcard', which is civil conflict (Escudero, 2017). Chapter 4 of the National Development Plan (NDP), entitled: "Economic Infrastructure-the foundation of social and economic development" states:

Climate change has the potential to reduce food product and the availability of potable water, with consequences for migration patterns and levels of conflict. South Africa is not only a contributor of GHG emissions, but also particularly vulnerable to the effects of climate change on health, livelihoods, food and water, with a disproportionate impact on the poor, especially women and children (NDP, 2030).

The Inayatullah (2015) questions which has guided the environmental scan and questions the future, are broken down and answered in the three main discourses. The questions frame the logical gathering of data in this first chapter of the environmental scan. At the end of each of the three chapters, the solutions to these questions are summarised. Table 3.5 below, offers some solutions to these future-based questions from safety discourse.

Table 3.5: Inayatullah's Questions (2015) in the Context of the Safety Question

Inayatullah's Questions	Data on the Safety Question
What stays the same?	The current trajectory sees Government following the business as usual path, and tracks 4º warming and experiences climate risks such as flooding and drought conditions, which effects food production and prices.
What are the key trends?	Adaptation and mitigation of climate risks become widespread. Technological breakthroughs witnessed advances in the RE sector. Battery storage through capacitors are launched although hardware remains costly, which hampers the current road to RE.
What are the main processes of change?	Cooperative governments globally and in Africa rise and seek ways to combat new environmental challenges. The CFTA (2020) is the first noteworthy step forward for Africa. For South Africa, the investigation into FFSR will level the playing fields between the coal companies and the RE companies, providing attractive energy prices. In terms of UOG extraction, the investigating of new exploration contracts would cope better with the ownership of the country's natural resources. The new framework on water will yield better management of water affairs. Solid climate action, backed by regulatory frameworks is linked to policy implementation. Large- scale capacity-building programmes commence in favour of sustainability and address inertia. Poverty alleviation through green projects, sees green financial mechanisms favouring CDM. CDM agenda projects are eventually linked to the ETS. Negotiated settlements through principles of development diplomacy, galvanise the bottom-up approach, which supports a de-centralised energy model.
What are the new issues in the pipeline?	Water-energy-food nexus approaches are implemented. Better electrical access. Water and sanitation are available for all. Efficient waste treatment produces energy. Better food supply systems through biotech processes.
What are the sources and hopes?	Sustainable development sustains populations with greener, cheaper energy, providing for widespread economic growth with limited degradation of the environment.

(Researcher's Construction, 2019)

3.14 CONCLUSION

The South African government is mindful of the ravages of climate change and the country's vulnerability. Chapter 4 of the National Development Plan (NDP), entitled: "Economic Infrastructure-the foundation of social and economic development" states:

Climate change has the potential to reduce food product and the availability of potable water, with consequences for migration patterns and levels of conflict. South Africa is not only a contributor of GHG emissions, but also particularly vulnerable to the effects of climate change on health, livelihoods, food and water, with a disproportionate impact on the poor, especially women and children (NDP, 2030).

Whilst climate emergency conjures up alarm, there are positive upsides for society and the environment. Firstly, is it encouraging to note the at average, the past twelve months have witnessed a climate increase of 1.2 degrees Celsius over post-industrial times. Secondly, IRENA estimates that there are 10.3 million jobs in renewables (enterpriseswebinars@ilo.org, 2019). This figure could increase to nearly 29 million in 2050, which will reshape all aspects of how energy is produced and distributed. Women are becoming more emancipated and the changing values across generations sees youth having significant career opportunities in this rapidly growing field.

CDM adaptation initiatives supported by capacity building programmes, similar to the BRICS Academic Forum initiative, should help to develop skills and knowledge that enables the energy transition. Sustainability becomes a discourse that is firmly and numerically rooted, with the emission trading schemes manifesting in many markets and which sees the trading of carbon credits between developed and developing markets proving the efficacy of the Paris Agreement's (2015) bottom-up mechanisms.

Africa, rising to the opportunity of being the last continent to industrialise, learns from the more established EU block which has evolved over the past thirty-six years with the harmonisation of policies amongst its member states. The African Continental Free Trade Agreements (AfCFTA), which seeks to harmonise African states and facilitate growth and development recognises that sustainable development still needs to be instituted as a cornerstone policy of economic development as seen in the EU (Barrow, 2019; Sabatucci, 2019).

The nexus approach is the new modern implementation of systems thinking and implementation. Initially, indoctrinated by the Convention (1992), the approach demonstrates efficiency and cost-benefits for the climate agenda as well as for developing governments around the world. The sources for new hope are illustrated by strategies which are underpinned by sustainable development goals and which start to manifest and sustain populations with greener, cheaper energy, thus providing for widespread economic growth with limited degradation of the environment.

This research has merely referenced the views of the various writers that shale is a cleaner burning fuel. Gas, in general is a cleaner burning fuel than coal, and further analysis yields that it is methane that burns cleaner that shale gas. The worrisome fact is that methane, during the various processes of shale, namely during drilling, extraction, processing and transport, is emitted and is 25 times deadlier that carbon, if it is combusted. In light of the safety issues, the reader is left with the question; Is shale gas really the stepping stone towards renewable energy?

Even though air-quality is critical to the UOG extraction debate, as is water, this research has noted the effects of methane leakage. Research on methane leakage is a broader environmental issue and, in the context of UOG extraction, is globally still in the formative stages. Given the vast amount of water used in the extraction and, the ethical defensibility in the social context, the research in this chapter has focused priority on the water – energy - food nexus discourse. It is noted and accepted that the debate becomes skewed, in this first chapter of the environmental scan. The authors of the Esterhuyse and Glazeswki (2016) publication, ask whether in the light of so many environmental externalities, UOG extraction is worth all the fuss?

Nonetheless, the research moves forward and in terms of making choices the South African government is advised to consider and adopt the decision-making patterns from the UK, Germany, France, Poland, Canada and Australia. Canada in terms of adopting a 'wait and see approach', learning from its neighbour as a prime candidate. Australia is also a good model to watch and imitate. Figure 3.6 illustrates that coal-bed methane on the upper levels was easier to navigate and once teething problems were overcome; deeper shale beds could be accessed. Furthermore, the Australian government only permits sand and water as proppants in the extraction, thereby minimising waste-water contamination issues at surface levels.

This research summarises this section by putting forth the following preliminary recommendations that would support solutions towards a safer UOG exploration in the country.

- South Africa must firstly conduct extensive baseline studies to facilitate the unambiguous evaluation of environmental impingement during UOG extraction by the industry (ASSaF, 2017).

- South Africa must also seek to expand its knowledge base, drawing on other scientific institutions to facilitate knowledge, particularly with China, a BRICS country which is also in the infancy stage of the exploration (ASSaF, 2017);
- South Africa needs to balance the long-term shale exploration strategy with all four elements of sustainability, namely; security of supply, the efficiency of extraction, environmental protection and societal communication (ASSaF, 2017);
- South Africa should build on the knowledge from experiences in the USA, Europe, Asia and Australia, and by thoroughly analysing the literature from the most renowned scientific institutions from the U.S., U.K, Germany, and Australia. South Africa should equally note that the negative press essentially halted exploration in Europe (ASSaF, 2017).
- Base-line assessments should include the participation of civil society, the environmentalists, the international NGOs, the concerns of the white farmers of the Karoo and all other interested parties (Glazewski & Esterhuyse, 2016, Green, 2016).
- Inertia in environment affairs, as pointed out by Murthi (2019), must be addressed at all levels and wherever necessary, fit-for-purpose capacity-building programmes should be investigated and implemented.
- South Africa must commit to a 'learning-by-doing' approach, as UOG potential is never realised overnight but by trial and error. South Africa should further note that apart from geological differences, there are many political, economic, social and other factors at play in the energy sector.
- It should also be noted that unrealistic public expectations hit Poland and China in a very challenging manner (ASSaF, 2017). Careful attention needs to be paid to the expectations of the youth in the Karoo, South Africa. These can be managed if contingency plans are devised should shale exploration be deemed not to be the best choice for South Africa's energy futures (personal interview with De Vos, 2018).

If the South Africa government does not seriously commit the NDC of the Paris Agreement (2015), the country will experience the 4º Celsius trajectory, and the Karoo in particular, will face even more adverse weather conditions. The UNFCCC (1992) agenda principally maintains that adaptation is better that mitigation, from the human endurance perspective as well as from a financial perspective. The Convention (1992) does not condemn OUG extraction, as it is a widely accepted view that with the correct regulatory framework and stricter monitoring controls, (even the stern German government was the first to ban the extraction), OUG extraction may be permitted. GHG from a very widespread global extraction, leaves many unanswered questions as specific research on methane leakage is still in its infancy (Howarth, 2014; personal interview with Howarth, 2017).

The chapter aptly has been divided into three parts to categorise the discussion with summary insights for further consideration for each section. Part One drew on ideas from the global oil and gas sector and traced the emerging trends in shale, asking the questions put forth by Inayatullah (2015). Part Two examined other new entrants into the global industry and used the Shale Ten Point Assessment Check. Part Three applied the data gathered from the first two sections and reviewed the readiness of the South African case for shale exploration, from a safe environment perspective and attempted to answer the first main research question on safety.

Chapter Three, considered the role of fossil fuels and coal in the climate risk as a megatrend discussion. Mechanisms of support, i.e. subsidies were discussed in detail, which yielded some economic indicators. Chapter Four picks up from this discussion and then examines a bouquet of new petroleum contracts which could lead to a higher return on investment than the current licence agreement. As a helpful economic question, the land expropriation without compensation is examined and the effect of this trending discourse could impact on the UOG extraction in the Karoo, South Africa, and which could see a critical success factor, as witnessed in the U.S., play out in the Karoo. The land question then spills over into Chapter Five, which deals with societal questions, such as; For whom exactly, is shale exploration and economic game-changer?

Chapter Four and Chapter Five continue the mapping process. Chapter Four focuses on the economic matters and attempts to answer the question of whether UOG extraction in the Karoo, South Africa would be an economic game-changer for the South African economy.

CHAPTER FOUR

4 THE ECONOMIC IMPACTS OF UOG EXTRACTION IN THE KAROO, SOUTH AFRICA

4.1 INTRODUCTION

This chapter of this research continues the mapping process with Inayatullah's first and second pillars, which is the mapping of the past, present and future (Inayatullah, 2013a). The pillars examine and discuss critical global trends that characterise today's shale industry without attempting to predict the future. The chapter considers 'the where', 'the what', 'the who' and 'the how' of the shale industry in South Africa and as it advances into the future. Horton (1999) describes the mapping phase as the collection, collation and summarisation of available information, drawing on trends and expected developments and resulting in the creation of foresight knowledge. Lindgren and Bandhold (2009), term this process as tracking changes in the environment which may have an impact on the central question.

In this chapter, the research examines to what extent the UOG extraction in the Karoo, South Africa, could be an economic game-changer for the nation. The use of the future triangle identifies the key factors, or forces of the present, as well as the future drivers and trends that may exist, taking into account the possible impacts on this new business sector. The analysis is achieved through the examination of markets which have decided to exploit the exploration, as contained in Chapter Three, and focuses on the economic reasons for approving the exploration, the timelines for the exploration and how these markets mitigate any hazardous impacts.

This chapter then focuses on the exploration's game-changing opportunities by presenting a business case for shale, and examining the role of the government, as a regulator. The research then presents a review of the types of petroleum contracts that government may enter with international oil companies (IOC) in the upcoming exploration. The examination of petroleum contracts is critical to the shale argument as this research refutes the use of the current licence agreements, which government is about to award. Petroleum contracts have been effectively amended to suit the needs of other developing markets. These have been referenced in this research.

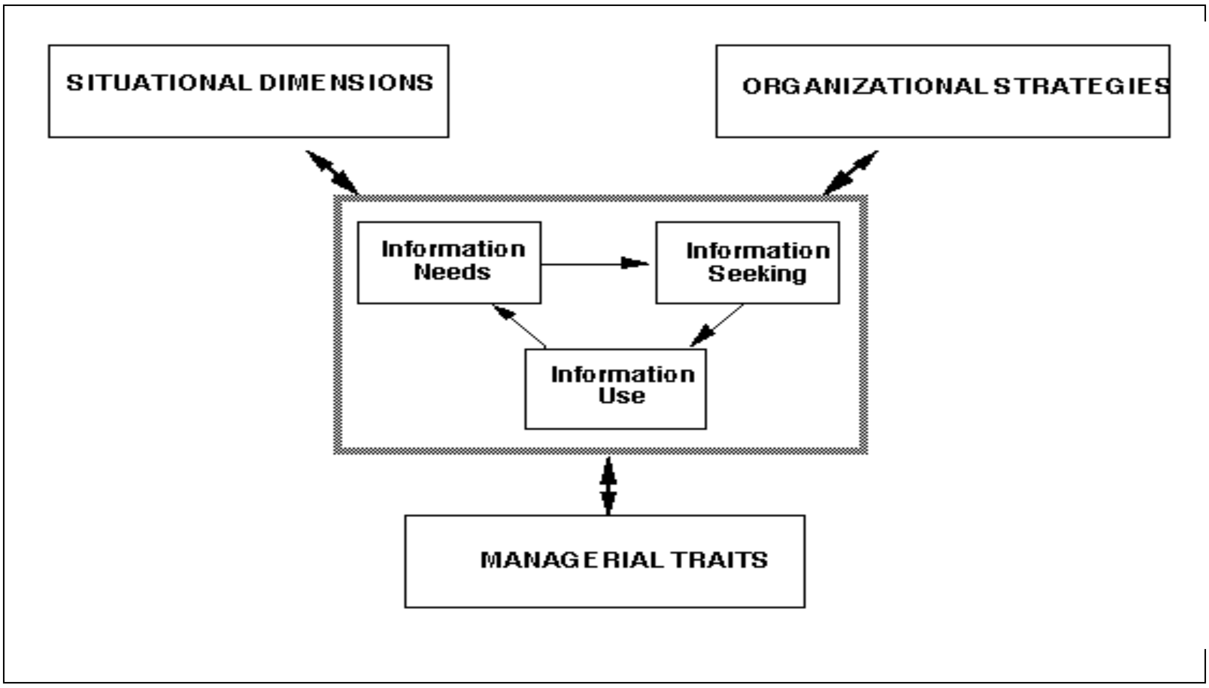
In September 1999, the quotation was a theme of a letter to the editor of The Times of London:

Sir, it is too early to expect the last word on the end of the oil era but the one to beat, at least in epigrammatic terms: The stone age did not end because the world ran out of stones, and the oil age will not end because we run out of oil. (The Times, 1999)

Environmental scanning (E.S.) was defined by Choo (2003) as “the acquisition and use of information about events, trends and relationships in an organisation’s external environment, the knowledge of which would assist with planning the organisation’s future course of action” (Choo, 2003, p.1). Albright (2004) describes it as the internal assessment of external information about issues that may influence an organisation’s decision-making process. In selecting the future, it is essential to have a grasp of the possibilities of the future and to identify what could be disruptive drivers. In the case of shale exploration, an excellent example of a disruptive driver would be technological innovation. Technology is often assumed with hardware and software as this relates to platforms.

Harman (1976), stresses the principle of continuity, which is one of six principles that characterise complex, highly-interconnected systems and which guide the analysis of trends through the continuity of societies. Societies generally change smoothly from one state to another without discontinuous jumps. The principle of continuity is used in all types of projections of trends and cycles, even though the uncertainty of the future must be recognised with the analysis of trends (Harman, 1976). Cornish puts forth that the uncertainty of forecasts based on trends is not something to be deplored but rather to be celebrated, since it results from the increasing ability of humans to choose the future (Cornish, 2004). Figure 4.1 refers to a conceptual framework for environmental scanning, put forth by Choo, 2003.

Figure 4.1: Conceptual Framework



(Source: Choo 2003, p 86.)

Cornish (2004) states that trends provide a conduit from the past into the future, allowing the logical tracking or transfer of information of what has happened into knowledge about what might happen in the future. In the previous chapter of environmental scanning, a great emphasis was placed on the activities in the U.S., as the U.S. experience has been the blueprint for comparison and learning. In this chapter, an in-depth environmental scan of the South African shale industry is performed to detect the forces of the present and to uncover the quantitative drivers and trends that exist and will have an effect on the future of shale and its potential to be a veritable game-changer in the South African economy. The environmental scan assists South African shale exploration to form a strategic standpoint from which it can deal with external forces over which it has little or no influence (Albright, 2004).

Urban population growth is witnessed in all of the African cities. South Africa is growing organically, as well as from the annual influx of foreign immigrants. StatsSA (2019), revised the population number to 58.8 million people. The following questions formulated by Inayatullah (2008) guide the logical gathering and synthesising of data in order to arrive at tangible indicators on which to base the scenarios. This data is interpreted as the 'meat and bones' which grounds the scenarios. This research remains consistent in this second chapter of the mapping process and continues with questions: What stays the same? What are the key trends? What are the main processes of change? What are the most critical problems and issues? What are the new issues in the pipeline? and What are the sources and hope?

Even though the shortcomings in the U.S. scientific literature were identified, there exist other valuable lessons from that market which pertain to legal frameworks, economic policy development and the development of institutions which have resulted in a cohesive machine that is known as the U.S. shale economic success story (Green, 2016). Within the economic policy discussion in the U.S. lies the critical success factor of property rights in the U.S. Therefore, this economic discourse focuses primarily on two key actors; state and industry (i.e. the developers). In this chapter, this research strives to achieve the following:

- Identify the main trends and events that have led up to the present and construct a historical timeline to the present using the Horton model (Horton; 2004).
- Identify the continuities and discontinuities in the history of the UOG industry.

While the importance of Williston has been stressed, the understanding and care of the environment is critically analysed and evaluated through the eyes of the European governments of the European Union (Talus, 2016) of which environmental law is the cornerstone. Driven by the IPCC (2013), climate change law, states that in order to meet the global target of 1.5 degrees centigrade over pre-industrial times, two-thirds of the current reserves of oil must remain underground (IPCC, 2013). Meeting this target will ensure that there is minimal harm to the environment.

That humankind runs out of oil, metaphorically relates to the fact that humanity cannot endlessly use this resource, owing to the emissions emitted to the detriment of the planet (Hubert, 1999). At this stage this research highlights two critical wild cards; global warming to 4 degrees Celsius for South Africa and technological breakthroughs. Both impact upon the economic viability of the exploration.

Whilst the Convention (1992) favours the direct path to renewable energy, this research argues that shale extraction is necessary to finance the transition to a lower-carbon future for a developing country, such as South Africa. Therefore, sufficient drilling is necessary to accumulate financial reserves for South Africa to overcome its current, pressing social challenges and to enable infrastructure for renewables to be put into place. A technological breakthrough, the phenomenon that is impacting the energy systems of Africa (EUEI PDF, 2017) is a wildcard, which could positively impact upon the exploration and would be vital for profitability in the South African case. However, society must be capacitated to use this technology efficiently or be left behind. Financial projections are based on current hydraulic fracturing methods. Further advanced methods in the technique as well as associated processes will contribute to better economic feasibility and environmental benefits. (Jackson, 2000, personal interview with Jackson at Stanford University, 2018, Kramer, 2014; SAOGA, 2018). Exploration techniques, seismic risk analysis and advances in cleaner, greener chemicals contribute to the safety of UOG extraction. The use of robots and automation would be more effective in monitoring issues below the surface such as seismic activity (Jackson, 2018).

On a human level, human capacity development may be fast-tracked by technology. Driving forces and emerging trends provide an excellent way to commence this crucial task, enabling improved decision-making about what should be done and researched. Following the steps of CLA, this research attempts at the deconstruction of the various complex issues in the environmental, economic and social discourses of this subject (Cornish, 2004b). Lunn (2015), an industry negotiator with the government on behalf of the developers, mentions that legislation is a significant factor in projects being given the permission to explore (Business Day, 2015). According to studies in the U.S., the average time from obtaining a drilling license to bringing a well online is just a matter of months. Production is also swift (Magueri, 2013). Meticulous planning is associated with this process, given that there is a shortage of rigs and rig workers around the globe.

The Council of GeoSciences of South Africa, which works in close collaboration with the Department of Minerals and Energy, has confirmed that the exploratory project to determine the extractive reserves has been delayed by one year, and the tender was re-drafted to recruit international expertise, given the lack on local competencies (personal interview with Mabusa and Shelembe, 2019). South Africa will not achieve the full game-changing if capacity-building is not rapidly advanced (Jackson, 2018;

Magueri, 2013). Coupled with clear legislative frameworks, trained court officials must be able to manage regional mobile courts for swift action. Municipal workers must be trained to administer effective policing on the ground (De Wit, 2011b; Fakir, 2014).

As seen in many examples in North Dakota, Oklahoma and California in the U.S. as well as in Lancashire in the U.K., the government must reserve the right to stop the projects in high risk cases. Similarly, strict protocols must be in place to address substantiated claims by environmentalists. The U.S. Federal Government has allowed hydraulic fracturing in 32 of 52 States and the U.S. Government, through command and control mechanisms, has been very effective in managing problematic areas (Magueri, 2013).

4.1.1 The Global GDP

The global GDP is set to double by 2040 (Escudero, 2016). OPEC, dominated by Saudi Arabia, started the cold war against Iran and Iraq (Salameh, 2015). The shale producers, at that time were harmed in the process. Salameh, (2015) oil consultant to the World Bank, defends the position that the oil price is required to re-bound to almost USD 110.00 per barrel for shale to be viable. According to Salameh (2015), if the situation persists at current low price of USD 69.00 (2019), 2021 could see the bankruptcy of Saudi Arabia (Salameh, 2015). Arab Spring could re-surface in Saudi and shift throughout the other Arab oil-producing nations of the Middle-East (Salameh, 2015). OPEC countries can only balance the budget if oil prices rebound to around USD 80.00 a barrel.

Blaming Saudi Arabia, Salameh (2015) states that Saudi attempts to dominate the OPEC countries yet pursues aggression towards Iran, as Iran emerges after years of sanctions. The low oil price is a factor of concern to international markets whose balance sheets are based on exports. In the case of South Africa, shale is predominantly for industry consumption. Coal volumes start to show a decline as world governments pledge to support COP 22. (EIA Annual Energy Outlook, 2015). With coal accounting for 85 per cent of South Africa's energy, President of South African Local Governments Association, Tau, (2017) cautions that while renewable energy is favoured and is high on the agendas of South Africa municipalities, coal remains part of the energy mix towards 2035. Fossil fuels still dominate the energy mix, as even the newcomers, shale, and tight gas, are considered fossils (personal interview with Parks Tau, (2017).

The selection of a country's energy mix is paramount to setting up effective policies. These policies if well-implemented will lead to surprise-free futures 2035. In South Africa, the various actors of energy forms such as nuclear, hydro, tight gas, crude oil, UOG and coal, impact differently on the UOG initiative in the Karoo. The shale revolution in the U.S. demonstrated a profound impact, as China and other markets start to aggressively explore programmes (Aloulou, 2016; Brown & George, 2016; EIA Annual Energy Outlook, 2016; Park, 2016; Rapier, 2016; Salameh, 2016; Villar, 2016). The growth of China's energy requirements and the country's response in the short-term and the forecast that it will become the most significant shale producer in the world, impacts on the shale scenarios of the Karoo (Brown & George, 2016). South Africa with its growing association with China would need to consider the various' what if?' scenarios towards the world energy dominance of China between the years 2025 to 2035 (Brown & George, 2016).

4.1.1.1.1 Chindia GDP

Population and income growth are the key drivers behind the growing demand for energy. The world's population is projected to increase by around 1.5 billion people to reach nearly 8.8 billion people by 2035 (IER, 2013). Over the same period, GDP is expected to more than double with around one-fifth of that increase coming from population growth and four-fifths from improvements in productivity (Pesaran & Pesaran, 2010). China and India together account for almost half of the rise in global GDP, with OECD economies accounting for around a quarter. By 2035, Africa's population is projected exceed the population of China by 30 per cent, and of India by 20 per cent. Africa accounts for less than 10 per cent of the increase in both global GDP and energy consumption over the next twenty years (Mitra & Nagar, 2015; Pesaran & Pesaran, 2010; Sinha & Sharma, 2016).

4.1.1.1.2 The South African GDP

In light of the country's severe energy crisis, electricity shortages, high costs of electricity and the high emission due to the reliance of coal for industrial development, South Africa is hard-pressed to look at alternatives (Wakeford, 2016, Book Chapter 7 in Esterhuyse and Glazewski, 2016, Du Toit, 2016, Book Chapter 2 in Esterhuyse and Glazewski, 2016). In South Africa, UOG extraction could be beneficial for several reasons. The country faces an energy crisis as its current demand outstrips supply. MossGas is at 50 per cent capacity, as feedstock is in short supply (Wakeford, 2016). UOG could be a short-term solution for South Africa's energy problems as 85 per cent of the nation's electricity is currently sourced from coal (CEF, 2018; IGAS, 2018, personal interview with Kramer, SAOGA, 2018). By weaning the country off coal, gas could be used as an alternative to generating electricity at a much cheaper cost, with a relatively smaller carbon footprint than coal while the country moves towards a low carbon trajectory with the effective implementation of renewable energy sources such as solar and wind technologies (CEF, 2018; IGAS, 2018, SAOGA, 2018).

4.2 PART ONE: MEGATREND MANIFESTATION

Two megatrends, economic growth and the increased demand for energy, impact upon the economic discourse of UOG extraction in the Karoo, South Africa. The megatrend of increased population, impacts these two megatrends but is reserved and discussed in the next chapter, which treats the social factors. Economic development is required to sustain the growing masses of the world, and this megatrend requires increased energy.

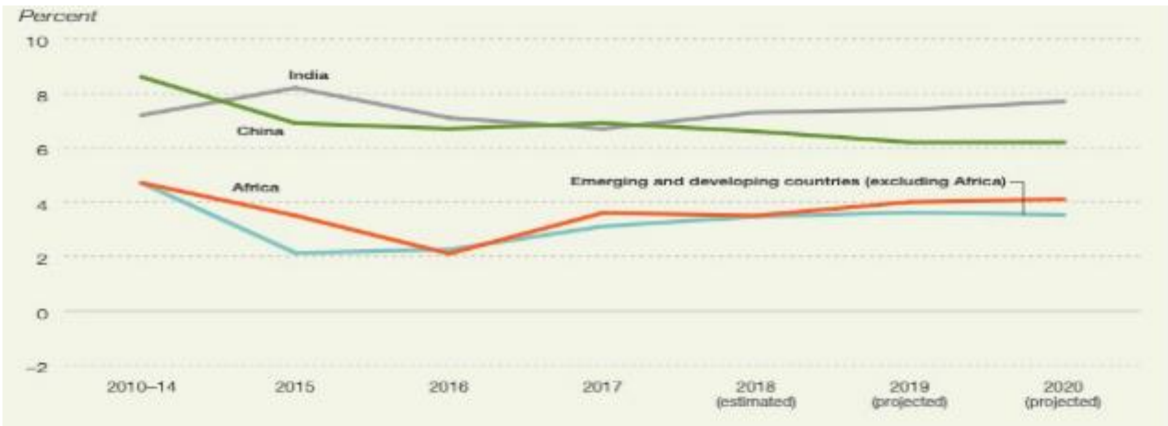
4.2.1 Megatrend Manifestation One: Economic Growth Caused by Urbanisation

Since the early nineties, Sub-Sharan Africa, on average has experienced continuous gross domestic product (GDP) growth. Recent growth figures show a decline, although remaining above those of G7 economies. Current projections suggest higher rates of economic growth are likely to rebound in the short term (personal interview with Escudero, at the Vienna Energy Forum, 2017).

Economic growth is dependent on a sustainable and secure energy supply that is resilient and reliable, from a low carbon source and it must be provided at the lowest price. Africa is on a quest for prosperity, and seeks rapid industrialisation (Wait & Roussouw, 2019). The International Monetary Fund (IMF) forecasts up until 2021, that Africa's GDP figures will have surpassed G7 economies, as well as those of more advanced economies, and will have substantially outpaced per capita GDP growth (IMF, 2018). The individual growth of African cities is dependent on natural resources. The efficient production of agriculture, heavy industrialisation, the growth of the service economy and the growth of the informal sector are linked to the growth of formal industry and which in turn is linked to advanced education systems. The implications, therefore, are that economic growth rates have the potential to improve the lives of urban residents through increased employment and income. An enabling commercial environment, provided by governments, together with the human resources, skills and infrastructure, is required for this growth upturn (IMF, 2018).

Furthermore, the distribution of economic growth impacts development of society in African cities. It is assumed that total GDP growth will remain positive until 2050 for sub-Saharan Africa on aggregate (Escudero, 2017). South Africa, however, experiences a different challenge as not only must economic growth cover the growth of the South Africa population, it must also further seek to cater for an additional million immigrants per annum. The economic growth level must be at 3 per cent per annum to sustain current levels of population growth. Previous growth figures have been 1.3 per cent in 2015, 0.6 per cent in 2016, 1.3 per cent 2017 and 0.5 per cent in 2018 (StatsSA 2019). Figure 4.2 refers to GDP growth in Africa between the period of 2010 to 2020.

Figure 4.2: GDP Growth in Africa 2010 - 20

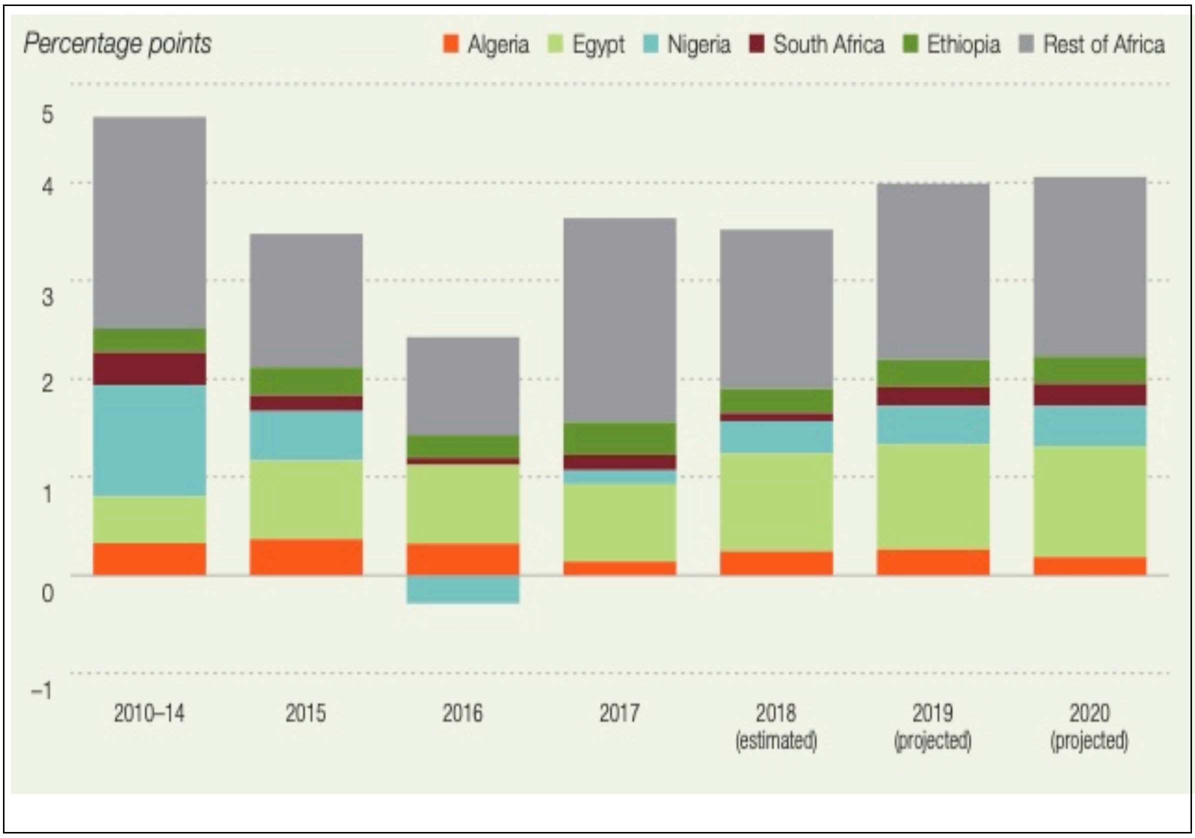


(Source: AfDB, Statistics and IMF, 2019)

In the transport sector there has been a contraction of 4,9 per cent, resulting from decreased activity in both land and air transport. Industrial action within the industry saw a decline in freight transport (StatsSA, 2019). In its second consecutive quarter of negative growth, the trade industry experienced a drop of 1,9 per cent with subdued sales in both motor and retail trade, contributing to the lower figures (StatsSA, 2019).

Household consumption expenditure in South Africa fell in the second quarter of 2019 compared to the first quarter of 2019 and which was in line with the fall in retail trade sales, with South Africans spending less on items such as transport, food, beverages and clothing (StatsSA, 2019). Manufacturing, followed by agriculture and trade, was the third industry to record a second consecutive quarter of negative growth. Manufacturing activity fell by 0,3 per cent (StatsSA, 2019). Mining's growth rate of 4,9 per cent was primarily spurred on by a rise in the production of the platinum group of metals, copper and nickel. Construction activity showed an increase of 2,3 per cent, which came from the rise in non-residential buildings and construction work activities (StatsSA, 2019). Figure 4.3 refers to African economic growth by the main contributing countries.

Figure 4.3: African GDP Growth by Country



(Source: AfDB, 2019)

4.2.2 Megatrend Manifestation Two: Increased Energy Demand

Global economic growth requires more energy, which is mostly consumed by emerging economies. The growth happens between 2014 and 2035. The additional energy is consumed in fast-growing emerging economies while energy demand within the OECD barely grows. The growth of electricity decreased in the recent past (1.4 per cent per annum (p.a.) versus 2.3 per cent p.a. in 2000-14). This reflects a significantly faster fall in energy intensity which is the energy used per unit of GDP (EUEI PDF, 2017). By the end of two decades, China contributes less than 30 per cent to global energy growth, compared with nearly 60 per cent over the past decade. A pickup in other developing countries partially offsets the sharp slowing in China's energy demand growth. India accounts for more than a quarter of the increase in global energy demand at the end of twenty years, double its contribution over the past decade.

4.2.2.1 Global Energy Demand

The shifting patterns of demand and supply cause regional oil imbalances. The removal of the U.S. crude export ban helps this adjustment process. By contrast, Asia's dependence on oil imports increases significantly, accounting for virtually all of the growth in global imports over the next twenty years and for nearly 80 per cent of inter-regional net imports by 2035. Nineteen Mb/d is projected between 2018 and 2035 for total liquids. Almost half is expected to be accounted for by NGLs, biofuels and other liquids. These liquids do not require refining (IEA, 2013).

According to the IEA, (2018) the oil and gas projections between 2018 – 2023, see natural gas demand growing by 1.8 per cent p.a., making it the fastest growing fossil fuel over the next five years (IEA, 2018). Sustainable supplies and supportive environmental policies assist growth. The majority of the increase in demand comes from emerging economies. China and India together account for around 30 per cent of the increase. The remainder comes from the Middle East. Gas in emerging markets is used in the industrial sector. As economies industrialise, power generation becomes vital. Growth in Organisation of Economic Co-operation and Development (OECD) gas consumption is more concentrated in the power sector (IEA, 2013).

Current spare refining capacity, as well as planned refinery additions over the next five years are already enough to meet the incremental growth in crude and condensate supplies projected over the next two decades (10 Mb/d), (IEA, 2018). It is assumed that if the growth regions, such as China and India, continue to invest in refining capacity, the forecasts for the next twenty years imply a long period of volatile margins, with capacity reductions required in disadvantaged refining centres. NGLs provide the most significant increment of non-refined liquids, expanding by more than 6 Mb/d by 2035, and supporting the growth in petrochemicals demand (IEA, 2018). Growth is driven by the U.S. (4 Mb/d) and the Middle East (2 Mb/d). The U.S. is expected to become a significant exporter of LPG to both Europe and the Asia Pacific markets (IEA, 2018).

The increase in global gas supplies is roughly evenly split between increases in conventional production and shale gas. Much of the increase in conventional production comes from non-OECD countries, with marked increases in the Middle East, China, and Russia. By 2035, LNG surpasses pipeline imports as the dominant form of traded gas. The growing importance of LNG trade is likely to cause local gas prices to become increasingly integrated. The growth in LNG coincides with a significant shift in the regional pattern of trade. International trade in gas grows broadly in line with global consumption, and the global trade share of gas remains around 30 per cent. Within that, LNG trade grows twice as fast as consumption, with LNG's share of world demand rising from 10 per cent in 2014 to 1 5 per cent in 2035 (IEA, 2018).

Over 40 per cent of the increase in global LNG supplies is expected to occur over the next five years. Already energy independent, The U.S. is likely to become a net exporter of gas by 2025 (Glazewski & Esterhuyse, 2016; Wait and Roussouw, 2019). The dependence of Europe and China on imported gas is projected to increase further in the years towards 2030 (IEA, 2018).

4.2.2.2 BRICS Energy Demand

UOG thrives at an expected 5.6 per cent p.a. throughout the next twenty years with the share of UOG in total production increased from just over 10 per cent in 2014 to nearly 25 per cent by 2035. Almost all of the growth in shale output stems from the U.S. towards 2035. After that, growth in China's UOG production is forecast to increase. In 2045, China is the most significant contributor to growth in UOG production.

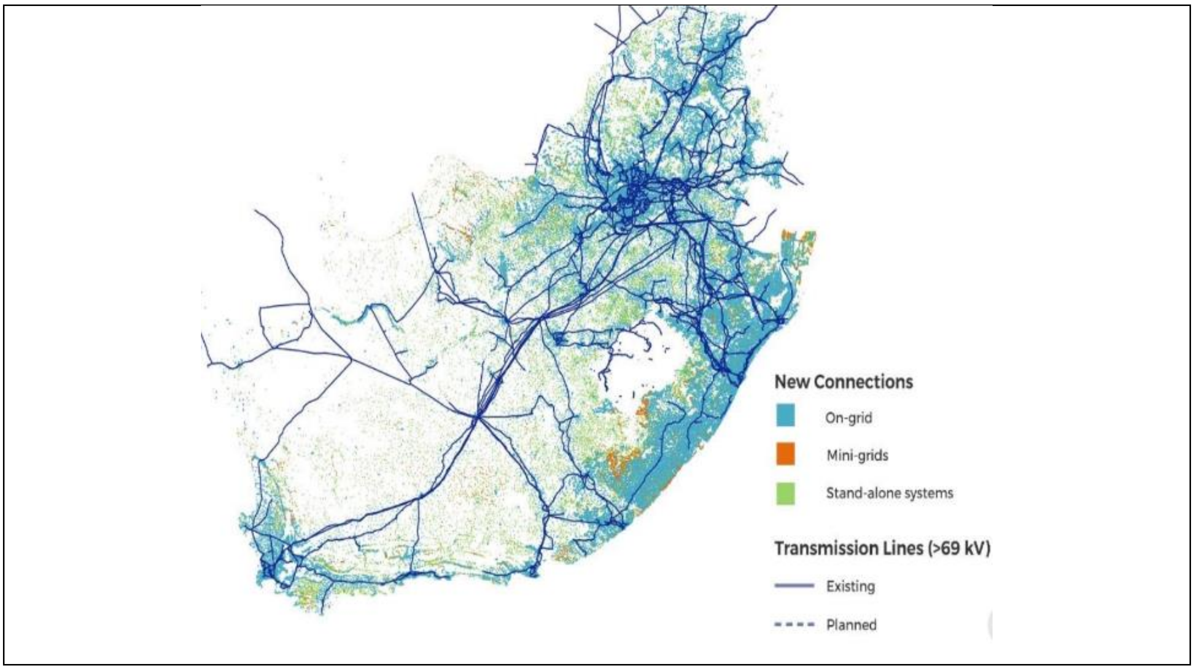
Growth in global coal demand is expected to slow sharply. The past twenty years witnessed a growth of almost 3 per cent p.a. The next two decades, projects just 0.5 per cent p.a. The deceleration attributes this slowdown in China's coal consumption to its economic rebalancing (Du Toit, 2016). China's demand for coal grows by just 0.2 per cent p.a. over the next twenty years, down from over 8 per cent p.a. during 2000-14, and by 2030 it is in decline (Du Toit, 2016). Nuclear energy would contribute to about 60 per cent of primary energy in 2100 (compared with 10 per cent in 2008), 10 per cent from renewables (from 5 per cent in 2008) and 30 per cent fossil fuels (from 85 per cent in 2008). Nuclear contributed 51 per cent of the emission reduction; 38 per cent from power generation and 13 per cent from hydrogen production and process heat (World Nuclear Association, 2016).

4.2.2.3 Africa's Energy Demand

Africa is the last continent to urbanise, requiring 70 to 80 per cent of infrastructure to serve the growing populations, so the demand for energy will rise considerably (EUEI PDF, 2017). African cities, therefore, have an opportunity to leapfrog old patterns of growth and to be built more sustainably. From the start, this study references scenario-based strategic foresight methodologies which support long-term energy infrastructure planning for local governments, breaking down complexities around energy planning, identifying the megatrends shaping African cities, classifying drivers for change and wildcards and finally using these commonalities to drill towards opportunities and challenges facing South African cities in the short, medium and long term.

African cities are energy constrained and these include cities currently possessing access to oil and gas reserves (Escudero, 2017). South African cities do not possess petroleum reserves and energy prices are subject to forex volatility and high global prices, according to experts (CEF, 2017). With the increase in population, economic development is required to sustain the ever-increasing demands and this means that more energy is required. IEA (2016), estimates that the energy demand in 2040 will be well over 70 per cent greater than in 2012 and is attributed to economic and population growth. Figure 4.4 illustrates South Africa's electricity access by type. In the area of the Karoo's UOG extraction, mini grids are projected. Shale gas is expected to supply industries as part of the future energy mix, which will include cleaning burning coal technology, wind and solar technologies. Wind and solar technologies are expected to power the domestic homesteads in the Karoo towns.

Figure 4.4: South Africa's Electricity Access Solution, By Type



(Source: IEA Africa Energy Outlook, 2019)

Presenting a seminar as a side-event at the Vienna Energy Forum, in 2017, Escudero (2017) pointed out that the expected growth in African economies and populations will see the need for increased energy demands in cities until 2040 and beyond. This phenomenon will also be driven by improvements in access to energy, as African markets with the assistance of global NGOs, start to implement the adaption and mitigation mechanisms, which are provided for in the Paris Agreement (2015), (Escudero, 2017; EUEI PDF, 2017). Despite the potential for reduced emission and improved efficiency, energy demand is still likely to increase across industrial, residential and transport sectors. Therefore, a decentralised energy model is required just to be able to establish and sustain an affordable system for the growing masses (Escudero, 2017; EUEI PDF, 2017).

Rolling blackouts since 2008 have become commonplace in South Africa, resulting in the deepening concern over Eskom's coal-fired power plants which are close to the end of their lifecycles. The ability of Eskom to meet demand in the next five years towards 2023 is a concern for the nation. Eskom is currently operating its emergency open-cycle gas turbines in the Western Cape on an almost daily basis to meet demand and to avoid load shedding. The energy availability factor (EAF) shows deterioration from 78.61 per cent in 2017 to 73,74 per cent in the 2018 (Eskom, 2017). Unplanned plant breakdowns have been more frequent. There is scheduled maintenance for outages, but given the increased occurrence due to blackouts, the systems are not able to cope. Increased outages are measured by the planned capability loss factor (PCLF). The total energy sent out in the 2018 calendar year, compared to the same period in 2017, shows a decrease by 0,37 per cent to 155,87 TWh. (Eskom, 2017)

Eskom’s plant performance for the next five years from 2019 to 2023, as measured by the energy availability factor (EAF), is forecast to range between 72 per cent (pessimistic) and 78 per cent (optimistic), with a declining trend in the latter half of the five years. Another issue that Eskom still has to resolve is whether it will receive any further postponement of requirements for the utility’s coal-fired power stations to comply with the existing and new draft minimum air pollution emission legislation, regulations and standards beyond 2020. If not, this would add a new dimension to Eskom’s medium-term operational, financial and environmental sustainability. It is becoming more evident to Eskom that the reality of declining coal-fired generation plant performance and the identified risks require urgent short - and medium-term interventions and the deployment of new capacity.

Gordhan (2019), the incoming minister of Public Enterprises specifies that to fulfil the current mandate, the following interventions are required:

- Increase spending and efforts on maintenance.
- Promote a culture of accountability at power stations for generation plant outages.
- Accelerate deployment of new, utility-scale renewable energy capacity.
- Add utility-scale storage to the system to assist during peak times.
- More aggressive incentivising of energy efficiency.
- Hasten the deployment of industrial cogeneration and IPP projects.
- Optimise the current coal fleet more flexibly to complement renewable energy generation sources.

4.3 PART TWO: ECONOMIC SITUATION ANALYSIS

In this section, this research dissects the current trends leading to increased demand for energy for economic development in South Africa. This research references and notes the fast-developing impacts that UOG extraction is already having on the U.S. market. EIA statistics (2019) are already indicating the positive effects of shale gas. These are significant in terms of climate change, as the U.S. illustrates a phenomenal decrease in coal usage, with a remarkable reduction in carbon. Most phenomenal is not only that shale revitalised the U.S. economy after the financial crisis of 2008, but that the U.S. also emerged as the largest net exporter of oil products, overtaking the OPEC countries (EIA, 2019). The IPCC, over the past twelve-months average, shows the planet is tracking 1.2 ° Celsius over pre-industrial times (Bloomberg, 2019).

4.3.1 Economic Growth

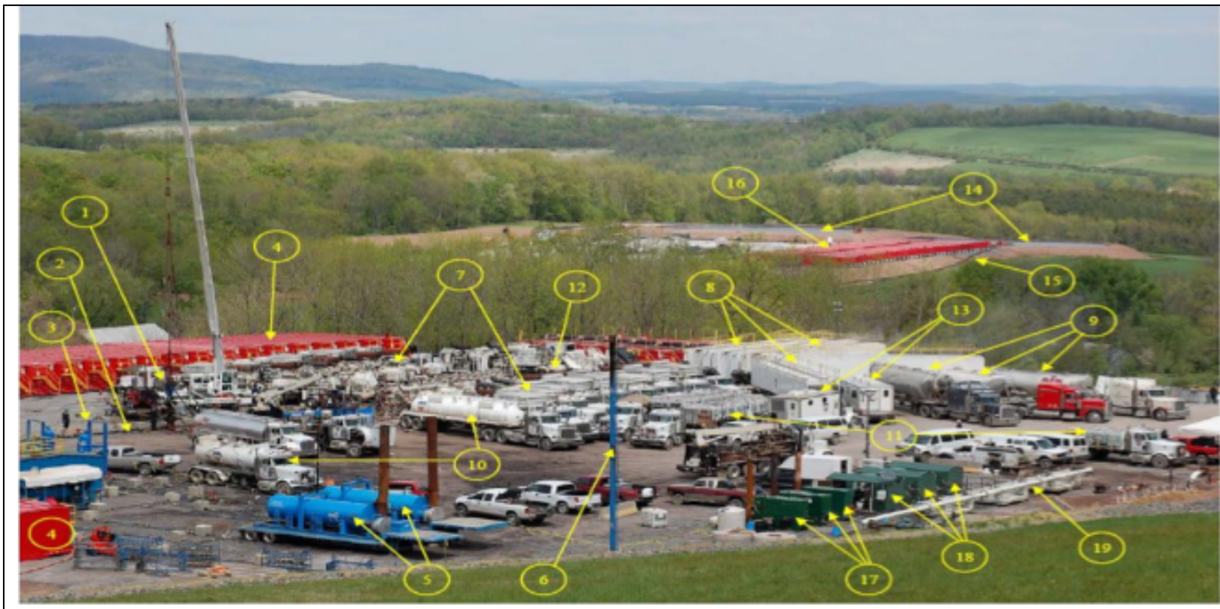
Governments are burdened with growing populations and with having to provide for the growing energy demands of the people. This phenomenon can only be served by growing economically. In the above sections and this research provided an overview on the energy situation. The research now dissects the global economy, highlighting shale economic factors which influenced the U.S. causing other jurisdictions to consider this exploration.

4.3.1.1 The U.S. and Global Economics.

The Vengosh *et al*. (2013) report, as well as the authors, Considine, Watson and Martin of Considine *et al*. report (2009), were not able to quantify the costs of damage to the environment. In light of the country's severe energy crisis, electricity shortages, high costs of electricity and the high emission due to the reliance of coal for industrial development, South Africa is hard-pressed to look at alternatives (Du Toit, 2016; Glazewski, 2016; Wakeford, 2016). Twine (2013), Econometrix economist and principal analyst in the Karoo UOG Report (2013), supports swift action in UOG extraction. The reports stated that there would be the creation of 700 000 jobs (Econometrix, 2013). The breakdown of these functions suggests an improvement in living standards for 600 000 - 700 000 households. A new hypothesis emerges whereby commentators are concerned that the UOG extraction, as seen in the U.S., will drive demand for a limited work-force from other sectors (Wait & Roussouw, 2019).

The Econometrix report also states that if UOG estimates were confirmed, the country would have 93 years' worth of energy supply, effectively meaning that South Africa's energy problems would be over and energy requirements for future generations would be guaranteed (Econometrix, 2013). Adopting a conservative view, the Econometrix report bases assessments on 20 TCF and 50 TCF. A report by PwC found that there is a significant benefit in natural gas exploration for development in South Africa and quoted reserves similar to the IEA (2013) forecasts (PwC, 2014). Both reports are based on the assumption of reserves of 496 TCF. Figure 4.5 illustrates the scope of development that accompanies extraction at well level.

Figure 4.5: Scope of Development Required for UOG Extraction



1.Well-head with frac tree with "goat head"	11. Frac additive trucks
2. Flow Line for back flow and testing	12. Blender
3. Sand separator for flow back	13. Frac Control and monitoring centre
4. Flow back tanks	14. Fresh water impoundment
5. Line heaters	15. Fresh water supply pipeline
6. Flare stack	16. Extra tanks
7. Pump stack	17. Line heaters
8. Sand hogs	18. Separator-meter skid
9. Sand trucks	17. Production manifold
10. Acid trucks	

(Source: Tyndall Centre, 2011)

Later in this chapter, this research provides a rudimentary cost-benefit analysis, drawing in the American UOG extraction success factors, some of which were imitated so far in U.K. (personal interview with Jackson, 2018). The research summarises the main factors:

- High oil prices in the 2000s
- Favourable geology
- Private land and mineral ownership
- Market structure
- Availability of water
- Natural gas pipeline infra-structure
- Efficient and supportive banking systems
- Government, academia and the private sector collaboration
- Good energy, and economic policy interventions
- Property ownership

However, for the scenario development process this research considers a range of 40 TCF to 496 TCF and attempts to demonstrate that not all of the extractable reserves are required to be drilled to address the Triple Challenge of poverty reduction, unemployment and inequality as well as the transition to an energy future of renewables. Conservative forecasts for the range of shale options should commence based on 40 TCF (Green, 2016). Based on the assumption, this would be a short-term solution and renewable energy would be from long-term sustainable energy forms and would result in a low-carbon and lower emissions environment (Glazewski *et al.,* 2016). This research, for planning purposes, commences with the more conservative figure of 40 TFC, which is ratcheted to 496 TCF over the various scenario options.

4.3.1.2 Land Ownership. Why was it an America success?

For a boom in the private sector, high profitability is a necessary ingredient (Fakir & Davies, 2016). The U.S. case demonstrates key drivers converging from the early years of 2000 making the exploration profitable for firms to produce large quantities of shale gas. The most critical driver was technological innovation which, eventually, caused the exploration and production to become cost effective. UOG provided for only 1.6 per cent of total US natural gas production in 2000. According to the authors Krupnick, Wang & Wang 2013, that figure reached almost 30 per cent at the end of that decade. Michelle Energy had the demand and the financial capacity to develop the Barnett plains and was also motivated by the incentive to obtain substantial financial rewards from royalties of its innovations (Krupnick et al, 2013).

The company obtained large financial rewards by leasing large tracts of land and the associated mineral rights at low prices early on and then later selling the company, the property that it had hired and the innovations that it had made and the know-how that it had accumulated, at a much higher price. This mechanism was assisted by the private land ownership rights system in the US. Unlike in South Africa, the US citizens own the rights to the land, above the surface of the ground as well as the rights to the resources below the ground (Fakir, 2015). The high oil prices of 2000 also played an essential role in making UOG production profitable. Other factors included favourable geology, private land and mineral rights ownership, market structure, water availability, natural gas pipeline infrastructure and the associated open-access policy. U.S. shale success is primarily because the U.S. has a well-oiled infrastructure of supply networks and banking systems. The support of banking system encouraged the speculation required in a project such as oil gas exploration as the exploration for oil started in 1901 and has been the catalyst for the growth of the U.S. so much so that it became the world's powerhouse (Jackson, 2018; Krupnick *et al,* 2013; Maugeri, 2013).

In the U.S., a collaboration between government, private sector and academics was critical and South Africa can learn from this model in the South African shale exploration (De Wit, 2010). Mitchell Energy cites this collaboration as one of its critical success factors. Nelson (1986) stated that in 30 sectors out of 130, university research, especially in chemistry, materials science, computer science and metallurgy, was considered to be very important for sectoral innovativeness (Dosi,1988). Chesnais (1968) analysed a complex thread of joint ventures between universities and industry in a study that addressed and defined whether research should be in-house or be a national resource (Dosi,1998). Dosi (1988) concluded that academic institutions provide unbiased insights for a national pool of knowledge. For an objective appraisal of the game-changing economic possibilities, South Africa cannot rely on the ideas of the developers but must develop its national pool of scientific instruments and consolidated research finding (De Wit, 2015).

4.3.1.3 Land Ownership and UOG Extraction in the Karoo, South Africa

In South Africa, as well as in most other jurisdictions, the mineral rights below ground belong to the state and this contributes to the negative sentiments of the white farmers who own most of the land where fracking in anticipated (Fakir, 2015). Towards the latter part of 2017, the disgruntled youth, formalised under the auspices of the EFF in the 2014 elections, started a new and controversial discourse. This discourse would see the amendment to Section 25 of the South African Constitution (1994), which could see the change in the structure of land ownership in South Africa. The EFF proposed the re-possession the land owned by predominantly whites without compensation (Mail and Guardian, 2018).

The discourse, while radical and alarmist, drew the attention of the global media and sparked responses from the U.S. and Australian governments and a further exit of white farmers to these countries. Other political parties such as the African National Congress (ANC) and the Democratic Alliance (DA) started the discussion along more formal lines of revisiting Section 25 of the South African Constitution (2004). The British Prime Minister stated that the British Government was keeping an eye on the events unfolding in South Africa and supported land expropriation but that it needed to be done in a controlled manner (Mail and Guardian 2018). Ramaphosa (2018) stated that the government was working with the World Bank to ease the process of doing business and enabling new foreign direct investment (FDI). This attempt would enable faster timelines and confront challenges in some of the largest state-owned enterprises (SOEs), admitting a decline in governance and financial performance and which had been eroded by corruption. He stated the following:

The private sector plays the most prominent role. Where we have played the part of the state, many of our own companies have faltered and stumbled along the way. It is essential that those companies be restored as drivers in the economy (Ramaphosa, 2018).

On land reform, as a concern for investors, Ramaphosa (2018) emphasised widespread agreement that most South Africans believed it should be accelerated,

…not only to address the historical injustice perpetrated against the majority of our people, [but] … to effectively unlock the economic potential of our land (Ramaphosa, 2018).

The president further added that the government was providing certainty to those who own land, who need property and those looking to invest in SA's economy,

Our constitution should allay any fears that the factories will be expropriated. That shall not happen. Your investment will be protected. In furtherance of this commitment, I call upon South African companies to engage with the investment envoys, to participate in the investment plans, including capital expenditure. Several pertinent issues will be raised, including policy uncertainty and regulatory obstacles investors have identified. (Business, Day, 26 Oct 2018, page 1).

4.3.1.4 The Banking Sector in the U.S.

Since the early 1900s, which saw the growth and development of the oil industry in America, U.S. financial institutions have played a critical role in the development of the sector with industrialists benefitting greatly, and the same transpired with the shale boom which led to a well-heeled financial system supporting the new exploration, thereby enabling small- scale shale contracting companies to develop and grow and thus leading to widespread wealth and an environment of positivity for shale exploration in the States (Dosi, 2016).

4.3.1.5 Financial Industry Trends and UOG Extraction

UOG extraction may be categorised under the oil and gas sector, but its behaviour and dynamics displays little similarities to its crude cousin. The U.S. experimented with shale in the early sixties but perfected the exploration between 2002 to 2013. While South Africa has a legacy in the mining sector, UOG extract is still in the formative stages of exploration. At this stage it is assumed that foreign developers, with foreign direct investment, would bring in capacity to operate the highly technological processes of UOG extraction (De Wit, 2015; Steenkamp & Glazewski, 2016). Even though the AEON Institute at the Nelson Mandela University, trains young scientists in the collection of samples for baseline studies, capacity building is not yet on a scale large enough to provide foreign developers with adequate local content (De Wit, 2015; Wakefield, 2016).

For many reasons, the shale discourse has been hampered and, therefore, South African banks and other financial institutions, in the absence of an agreed business case of shale, do not support the UOG extraction (Steenkamp & Glazewski, 2016). Furthermore, historically, given the volatile oil prices, banks do not have an appetite for oil and gas projects (Investec, 2014). However, for the renewable energy sector, given the widespread global support, 'green finance' is emerging as a growing financial trend which is favoured in the EU as well as in the BRICS countries (Josie, Naidoo, Pillay and Prinsloo, 2018).

4.3.1.6 The Size of the Prize: Sources and Reserves

For South Africa, one wonders what the fuss is all about, as the TTR has not been determined (De Wit, 2010; Green 2016). A study commissioned by the US (EIA) indicated that South Africa might have 495 trillion cubic feet (TCF) of technically recoverable resources (TRR), (US EIA, 2013) TRR is referred to by geologists as the amount of gas that can be extracted, but not accounting for the costs of operations, distribution and the selling price (Wakeford, 2016). The Shale Working Group, assembled by the Minister of Mineral Resources (2012) concluded that it was impossible to provide an accurate figure merely stating that 'it was substantial' (RSA, 2011). The South African scientific community widely accepts a conservative view of 40 TCF (ASSAf, 2016, SEA, 2017, U.S. IEA, 2013). Therefore, for the purposes of creating a context or a platform of understanding to see 'what the fuss is all about' and to what extent UOG extraction could be an economic game-changer, it is assumed that 40 TCF is still very significant and possesses significant game-changing commercial properties (Esterhuyse and Glazewski, 2016).

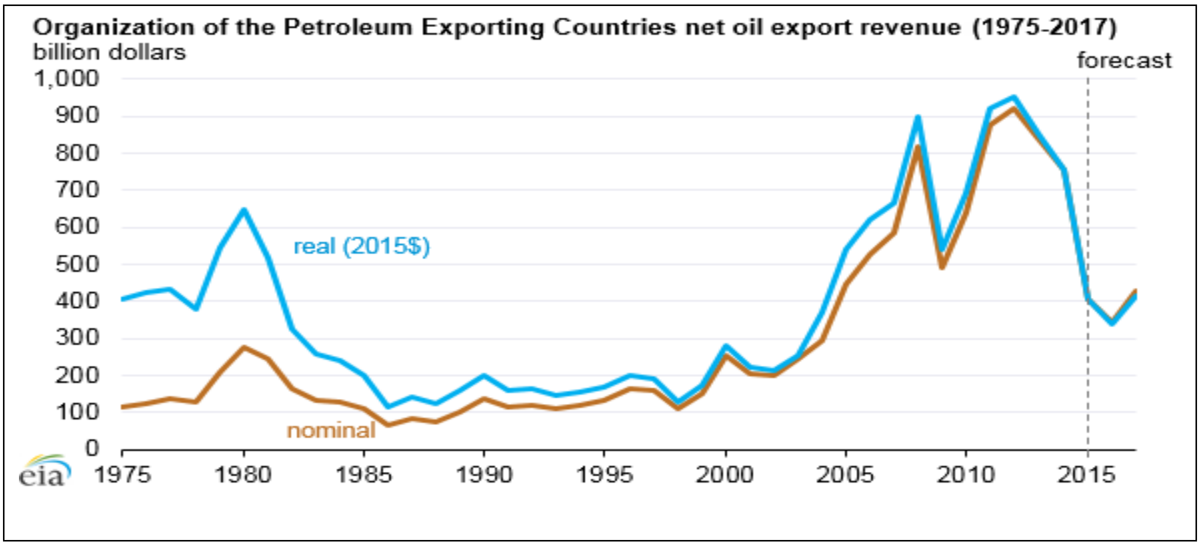
4.3.1.7 The Favourable Price of Oil

This section examines the oil price of 2014 – 2016 and the effect of the shale disruption on the sector and the global economy. South Africa depends on the Organisation of the Petroleum Exporting Countries (OPEC) countries for 73 per cent of its annual consumption. In 2014 according to the EIA (2015), the domestic consumption, imported from OPEC countries, was 655 000 barrels per day (BPD). The remainder is provided by SASOL's coal to liquid technology, sourcing the coal supply from Eskom. PetroSA's plant in Mossel Bay, produced a meagre 15 million barrels by December 2014 (EIA, 2015). With the global oil prices dropping during this period, due to the growth of shale, OPEC countries began to hurt (Wakeford, 2016; Salameh, 2015).

Members of the OPEC, earned $404 billion in net oil export revenue in 2015 (Brown & George, 2016; EIA, 2016; Villar, 2016). The revenue earnings represent a 46 per cent decline from $753 billion earned in 2014. Although these net export earnings include Iran's revenues, the net export revenue is not adjusted for possible price discounts that Iran may have offered its customers between late 2011 and January 2016, when nuclear-related sanctions targeting Iran's oil sales were in place. OPEC members' net oil export revenue has fallen as crude oil prices have declined (Brown & George, 2016). The monthly average Brent spot price dropped from $112 per barrel (b) in June 2014 to $38/b in December 2015, and by the end of 2018, that figure rose to USD 62.00, below market expectations (Salameh, 2015).

On many occasions, OPEC members planned to freeze the crude oil output (Mourdoukoutas, 2016). In 2016, Iran, which previously did not take part in similar talks, announced that it might be willing to discuss a production freeze demonstrating a need for OPEC to work together as all members were hurting and other buyers started to build up inventory reserves, benefitting from the low prices (Kramer and Reed, 2016; Salameh, 2015). Figure 4.6 tracks export revenues over the years 1975 to 2017.

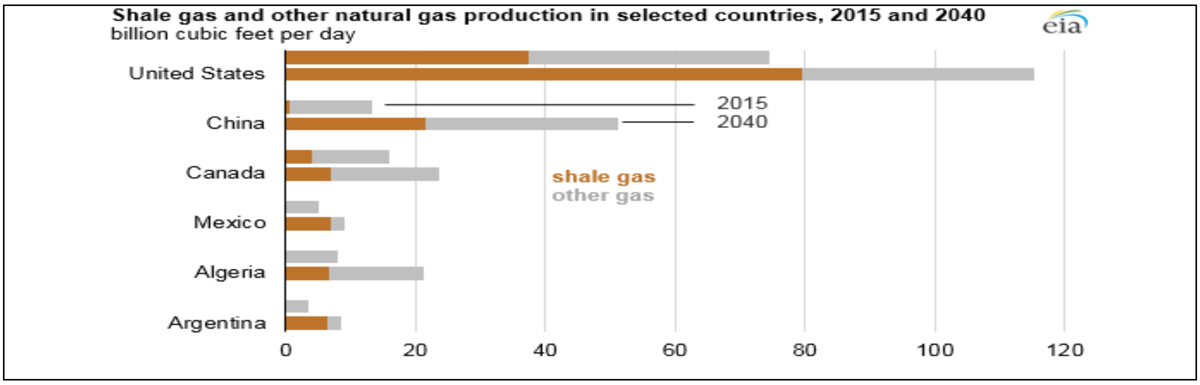
Figure 4.6: Net Oil Revenue of OPEC Countries



(Source: Energy Information Administration, 2017)

The prominence of U.S. UOG extraction encouraged other countries to start exploration putting further strain on OPEC and by end of 2018, most countries on the top 20 list of the highest extractable reserves begin serious considerations of the resource extraction, except for the OPEC members such as Russia (Georgiev, 2016). Figure 4.7 refers UOG extractive markets.

Figure 4.7: UOG Production of Selected Countries

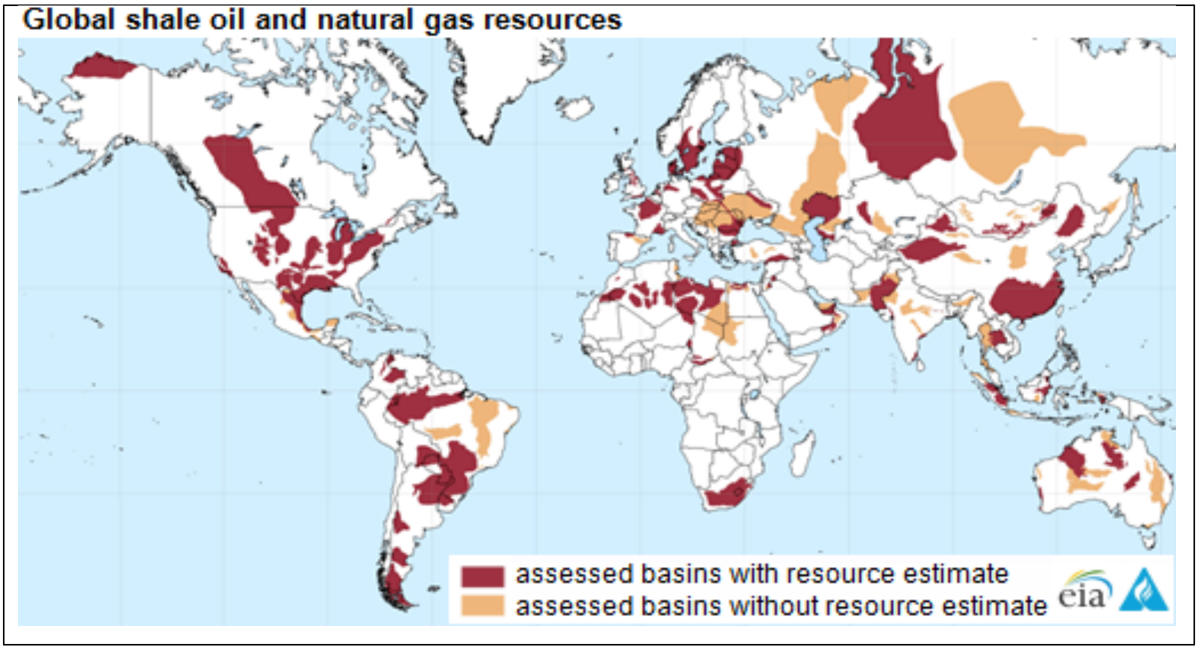


(Source: EIA, 2017)

It is expected that collectively, the U.S, Canada, China, Argentina, Mexico and Algeria, could account for 70 per cent of global shale production by 2040 (Aloulou 2015). The energy world faces critical uncertainties. The following are the vital factors which disrupt the world energy stage and are the essential drivers for change, and which are discussed in the various scenarios towards 2055. The global energy platform and its impact on the shale exploration of the Karoo are assessed on the performance of the past twenty years and the forecasts of the next forty years leading towards 2055. In South Africa, base-line information gathered by academics regarding the sciences and geology before exploration began set a platform for comparison (De Wit, 2011).

This research strives to capture the current economic and social climate of all rural communities, but notably the towns of the Karoo and considers a base case which outlines the most likely path for energy demand by fuel, based on assumptions and judgements about future changes in policy, technology and the global economy, and then develops several alternative cases to explore key uncertainties. In the base case, world GDP more than doubles. There are unprecedented gains in energy efficiency, which means that the energy required to fuel the higher level of activity grows by only around a third towards 2055. If the world employs sustainable, renewable energy forms, fossil fuels are likely to remain the dominant form of energy powering the global expansion by providing around 60 per cent of the additional energy and accounting for almost 80 per cent of total energy supplies in 2035 (IEA, 2013). Figure: 4.8 illustrates the global shale and gas reserves.

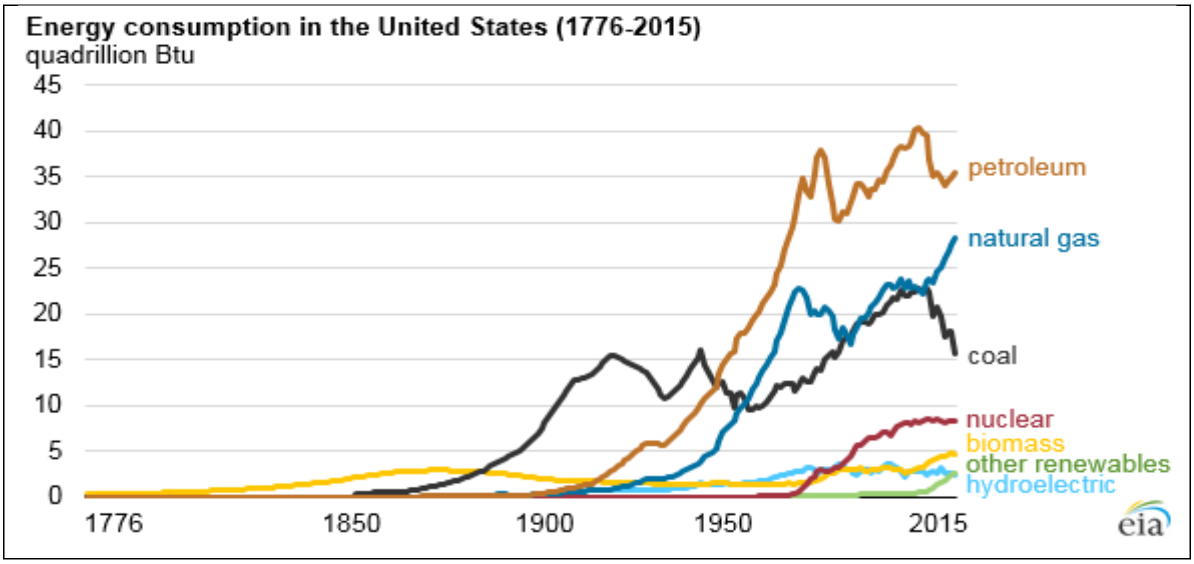
Figure 4.8: Global Shale Oil and Gas Resources



(Source: EIA, 2017)

Gas is the fastest growing fossil fuel, supported by strong supply growth, particularly of the U.S. and UOG and liquefied natural gas (LNG). At a recent gas forum, hosted in New York at Columbia University, the IEA concluded in its presentation of the gas five-year forecasts that China will top the demand for gas between 2018 - 2023 and this demand is fuelled by both price-driven requirements and policy-driven demands, policy based on the need for low emissions and the cleaner burning properties of gas (IEA France, 2018). Three fossil fuels; petroleum, natural gas, and coal, have provided more than 80 per cent of total U.S. energy consumption for more than 100 years. In 2015, fossil fuels made up 81.5 per cent of total U.S. energy consumption. That percentage declines to 76.6 per cent by 2040. Technology breakthroughs could significantly change that projection. Figure 4.9. refers to sectors within the fossil fuel business.

Figure 4.9: The Actors Within Fossil Fuel Business



(Source: EIA, 2015)

In 2015, the renewable share of energy consumption in the United States was at its most significant since the 1930s at nearly 10 per cent. The most considerable growth in renewables over the past decade has been in solar and wind electricity generation. Liquid biofuels have also increased in recent years, contributing to the growing share of such energy in total energy consumption. The oil market gradually rebalances, according to the experts and academics, with the current low level of prices boosting demand and dampening supply. Oil demand increases by almost 20 Mb/d over the next twenty years, with growing use in Asia for both transport and industry. Tight oil continues to grow, although at a gradually moderating pace (IEA, 2015).

The continuing reform of China's economy causes growth in China's energy demand to slow sharply. This slowing demand weighs heavily on global coal, which grows at less than a fifth of its rate over the past 20 years. Renewables proliferate, almost quadrupling by 2035 and supplying a third of the growth in power generation. The price of growth of carbon emissions more than halves in relation to the past 20 years. This phenomenon is reflecting gains in energy efficiency and the changing fuel mix. According to experts, emissions continue to rise, suggesting the need for further action (Guo et al, 2016; Howarth, 2018). The uncertainty around the base case is explored in three alternative cases: slower global GDP growth, a faster transition to a lower-carbon world and shale oil and gas having even more significant potential.

4.3.1.8 Economics and Shale Gas

The IEA's 450 Scenario, illustrates a climate challenge, despite the expected reduction in the growth of carbon emissions (Godeke and Hossain, 2012). The base case already witnesses the global energy intensity declining at an unprecedented pace. A fall in carbon intensity matches what the world achieved in 1965-85, when the first cheap oil displaced coal from the fuel mix, and then when nuclear power replaced both oil and coal (Hertwich and Peters, 2009) . For the given projected path of GDP, achieving anything close to the IEA's 450 Scenario by 2035, would require an unprecedented pace of improvement in both global energy intensity and carbon intensity. A meaningful global price for carbon is likely to be the most efficient mechanism through which to achieve these improvements (IEA, 450 Scenario, 2015).

The world has been repeatedly surprised by the strength of U.S. tight oil and UOG throughout the history of oil (Salameh, 2016). Technological innovation and productivity gains have unlocked vast resources of tight oil and shale gas, causing analysts to revise the outlook for U.S. production successively higher (IEA, 2013). The IEA, in 2013 released a statement that U.S. tight oil was projected to reach 3.6 Mb/d by 2030 (IEA, 2013), a level that was surpassed in 2014. After a brief regression in the industry, due to low prices and falling investment, U.S. tight oil production is now expected to plateau in the 2030s at nearly 8 Mb/d, accounting for almost 40 per cent of total U.S. oil production. U.S. UOG is expected to grow by around 4 per cent p.a. over the next twenty years (IEA, 2013). Low prices allow U.S. UOG to account for approximately three-quarters of total U.S. gas production in 2035 and almost 20 per cent of global output. The past surprises in the strength of the shale revolution, underline the considerable uncertainty for the rest of the O&G products.

4.3.1.9 Features and Benefits of Shale Gas

In South Africa, where energy security is acute, the proposal to extract, raised a myriad of views (Glazewski, 2016). Natural gas features prominently in most national energy portfolios, for the benefit of transport and a lower carbon footprint than coal, and is regarded as the most critical bridge towards the transition to renewable energy. Given the geography of the Karoo, South Africa, the usage of UOG is more easily distributed to industries. It would be too costly for residential use as the larger cities are too far from the fracking sites. Usage in the sector alone would allow the clean-burning properties of UOG, and would make a marked impact on the levels of emissions into the atmosphere during the usage phase (Green, 2016). Given the volatility of O&G prices, as well as the gradual switch to renewable energy forms, the viability of UOG and oil exploration comes under scrutiny, due to the potential environmental hazards (Green, 2016).

UOG extraction through the use of the hydraulic fracturing technique is considered new and risky. Since 1947, the method of hydraulic fracking, been used on more than 2 million wells drilled mainly in conventional petroleum systems. (Glazewski & Esterhuyse, 2016). The factory-style of using the technique and extracting the gas by the use of proppants which are a mix of water, sand and other additives is new and has been drilled into more than 700 000 wells over the past ten years (Maugeri, 2013, Glazewski & Esterhuyse, 2016). The question of the safety of hydraulic fracturing and the methods of extraction using proppants has been debated. It is widely accepted by many parliaments that the technique is safe, as are the safety issues around the implementation of the associated processes (Du Toit, 2016).

This research compels South Africa to carefully consider energy options of the future, based on the questions which are posed by Esterhuyse *et al.* (2016), arising primarily from the uncertainties of environmental factors such as water, seismic activities and emissions of GHGs during the fracking process. UOG is seen as a stepping stone towards renewable energy forms and the South African government in 2005 pointed towards a gas, coal and renewables future towards 2030 (CEF, 2018; Glazewski, 2016).

4.3.2 Energy Options for South Africa

The climate change agenda is driven by the need to reduce carbon and global warming. Economic development in developing markets sees the dominance of coal usage and the situation in South Africa, is currently no different. This research discusses energy choices before discussing the financial viability. This allows a sober view understanding of the path towards cleaner, cheaper and sustainable energy.

4.3.2.1 Increased Demand for Energy

Today, fossil fuels power the global economy. Fossil fuels provide around 60 per cent of the growth in energy and accounting for almost 80 per cent of total energy supply in 2035. This is a decline from 86 per cent in 2014 (IEA, 2016; Wakeford; 2016). Gas is the fastest growing fossil fuel at 1.8 per cent p.a. The share of gas in primary energy is gradually increasing. Oil grows steadily at 0.9 per cent p.a., although the trend shows a decline in its share. The combined increase of oil and gas predicted for the next twenty is similar to the past 20 years. By contrast, coal suffers a sharp reversal in its fortunes. After increasing its share since 2000, the growth of coal is projected to slow sharply at 0.5 per cent p.a. By 2035, the percentage of coal in primary energy is expected to decrease to an all-time low, with gas replacing coal, as the second-largest fuel source (IEA, 2016).

Among non-fossil fuels, renewables, including biofuels, increase at 6.6 per cent p.a. This causes the share in primary energy to rise from around 3 per cent in 2015 to 9 per cent by 2035 (Herleman and Weber, 2017; IEA, 2013). More than half of the increase in global energy consumption is used for power generation. As the long-run trend towards universal electrification continues, the share of energy used for power generation rises from 42 per cent in 2019 to 45 per cent by 2035 (IEA, 2019). Almost a third of the growth in power generation takes place in currently non-electrified regions (IEA, 2013). Power generation is the primary sector where all fuels compete and so it plays a significant role in the evolution of the global fuel mix. The sector, since 2013, has witnessed an increase, of renewables and gas, gaining share relative to coal (IEA, 2013). The outcome is a more balanced and diversified portfolio of fuels for power generation. The percentage of coal declines from 43 per cent in 2014 to around a third in 2035. In contrast, the share of non-fossil fuels increases, reaching nearly 45 per cent by 2035 (IEA, 2013).

4.3.2.2 Energy to Power Plants and Logistics

Fossil fuels remain the dominant source of energy powering the global economy, providing around 60 per cent of the growth in energy and accounting for almost 80 per cent of total energy supply in 2035. However, a super-power like the U.S. illustrates a decline in coal usage in 2018, being the lowest in 39 years (IEA, 2019). This is a decline of 28 per cent since 2005 (Wakeford, 2016; IEA, 2019). Gas is the fastest growing fossil fuel (1.8 per cent p.a.), with its share in primary energy gradually increasing (IEA, 2018). Gas (through shale exploration) is a wildcard, which has manifested since 2012. Crude oil grows steadily (0.9 per cent p.a.), although the trend shows a decline in its share. The combined increase of oil and gas over the next twenty years is similar to the past 20 years.

4.3.2.3 The Fuels Market

The oil market gradually rebalances with the current low level of prices boosting demand and dampening supply. Global liquids demand (oil, biofuels, and other liquids) is forecast to increase by around 20 Mb/d, to reach 112 Mb/d by 2035 (IEA, 2018; personal interview with Rompannen, 2017). All of this increased demand comes from emerging economies, with China and India accounting for over half of the increase. By contrast, oil consumption in OECD economies continues its decline (-5 Mb/d). Non-OPEC supply accounts for the majority of the supply increase, growing by 11 Mb/d, while OPEC increases by 7 Mb/d. All of the net increase in non-OPEC supply comes from the Americas; U.S. shale, Brazilian deep-water and Canadian Oil Sands (Rompannen, 2017).

4.3.2.4 The Vehicle Parc

The growth in the global consumption of liquid fuels is driven by commercial road transport (CRT). CRT mainly services public transport and industries, accounting for almost two-thirds of the increase. The growth in transport demand reflects rapid increases in vehicle ownership in emerging economies, only partially offset by sustained gains in vehicle efficiency, which slows the sector's growth after 2025. Transport fuel continues to be dominated by oil at 88 per cent in 2035 (IEA, 2013). The share of non-oil alternatives increases from 7 per cent in 2014 to 12 per cent in 2035, with natural gas the fastest growing transport fuel at 6.3 per cent p.a. The other primary source of demand growth for liquid fuels is industrial use, which is the fastest growing source of demand. Growth in the industrial use of oil is aided by the relatively limited scope for efficiency gains and fuel switching. Moreover, over 40 per cent of the oil used in industry, is not combusted and so is less affected by climate policies.

The vehicle parc towards 2055 shows rapid growth. The global vehicle fleet consisting of commercial vehicles and passenger cars more than doubles towards 2035, from around 1.2 billion in 2018 to 2.4 billion by 2035 (API, 2018, EIA, 2018). Almost all of that growth comes from emerging economies. The non-OECD vehicle fleet more than triples from about 0.5 to 1.5 billion over the next twenty years, overtaking the OECD in the early 2020s. Growth in mature economies is much slower, as markets such as the U.S. and Japan are close to saturation levels, in terms of vehicle ownership. The efficiency of the vehicle fleet increases substantially over the next twenty-year period, improving by 2-3 per cent p.a. It is compared with 1.5 per cent p.a. over the past decade.

As a result, in 2035, an average passenger car is expected to achieve 50 kilometres per 5 litres, compared with only 30 kilometres per 5 litres today (API, 2015). Global liquids supply expands by nearly 19 Mb/d by 2035, led by growth in non-OPEC supply. U.S. shale (crude and NGLs), tight oil, Brazilian Deepwater, Canadian Oil Sands and biofuels together grow by 16 Mb/d, accounting for around half of non-OPEC production in 2035. It is assumed that OPEC acts to maintain its market share of around 40 per cent, increasing output (crude and NGLs) by 7 Mb/d to 44 Mb/d by 2035 (Salameh, 2015).

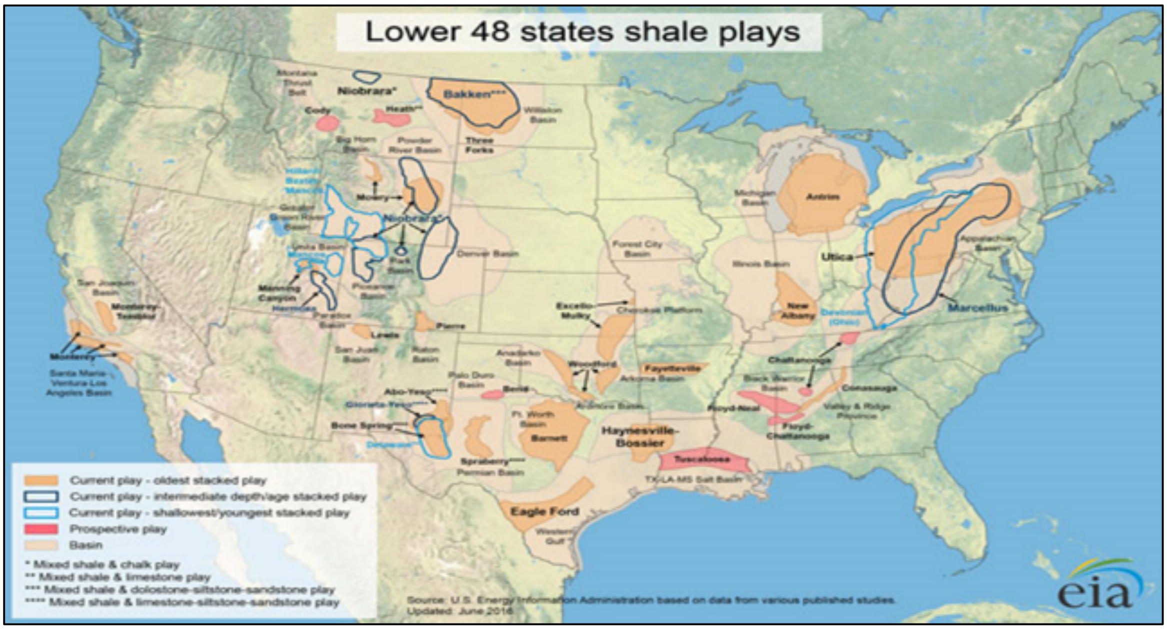
The low oil price globally of 2014 - 2016 adversely affected the shale industry in the U.S. For the U.S. shale industry to re-gain its buoyancy, an oil price of around USD 80.00 per barrel of oil is required (Salameh, 2015). Therefore, the breakeven price for profitable extraction of natural gas from a dry shale well is estimated at USD 5.00/ MMRTU. In October 2013, the spot price was already one and half times below this critical threshold (Lu and McElroy 2013). UOG momentum can only be sustained, if crude production were to drop, which will ultimately cause the prices to adjust.

By 2016, Saudi Arabia, continued to produce even at the oil price of USD 30 per barrel, providing a cheaper alternative to UOG for the U.S. domestic market. In a meeting with the German partners, in Berlin 2014, the Saudi Oil Minister said that Saudi Arabia could balance its budget and continue to sustain itself even if the global price of oil were to drop to USD 20.00 per barrel (Salameh, 2013). The South African government is on the brink of awarding the licences for developers to explore, and indicators point to the start of the pilot activity. Developers such as Shell believe that real exploration will not commence before 2022. The South African government believes that development and exploration of UOG would not only lead to the re-vitalisation of the ailing mining sector but would also be an overall economic game-changer in the South African economy and advance the country's position in the African continent (SONA, 2017).

The UOG extraction business case for South Africa along with other governments reference the U.S. numbers extensively when assessing business assumptions (Steenkamp & Glazewski, 2016). Shale oil and natural gas resources are found in shale formations that contain significant accumulations of natural gas and oil. The Barnett Shale in Texas has been producing natural gas for more than a decade. The information gained from developing the Barnett Shale provided the initial technology template for developing other shale sites in the United States (Steenkamp & Glazewski, 2016).

Another famous UOG play is the Marcellus Shale in the eastern United States. While the Barnett and Marcellus formations are well-known UOG plays in the United States, more than 30 U.S. states overlie shale formations. Within an individual shale play, geophysicists and geologists identify suitable well locations in areas that have the most significant potential to produce commercial volumes of natural gas and oil. Well location areas are identified using rock core samples while, geophysical and seismic technologies generate maps of the subsurface hydrocarbon resources in a shale formation. Figure 4.10 refers to the main plays in the U.S.

Figure 4.10: U.S. UOG Plays



(Source: EIA, 2017)

4.3.2.5 Shale Gas, Tight Natural Gas, and Tight Oil

The oil and natural gas industry generally distinguish between three categories of low-permeability formations:

- Shale gas
- Tight natural gas
- Tight oil (can be produced from shale or other low-permeability reservoirs).

4.3.2.5.1 Shale Gas

Large-scale natural gas production from shale began around 2000 when UOG production became a commercial reality in the Barnett Shale located in north-central Texas (EIA, 2008). The production of Barnett Shale natural gas was pioneered by the Mitchell Energy and Development Corporation. During the 1980s and 1990s, Mitchell Energy experimented with alternative methods of hydraulic fracturing in the Barnett Shale. By 2000 the company had further developed the hydraulic fracturing technique that produced commercial volumes of shale gas.

As the commercial success of the Barnett Shale became apparent, other companies started drilling wells in this formation so that by 2005, the Barnett Shale was producing almost half a trillion cubic feet (TCF) of natural gas per year (EIA, 2008). As natural gas producers gained confidence in Barnett Shale, with additional confirmation provided by well results in the Fayetteville Shale in northern Arkansas, producers started developing other shale formations, including Haynesville in eastern Texas, northern Louisiana, Woodford in Oklahoma, Eagle Ford in southern Texas, and the Marcellus and Utica shales in northern Appalachia (Krupnick & Wang, 2013).

4.3.2.5.2 Tight Natural Gas

The identification of tight natural gas as a separate production category began with the passage of the Natural Gas Policy Act of 1978 (NGPA), which established tight natural gas as a separate well-head natural gas pricing category and that was permitted to obtain unregulated, market-determined prices (IEA, 2013). The tight natural gas category was designed to give producers an incentive to produce high-cost natural gas resources when U.S. natural gas resources were believed to be increasingly scarce.

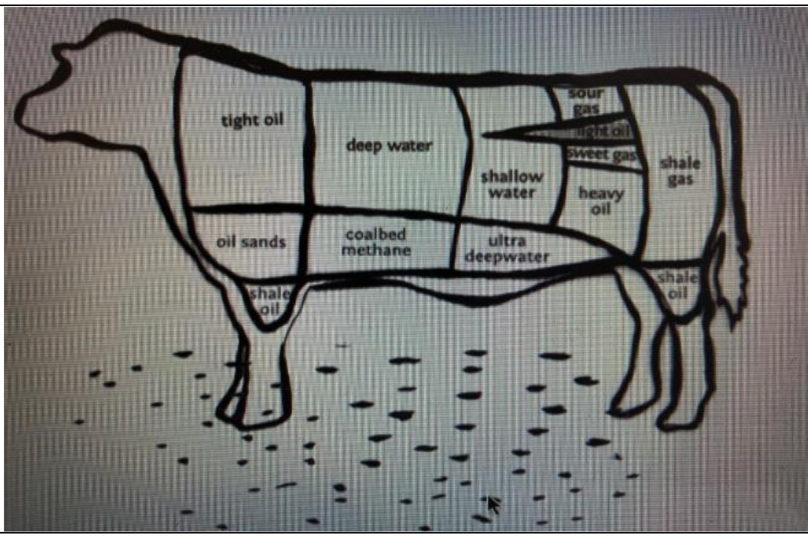
4.3.2.5.3 Tight Oil

In the United States, the oil and natural gas industry typically refer to 'tight oil' production rather than shale oil production. The industry uses the term 'tight oil production' because it is a more encompassing term concerning the different geologic formations producing oil at any particular well. Tight oil is produced from low-permeability sandstones, carbonates (e.g. limestone), and shale formations. The oil and natural gas industry's colloquial use of the term 'tight oil' is rather recent and does not have a specific technical, scientific, or geologic definition (Stephenson, 2015). The U.S. Energy Information Administration (EIA) adopted the term 'tight oil' to refer to all resources, reserves, and production associated with low-permeability formations that produce oil, including that associated with shale formations. Figure 4.11. illustrates all the sectors of the oil and gas extractive business.

4.3.3 The Economy and the Emergence of Gas as a Global Energy Source

At the latest presentation held in New York, in November 2018, The IEA presented the latest Five-Year Gas forecast at a special meeting convened at Columbia University (IEA, 2018). The meeting was deemed as a watershed, as for the first time, it was accepted that after the discovery of shale and the America successes over the past decade, gas could emerge as a wildcard and permanently upset the crude industry and OPEC in general (IEA, 2018). Therefore, oil and gas are separated as the financial implications differ vastly; moreover, legal frameworks and institutions also differ.

Figure 4.11: The Petroleum Cow



(Source: Oil Contracts, 2015)

The portions of these resources that become economically recoverable in the future will depend on crude oil and natural gas market prices, as well as the capital and operating costs and productivity within the countries. Each of the states has an existing oil and natural gas industry with infrastructure connecting the basins to global markets. All current production of oil and natural gas in Chad, Kazakhstan, Oman and the UAE is from non-continuous resources such as from high-permeability formations (Stephenson, 2015).

Technical requirements in shale assessment refer to the return on the energy invested (EROI); shale infrastructure, human capital or capacity and a national set of scientific instruments. Technically, recovered reserves (TRR) are often mentioned and this refers to the technical requirements which will make the gas a positive contributor to the South African economy (Wakeford, 2016). The EROI ratio is the first consideration and means that the amount of energy eventually delivered to consumers must be more than the energy used in the process of production. The second is the considerable amount of infrastructure that is required to extract, store and transport or transform shale gas, including access roads, trucks, storage tanks and pipelines to deliver the energy to the market (Wakeford, 2016). The third requirement is the specialised expertise and national scientific instruments, skills and knowledge (De Wit, 2011; Wakeford, 2016). According to an expert geologist,

…there is the existence of no integrated groundwater and gas units in South African institutions nor national and provincial agencies that can test if fracking products are entering the subsurface water reservoirs and affecting public health (De Wit, 2011, p.7).

The U.S. is the reference point for most debates on hydraulic fracturing. The U.S. provides the case study for successes and failures, and as the world faces an energy crisis, developing countries in the quest to industrialise, search for cheaper and greener energy solutions (personal interview with Van Asselt, 2017; personal interview with Talus, 2017). In the U.S., more than half of the country's industries and homes are heated by natural gas. Cheap gas in abundance is of general benefit to electrical utility customers as power suppliers substitute gas for coal to fire the generators (Lu and McElroy, 2013).

Natural gas is used as an industrial energy source in manufacturing products ranging from steel and glass to paper and clothing. Natural gas is also a raw material for fertiliser, paints, antifreeze, dyes, photographic film, medicine and explosives (Lu and McElroy, 2013). By 2007, 10 per cent of the U.S. market was supplied by domestic natural gas, and this figure rose to almost 30 per cent by 2010 (Lu and McElroy, 2013; Krupnick & Wang 2013). The spot price for natural gas on the New York Mercantile Exchange hit a record low of US$1.82 per million British thermal units (MBTU) which was down 86 per cent from a high of US$ 12.69 in June 2008 (EIA, 2013; Lu and McElroy, 2013).

Production and consumption of natural gas in the U.S. were approximately in balance up to 1986. The following twenty years saw a lag in production while the deficit was made up by imports from Canada by pipeline deliveries. Lower-priced natural gas had significant consequences for the U.S. economy and the rest of the global markets. Japan was an eager purchaser given the wholesale closure of its nuclear electric generating capacity in the wake of the Fukushima earthquake, a spate of tsunamis and the power-plant crisis in March 2011. Perspectives on oil and gas exploration and development are predominantly long range.

China remains the world's largest coal market, consuming almost half of global coal supplies in 2035 (Hao, Zou, Lu, 2013; Guo, Wang and Wang, 2016). Followed by China, India shows the most substantial growth in coal consumption (435 Mtoe), overtaking the U.S. to become the world’s second-biggest consumer of coal (IEA, 2018). Coal demand is projected to fall by more than 50 per cent in both the U.S. and OECD Europe, driven by plentiful supplies of gas, the falling cost of renewables and stronger environmental regulation. Both hydroelectric and nuclear energy is projected to increase steadily, growing at 1.8 per cent p.a. and 1.9 per cent p.a. respectively (IEA, 2014; Du Toit, 2016). The period of unprecedented growth of hydropower in China is coming to an end as China's hydropower sector is expected to grow only at 1.7 per cent p.a. over the next twenty years compared with almost 10 per cent p.a. over the previous two decades (Du Toit, 2016; Guo, Jiang and Liang, 2016).

Brazil sees the second most significant increase in hydropower (after China), overtaking Canada to be the world’s second-largest hydro producer (Du Toit, 2016). China’s nuclear output increases rapidly at 11.2 per cent p.a. over the next twenty years, a faster pace of growth than China’s hydropower over the past 20 years and then more than doubles by 2020 and increasing nine-fold by 2035. Nuclear output declines in the E.U. at a negative growth of minus 29 per cent, with North America following at minus13 per cent, as ageing plants are gradually decommissioned and the economic and political challenges of nuclear energy stunt new investments. Japanese reactors are expected to restart over the next five years to reach 60 per cent of the 2010 levels by 2020. In Japan, nuclear power is expected to play an even more prominent role in the future (De Almeida, 2009). While the Indian government continues to emphasise poverty alleviation and economic development as the country's highest priorities, recent stances on domestic emission reductions, indicate that India is taking significant steps to encourage more constructive global climate talks (Da Costa, 2016).

4.3.4 UOG Usage in South Africa

In South Africa, UOG extraction could be beneficial for many reasons (Fakir and Davies, 2016; Darrah et al, 2018). The country faces an energy crisis as its current demand outstrips supply. MossGas is at 50 per cent capacity as feedstock is in short supply (Wakeford, 2016). UOG could very well be a short-term solution for South Africa's energy problems. Eighty-five per cent of the nation's electricity currently originates from coal (CEF, 2018; IGAS, 2018; SAOGA, 2018). The alternative to coal would be cleaner-burning shale gas (CEF, 2018; IGAS, 2018; SAOGA, 2018).

Wakeford (2016) summarises the prioritised usage for shale gas within the energy mix:

- The most sensible use of UOG would be as feedstock for electricity and these turbines would be situated in the Karoo near existing pipelines to avoid the costs of new infrastructure.
- The second would be for industrialisation, i.e. as a petrochemical feedstock and which will require new, expensive pipelines from the Karoo to the industrial heartland of Gauteng. Alternatively, industries would need to be located in the Karoo, closer to the source. Residential consumption is unlikely as the large cities are too far from the Karoo.
- The third usage would be for PetroSA’s Mossel Bay GTL plant which is currently operating at 50 per cent capacity due to feedstock constraints.
- Table: 4.1. refers to an assessment of land mass and quantity of fluids required for successful drill.

Table:4.1: Estimates Based on the JD Hughes Drilling

Impact Type	Units	Per Well	Total for 20 TCF
Land footprint	Hectares	1	12 800
Water Usage	Million litres	20	256 000
Fracking Fluids	Million litres	0.1	1280
Sand	Cubic meters	1900	24 320 000
Truck Trips	Number	10 000	128 000 000

(Source: De Wit, 2011, p.8)

4.4 PART THREE: THE SHALE BUSINESS CASE

In an attempt to answer the economic question, the research attempts to construct a rudimentary business case to assess the economic feasibility. The following reports which informed decision-making in other jurisdictions have been consulted. The Hedden *et al*, report (2012), the work conducted by the Institute of Security Studies in association with the Frederick Pardee Institute as well as the Belfer Centre at Harvard, provide a rudimentary business case to ascertain the economic size of the shale prize.

4.4.1 The Economic Question

A report prepared by Wait and Rossouw (2012) concludes that according to Vermeulen (2012), 390 trillion cubic feet (TCF) of UOG is technically recoverable and, furthermore, many global studies have exaggerated the level of extractable resources (Wait and Rossouw, 2019). Kinnaman (2011) and Regeneris Consulting (2011) prepared a report for Lancashire and the United Kingdom stating that the economic benefits outweigh the costs of UOG extraction and note that lesser emphasis was placed on the environmental damage such as the consequences of earthquakes in the future. These consequences, coupled with the levels of GHG emissions, remain unknown and to environmentalists are the critical uncertainties that shale presents.

Ames et al. (2012) conducted a cost-benefit analysis for the U.S and concluded that the economic benefit outweighs the extraction costs (Wait and Rossouw, 2019). The Econometrix Report (2013), while attempting to provide some economic indicators, does not take into account the environmental impact. Therefore, it does not provide insightful information on which policy-makers can base any assumptions (Wait and

Rossouw, 2019). The report is based on insights from the U.S. and Lancashire, both of which have a legacy of oil and gas explorations, and established downstream infrastructure in place. South Africa, on the other hand, while steeped in mining, does not have oil and gas extractive experience and does not possess the necessary pipeline infrastructure (Wait and Rossouw, 2019). Table: 4.2 refers to a snapshot of the literature which informed this section.

Table 4.2: Table of Economic Reports on UOG Economic Feasibility

SOURCE	MAIN INSIGHT
Hedden *et al*, Report (2012) in collaboration with the Institute of Security Studies, Africa, the Frederich Pardee Institute and the Belfer Institute at Harvard University	Quantification of TCF to a barrel of crude
Wait & Roussouw Report, (2019)	Business case for UOG extraction in the Karoo, South Africa
The Econometrix Report (2013) Commissioned by Shell Oil Company, South Africa	Overview of the societal and economic benefits
Considine et al, Report (2009) for the Marcellus Region	Profitability
The Keystone Research Centre Report (2013) commissioned by the Pennsylvania Budget Policy Centre	Multi-state research collaborative
Regeneris Consulting Report (2012). Commissioned by Lancaster, UK	Job creation: Local and national
The McKay and Stone Report, (2012). Commissioned by the UK Government	Governance
The Royal Society Report (2012). Commissioned by the UK Government	Safety of UOG extraction
The White Paper, British Water (2016). Submitted to the UK Government	Socio-economic impacts of water in UOG extraction

(Source: Researcher's Construction, 2019)

The research in the following sections attempts to unravel the game-changing potential and the positive impacts on society and the economy. Table 4.3 refers to an indication of the manpower required to administer an average well, citing a U.S example. U.S. and English consumers are confident unlike South Africans (Wait and Rossouw, 2019).

Table 4.3.: Example of Manpower Required in an Oklahoma Well

POSITION	NUMBER OF EMPLOYEES
Financiers, accountants, lawyers arranging funding, preparing contracts	4
Land men, geologist, surveyors, seismic experts involved in well location	6-8
Labourers, dozer operators in location preparation	4
Personal staff during drilling-company man, mud logger, pet. engineer	3
Mud company-mud programmer	1
Drill bit engineer	1
Special tool contractor	1-3
Drilling rig contractor with 3-4 shifts of workers (18 minimum) plus tool pushers (2)	21
Completion drilling unit	6
Production string supply	2-4
Casting Crew	6
Fracking compression truck drivers	20
Fracking water truck drivers	20
Fracking sand truck drivers	20
Tank site construction and hook –up	6
Road construction and maintenance crew	2
General Admin	3

(Source: Wait & Rossouw, 2019).

Table 4.4 provides the financial data for evaluation by way a conservative approach of 20 TCF and 50 TCF. Table 4.4 illustrates the Econometrix calculations using 2012 prices.

Table 4.4: Econometrix Calculations Based on 2013 Price

	0% of gas exports		50% of gas exports		100% gas exports	
Combines upstream and downstream	Scenario A 20 TCF	Scenario B 50 TCF	Scenario A 20 TCF	Scenario B 50 TCF	Scenario A 20 TCF	Scenario B 50 TCF
Projected turnover (Rm)	4 031 773	9 520 268	3 069 827	7 115 402	2 107 881	4 710 537
Expected value added (Rm)	2 006 046	5 015 116	1 587 263	3 968 158	1 168 480	2 921 200

	0% of gas exports		50% of gas exports		100% gas exports	
Projected revenue (Rm)	886 808	2 223 494	705 894	1 771 208	542 979	1 318 922
Maximum employment	355 817	854 757	258 880	612 415	161 943	370 073

(Source: Econometrix, 2013).

The Econometrix Report (2013) used data from the Marcellus region to develop the figures above. However, based on the report by Considine et al., (2009), using the IMPLAN input-output model, the researcher by applying precise calculations, was able to deduce the rates of taxes that Federal Government received in 2008-2009. An estimate for income tax on the employed (average salaries of USD 82 000.00 per annum was assumed).

Given the challenges of UOG extraction and the potential hazards associated, the labour figure will vary drastically from one jurisdiction to the other. These figures are consistent with those critics who claim that the oil and gas sectors fail to meet tax obligations as outlined in a report by the Multi-State Research Collaborative conducted by Pennsylvania Budget Policy Centre in 2012 (Keystone Research Centre, 2013). It appears from the figures above, that the U.S. Federal Government collected an average of approximately 10.5 per cent in corporate taxes. In South Africa, the discussion in 2012 related to 22 per cent, which was revised to 18 per cent in 2016 (SAOGA, 2018). According to one of the panels of experts, the current discussion is around 10 per cent, which appears to be in line with the U.S. tax bracket. The reasons stated for the decrease from the 22-18 per cent mark is that the extractable reserves remain undetermined. Table 4.5. refers to the early successes of the Marcellus region, which was most sceptical of the extraction.

Table 4.5: The Economics of Marcellus Shale (2008 – 2009)

Year	Estimated Added Value USD Billion	Corp. Tax paid to State	Number of Jobs	State Taxes %
2008	2.3	240 000 000 000	29 000	10.43
2009	3.8	400 000 000 000	48 000	10.53

(Source: Researcher's Construction using Wait & Roussouw 2012 data)

Reserves have been historically undetermined, and this is the reason for concern, as pointed out by De Wit (2015) at a presentation at the AEON Centre at the Nelson

Mandela University (De Wit, 2015). In 2010, the Considine (2010) report conducted a further study on the Marcellus and noted that the job figures saw a significant decline (Considine *et al,* 2010). Table 4.6 refers to creation of jobs in the region.

Table: 4.6: The Job Creation Impacts of Marcellus Shale (2008 – 2009)

Year	Est. Added Value USD Billion	Jobs Created	State Taxes %
2010	3.8	44 098	10.40

(Source: Researcher's Construction using Wait & Roussouw 2012 data)

The Econometrix Report (2013) used the exchange rate of R7,49, and this research exercise used the current ZAR – USD rate of R15.00. The forex difference indicates the 100 per cent increase in value. Table 4.7 below illustrates the effect of retaining the resource and developing the economy. The latest available estimates of shale extraction in the U.S., according to Goldman Sachs (2019), is that the U.S. will be energy independent in 2019, ahead of the predictions of Salameh who stated that the U.S. will only be energy independent in 2022 and then become an exporter of energy in 2025 (Salameh, 2015). The researcher, however, has conducted a separate exercise which has been verified with the experts and PwC. The following results have been processed, based on the new price of shale TCF (2018) expressed as an equivalent to a barrel of oil at USD 62.00 (2018). To generate the highest numbers of jobs, shale should be explored and used domestically, with more tasks being realised in the value chain. Refer to Table: 4.7 below also provides a snapshot of expected employment.

Table 4.7: Potential Karoo Shale Sector Employment

	0% of gas exports		**50% of gas exports**		**100% of gas exports**	
Combines upstream and downstream	Scenario A 20 TCF	Scenario B 50 TCF	Scenario A 20 TCF	Scenario B 50 TCF	Scenario A 20 TCF	Scenario B 50 TCF
Projected turnover (RM)	8063546	19040536	6139654	14230804	4215762	9421074
Expected value added (RM)	4012092	10030232	3174526	14285368	2336960	5842400
Projected government revenue (RM)	13458416	4446988	10305764	3542416	1049958	2637844

	0% of gas exports		50% of gas exports		100% of gas exports	
Maximum employment (Number)	355 817	854 757	258 880	612 415	161 943	370 073

(Source: Researcher's Construction using Wait & Roussouw, 2012 data)

The following exercise is a rudimentary attempt by this researcher to quantify the size of the prize of the UOG of the Karoo, South Africa. This exercise attempts to measure the net additional revenue from the shale exploration to Treasury. It is noteworthy to mention that renewable energy does not provide this game-changing option, as renewable energy in the South African context attempts to replace coal. The argument for shale as part of the future energy mix of South Africa is that shale is a cleaner burning fuel and can live alongside renewable energy, and both can replace coal. Furthermore, shale has a significant advantage. The additional revenue from shale can assist the economy to fast track renewable energy in South Africa, not only in the Karoo but in the entire country.

The Belfer Centre for Science and International Affairs at Harvard University (2012), in association with the Institute of Security Studies in South Africa (2012) solved an important problem in quantifying one TCF of UOG to a barrel of crude oil (Hedden *et al.,* 2012). Using the Wait and Roussouw 2012 data, and applying the current forex rate, the researcher was able to arrive at a rudimentary business case, which South Africans are able to understand. Table: 4.8 below refers to calculations of the researcher.

Table 4.8: The Karoo Shale Business Case

Value calculations for the size of the shale exploration in the Karoo, South Africa				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
TCF	40	120	n/a	496
Into barrels	1700000	1700000	n/a	1700000
USD	USD 68 000 000	USD 204 000 000	n/a	USD 843 200 000
Rands	R 81 600 000 000.00	R244 800 000 000.0	n/a	R1011 840 000 0 00.00
SA GDP	USD 250, 600 000 000			

Value calculations for the size of the shale exploration in the Karoo, South Africa				
	Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
	SA GDP realised in 3 years	SA GDP achieved in 8 months		SA GDP exceed by 3.37 times
Fiscal Benefit @ 20%	USD 13 600 000	USD 40 800 000		USD 168 640 000
Net revenue to Developer @ 33.3%	USD 22 666 667	USD 68 000 000		USD 281 066 667
Supply Chain	USD 31 280 000	USD 93 840 000		USD 387 872 000
Fiscal and Supply Chain	USD 44 880 000	USD 134 640 000		USD 556 512 000
Real Economic Benefit/GDP	18%	54%		222%

(Source: Researcher's Construction using Wait & Roussouw 2012 data)

Table 4.9. explains the broad assumption and the indicators for the business case. These indicators may be used to arrive at quick calculations for the various scenarios. For example, in Scenario one, gas is not fully exploited and experiments with only 40 TCF. Scenario Two starts the extraction and the resource is not fully utilised and extracts only 120 TCF realises the GPD in 8 months, whereas, a focused, well-executed approach which considers the environment and human issues, yields 496 TCF, exceeds the SA GDP by 3.37 times or 222%. From this standpoint, these rudimentary calculations, allows for sound policy and decision making.

Table 4.9: Table explaining Assumptions to Table 4.8.

Indicators	Actuals
SA GDP	USD 250.6 billion
Forex	USD 1.00 = R15.00
License Agreement Fees	20% of turnover
Developer ROI	33.3%

A study prepared by Regeneris Consulting (2012) for Lancashire makes useful projections for the creation of jobs in the UOG sector over the period 2013-2032. The net effect of job creation was not only felt in the region of the exploration, but throughout the UK. In reality, the total number of jobs created around the UK is projected higher than for the UOG extraction region. Table 4.10 refers to the lower case, central case and the high case (scenario 1; scenario 2 and scenario 4 in this case) and the incremental employment opportunities on national and regional basis.

Table 4.10: Employment Opportunities in the UK. (National vs Regional)

	No. of Wells	Extraction Period	Jobs to the UK	Jobs to Lancaster
Lower Case	400	Nine years	3400	560
Central Case	190	Six years	5600	1700
Higher Case	810	16 years	6550	2500

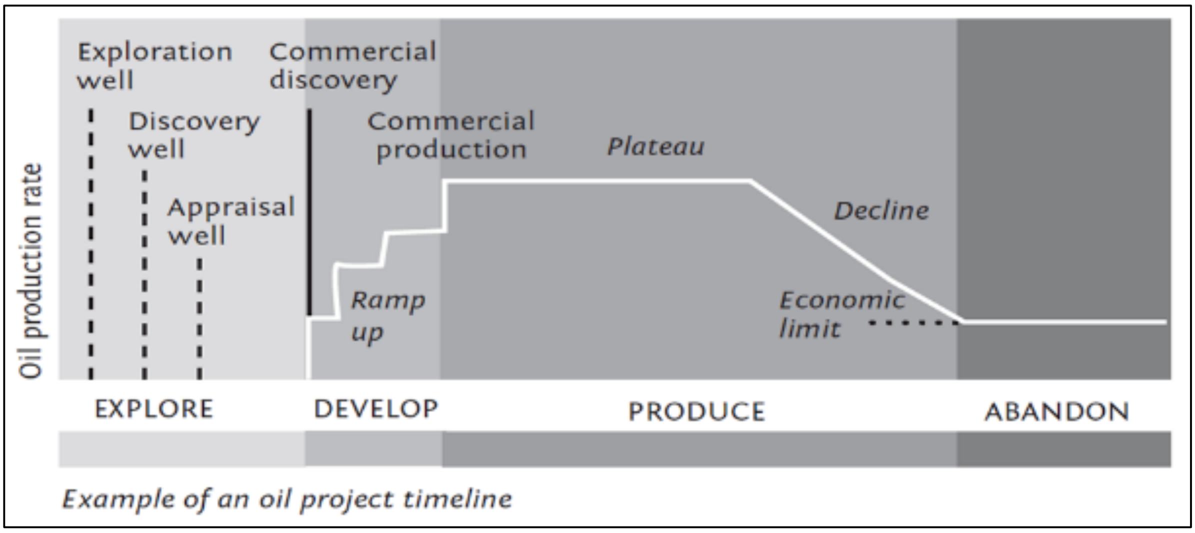
The Regeneris report (2012) concludes that the benefits exceed the costs to the community by 400 to 1. The research provides various examples or revenue with an impact on the United Kingdom's GDP. There have been fiscal benefits to the U.K. economy, in terms of the taxes and the growth of jobs. Lancashire projections illustrate that job creation does not only take place in fracking areas. The rest of the country also showed increases. However, the question, which will be addressed in Chapter Five, remains open: For whom, is it a game-changing opportunity and what are net impacts on the environment?

4.4.2 Petroleum contracts

The interpretation of laws and regulations can also differ from country to country, and for a global developer like Shell there is a choice of governments with whom the corporate may want to invest. With the shale licences not yet handed to developers, this research questions the use of other modern forms of petroleum contracts not being considered for the UOG extraction, in the Karoo, South Africa (Gard & Kitson, 2015, Burton *et al*., 2019; Van Asselt, 2017). Shabangu (2012) made the first announcements of UOG extraction in the Karoo and of the South African Government's proposed licence agreements with IOCs. The message was re-enforced at the SONA, 2014 (Shabangu, 2014). This research has investigated the new petroleum contracts which take the form of predominantly three types of agreements.

The first group can be categorised as licence and royalty agreements, production sharing agreements, petroleum sharing agreements. The second is categorised as concessions, exploration and exploitation contracts. The third is classified as service contract agreements (Wurstenburg, 2017; UEF Class Lectures, 2017) There are numerous ways in which governments can be rewarded using different fiscal tools. Payments can be made to the government at the various stages of the lifecycle of the exploration, and Figure 4.11 refers to the lifecycle of production.

Figure 4.11: Lifecycle of Exploration



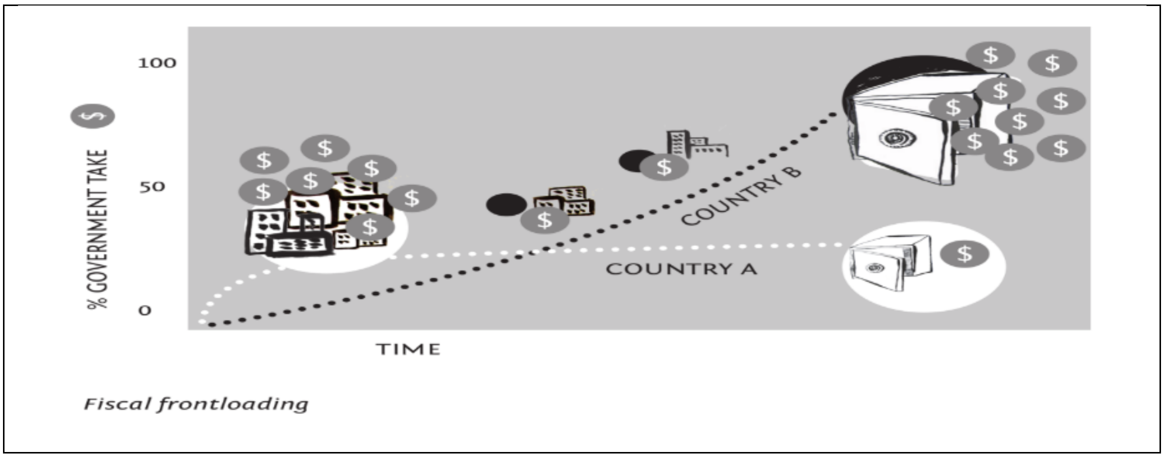
(Source: Oil Contracts, 2015)

Throughout the oil project timeline, governments are entitled to earnings. States and IOCs have many options at the various stages of the exploration, to share the value of oil and gas projects, which are referred to by the industry as 'tools' (Oil Contracts, 2015). However, tools vary with the following agreements. The fiscal regime of concessions, production-sharing contracts and participation agreements have one commonality. Each of them defines payment made to the government and the IOC retains the balance. Therefore, fiscal tools of these types of contracts include signature bonuses, production bonuses, rental, royalty, corporate income tax, profit share, state participation, other profit-based taxes, other general taxes such as import duty, sales tax, property tax, excise tax and withholding tax (UEF Class Lecture, 2017; Assiego, 2017).

Therefore, when a government is said to gain, for example, 22 per cent in licence agreements, it is not the total amount but also the various 'tools' which can be paid out at various times, and which could be standard, within the type of chosen contract. Governments self-protect by negotiating upfront payment upon signature. This is a signature bonus and is simply a cheque when the contract is awarded. Figure 4.12, below illustrates that ‘Country A’ could negotiate less, but receive an upfront payment and use it for the development of infrastructure. ‘Country B', on the other hand, could incur more risk and take a higher back-loading fiscal payment. Similarly, clauses detail the liability of the various actors in the agreement at every stage of the exploration. The following is such an example detailing the exploration phase.

The license and royalty agreement that the South African government, currently has on offer to developers were conceived in the formative years of the discussion. The decision-making process was informed by a few cursory visits to the U.S. which were facilitated by the additive suppliers and the developers (personal interview with Jackson, 2017). However, according to the in-depth discussion, regarding the evolution of petroleum contracts, the research questions the continued use of the current agreements (personal interviews with Assiego and Wurstenburg, 2017). Figure 4.12 also refers to various types of payment that developers or IOCs would agree with the governments at the signing of petroleum contracts.

Figure 4.12: Example of Fiscal Loading



(Source: Oil Contracts, 2015)

In an attempt to assess the viability of the various types of contacts, the research in the following sections, studies the use of the various contracts within several jurisdictions, around the world. Figure 4:13 provides information on the “tightness” of the clauses.

Figure 4.13: Example of Exploration Clause in an Agreement

EXCERPT FROM GHANA PETROLEUM AGREEMENT WITH TULLOW, KOSMOS, AND SABRE MARCH 10, 2006:
"Exploration" or "Exploration Operations" means the search for Petroleum by geological, geophysical and other methods and the drilling of Exploration Well(s) and includes any activity in connection therewith or in preparation thereof and any relevant process and appraisal work, including technical and economic feasibliity studies, that may be carried out to determine whether a Discovery of Petroleum constitutes a Commercial Discovery

(Source: Oil Contracts, 2015)

The role of government is to act as a regulator by using command and control mechanisms of a legislative and policy nature. The crucial next role of governments is to provide the necessary infrastructure for international and local investors. In doing so, the government also ensures a distribution network employing a central or de-centralised energy grid which may cost-efficiently distribute services to civil society. The actions of the government have come under sharp criticism for interference in the energy sector and the preferred treatment granted to the BBBEE dealmakers (Burton *et al*., 2019; Newell & Johnston, 2015). Porter's Five Forces framework (1979) is useful tool to analyse the current state of the South African micro-environment, the political economy of the state, the few black local investors and the unions which have a high influence, on maintaining the current *status quo* of coal as primary and dominant fuel to the South Africa energy supply.

The current coal phenomenon existed during the apartheid era, and continued into the new South Africa, providing the same comfort levels for both the investors and the labour unions. The dominant coal economy impacting upon the unions and the labour force, presents a barrier to any new alternative energy forms such as UOG or renewable energy (Burton *et al*., 2019). With roles and responsibilities clearly defined, the various actors are governed by clauses in the final, agreed petroleum contract. Stabilisation clauses, the doctrine of legitimate expectation, the provision of local content clauses and protection of foreign direct investments clauses are all detailed in petroleum contracts and are subject to WTO (1985) principles and other international commercial legal principles. The following examples used by the various markets, illustrate the innovate use of new petroleum contracts, which may be re-negotiated by the various actors. Table: 4.10 refers to the role and responsibilities of the various actors.

Table 4.10: Roles of the Actors in Petroleum Contracts

Stakeholder Obligations	Outcomes
Government Obligations	Revenues Economic Growth Infrastructure development Political Stability Technological Transfer The improved local supply of energy
Developer Obligations	Non-discrimination before the law Stability, legal clarity and certainty Protected investments Competent workforce High return on investment
Civil Society Obligations	Social investment programmes, like hospitals Environmental protection Economic benefits. Like employment Infrastructure like roads and energy grids

(Source: Oil Contracts, 2015)

Concession agreements are quite commonly used as part of the modern petroleum agreements. Figure 4.14 illustrates how Brazil uses the concession agreement.

Figure 4.14: Example of a Concession Agreement

BRAZIL
Type of agreement: Concession
Form of agreement: Model (2001)

In the 1990s, Brazil switched from a joint venture structure to a concession. They created a Concession agreement that addressed the issues of both state and investor, and significant activity and success has occurred off the back of it, both onshore and offshore, with Brazil now talking of joining OPEC one day.

(Source: Oil Contracts, 2015)

Figure 4:15 refers to the production-sharing contract used by Indonesia and Thailand, which in alignment with current policies are useful instruments in protecting sovereign mineral resources. Given the current discourses of the desire for the nationalisation of national resources and land expropriation without compensation, production sharing and contract agreements may be favoured in the South African context.

Figure 4.15: Example of a New Production Sharing Contract

INDONESIA:
Type of agreement: Production Sharing Contract
Form of agreement: Model (1998)

The production sharing form of contract was first developed in Indonesia, and is still used there, although it has evolved significantly from its first use in the 1960s. Indonesia is a long-time oil producing country and has created used many versions of the production sharing contract.

(Source: Oil Contracts, 2015)

Production sharing contracts (PSC) possess a certain degree of risks but nonetheless also possess attractive benefits. PSC are firstly useful at safeguarding sovereign assets and allow for greater transparency, when state and developers keep strict audits (UEF Class lecture: Petroleum Contracts and *Lex Petrolea,* 2018). However, if South Africa were to change from the current license agreements to the PSC, the South African government must remain mindful of what is accepted as 'infrastructure' and would be the departure from this definition. For example, water is generally accepted as an infrastructural provision, but in the case of UOG extraction, where large amounts of water are required, water is regarded as raw material, and therefore should remain the burden on the developer. These 'burdens' in the production sharing agreements may become blurred between governments and IOCs. Given the country's pressure to retain its position as an attractive investment destination, negotiators may relax certain important obligations. Figure 4.16 refers to the case of Azerbaijan, wherein stabilisation clauses are recommended to avoid a similar problem.

Figure 4.16: Example of a Stability Clause.

AZERBAIJAN
Type of Agreement: Production Sharing Contract
Form of agreement: Signed with a consortium of 10 companies headed by BP.

This contract signed in 1994 still governs the largest of Azerbaijan's producing fields and was instrumental in the renewal of production in the country after the collapse of the Soviet Union. Some aspects have aroused controversy in recent years but the government has chosen not to renegotiate to create a sense of business confidence.

(Source: Oil Contracts, 2015)

The assessment of UOG extraction as being an economic game-changer is complex. Given the rudimentary business case provided by this research in this chapter, as well as the review of the various provisions of the petroleum contracts, this research concludes that South Africa, may consider other contracts, apart from the current licence agreements, and these could go far towards managing a myriad of current problems facing the country, such as the retention of sovereign assets and the nationalising of mines.

4.5 PART FOUR: KEY ECONOMIC UNCERTAINTIES AND DRIVERS FOR CHANGE

As an expected economic game-changer, the extraction is likely to impact all sectors of the economy. These impacts provide opportunity to assist South Africa in the transition to sustainable energy futures, which could be the driving force behind large scale economic industrialisation. The following section covers the critical economic uncertainties of economic growth and demand for increased energy.

4.5.1 Economic Drivers for Change

The economic situation in South Africa requires a single, silver bullet (SAOGA, 2017). This bullet is shale, which is expected to the economic game-changer for the economy. Table 4.11 refers to the drivers for change which are influenced by economic growth and an increased demand for energy.

Table 4.11: Key Drivers for Change Driven by Economic Megatrends of Economic Growth and Increased Demand for Energy

Economic Growth 1. Economic modernisation 2. Income growth and distribution 3. Access to finance 4. Constitutional and national legislative frameworks 5. Fiscal transparency 6. Urban planning and policy environment 7. Local content and capacity development 8. Local first and city to city co-operation 9. Stakeholder collaboration: State and non-state actors (private sector, unions, NGOs and civil society) 10. WEF Nexus Approach
Increased Energy Demand 1. Government political will. Climate policy. Energy policy. Economic policy 2. Decentralised or centralised energy model 3. Agreed energy mix or coal-dominated energy supply model 4. Energy mix linked to stakeholders and commercial plan and grid 5. Sound infra-structure: pipelines linked to grid, roads and water 6. Government R&D support 7. Capacity building and development of local SME support 8. Strong government implementation and monitoring support. 9. Strong regulatory frameworks to support the increased energy demand 10. Strong fiscal benefits to support the increased energy demand 11. Strong financial mechanisms to support the increased energy demand 12. WEF Nexus Approach

(Source: Researcher's Construction, 2019)

4.5.1.1 Economic Modernisation

Economic modernisation refers to an upsurge in the economy driven by structured growth factors. Sectorial diversification results in increased manufacturing rather than resource extraction with higher labour productivity enabled by technological advancements and the creation of high-value positions (Henderson *et al*., 2013; personal interview with Inayatullah, at NMU, 2016).

4.5.1.2 Income Growth and Distribution

Income growth and distribution present other economic uncertainties. South Africa has already seen a growth in the middle class over the past twenty-five years. The shale opportunity is likely to produce the same in the Karoo. The African Development Bank (AfDB) defines the African middle class as earners of between USD 4.00 – 20.00 per day (R60 – R300.00), accounting for 13 per cent of the continents' population (AfDB, 2017). Twenty-one per cent earn between USD 2 - 4.00 per day, which is concerning as a slight African recession can push this group back into poverty, joining the 61 per cent who earn below USD 2.00 per day (AfDB, 2017).

4.5.1.3 Access to Finance

Access to finance is critical for economic growth and the lack of structured finance presents uncertainties. However, financial mechanisms could take the form of private investment capital markets on a regional or national basis and funding that is made available to African cities and not least, the ability for a city to collected municipal revenue regularly and free of corruptive forces. While global finance has been volatile during the past decades, Africa received USD 200 billion in external finance in 2015, and which was a 1.8 per cent decline from the 2014 figure. According to the WEF Global Competitiveness Index (2018) South Africa was shown as dropping five places in the 2017 ranking, to 67th position among 140 countries, with a score of 60.8; and second position in Sub-Sharan Africa, where its strength comes from a large sized market (68.4), good infrastructure (68.6) and a well-developed financial system (WEF, 2018; Business Tech, 2018).

4.5.2 Underlying Constitutional and National Legislative Framework Relevant to the Proposed OUG Extraction in the Karoo.

This section provides an overview on the legal framework which is pertinent to the UOG extraction (SGE) of the Karoo, South Africa, by reviewing pertinent aspects of the South African Bill of Rights (1994), particularly environmental issues which include a provision on sustainable development. The section also considers the move towards a de-centralised energy model which is a favoured model for African cities (Escudero, 2016). In the growing need for climate change mitigation and adaptation, the role of regional governance is becoming more important as the direct transfer of skills from international environmental organisations and NGOs to small cities becomes necessary. A buffer between central government incurs additional expenditure and institutes an overload on the resources of the central government.

4.5.2.1 Central Government

In the U.S., various acts were passed, or revisited, in the light of environmental issues surrounding UOG extraction and its effect on the environment. These comprised of the following: The Clean Air Act of 1990, The Clean Water Act of 1977, The Toxic Substance and Control Act of 1977, The Resource Conservation and Recovery Act of 1976, The Bird Migratory Treaty Act of 1918, The Endangered Species Act of 197, The Alaska Environmental Acts of 2014, The Coastal Zonal Management Act of 1972, The Deepwater Port Act of 1974, The Federal Land Law and Policy Act of 1976 and The Federal Oil and Gas Royalty Management Act of 1982 (Bohi, 1998). South Africa is yet to commence this process (CEF, 2018, Glazewski, 2015, IGAS, 2018, Kramer, 2018, SANEDI, 2018; SAOGA, 2018). After government has finalised the shale regulations and addressed similar subsidiary laws, government would be in an advanced position to bestow duties onto lower regional governments.

The South African government stated it would move swiftly and decisively in the shale debate considering shale as a part of the energy solution together with nuclear and renewable energy but this is still in its infancy regarding the amendments of acts which specifically cater to the uncertainties of the proposed shale exploration in this market (Shabangu 2013; Zuma, 2016; Zwane, 2015). The new Act promised in 2013, only saw daylight on 20 August 2018 with the announcement of the IRP (2019) which has been published for public commentary. Government’s involvement as a regulator in exploration and development is crucial to mineral exploration. In order to provide an attractive investment environment, government must seek to level the playing fields for all actors (Talus, 2016; Van Asselt, 2017) seeking commonalities within legal frameworks as per the World Trade Organisation WTO Rules (1985), and paying specific attention to the critical principles of world trade in terms of the doctrine of legitimate expectation clause, the most favoured nation clause and the protection of foreign direct investors (Chabra, 2014; Laing 2013).

4.5.2.2 Local Regional Government

While it is accepted that the central government plays the role of the regulator, the municipalities of the Karoo, mainly where fracturing is permissible, are required to define the role that would be played. Is the regional government to play a satellite role, an extension of the central government and dancing to the same tune as central government, or does it dance differently? Government involvement as a regulator in exploration and development is crucial to the development of minerals exploration. In new sectors, in order to provide an attractive investment environment, the government must seek to level the playing fields for all actors, seeking commonalities within legal frameworks as per the WTO Rules (1985) and paying specific attention to the critical principles of world trade (Talus, 2016; Van Asselt, 2017). Exploration and development refer to all of the upstream activities required to find new oil and natural gas reserves and develop the resources to the point of readiness to be used (Gard & Kitson, 2015). These activities are undertaken to replace existing reserves which become deplete as exploration continues (Bohi,1988). In a move towards a de-centralised energy model, the role of regional local government is re-iterated. The direct contact between global environmental organisations and lower regional governments is encouraged (Escudero, 2017).

4.5.2.3 Fiscal Transparency

This research at this stage cannot pinpoint the tune to which regional governments will dance, (i.e. the fiscal obligations of the regional government level) and whether regional government coffers are set up, similar to how a corporation may set up individual profit and cost centres. Transparent mechanisms need to be in place to prevent corruption and the abuse of power by government officials and organisations. South Africa could benefit from the national mechanism instituted by the German government for the collection and dissemination of data when that market examined and took the final decision to ban UOG extraction for the near future.

4.5.2.4 Urban Planning and Environment Policy

The case of Williston, North Dakota, is an example of how towns mushroom almost overnight. The development is providing a wide array of opportunities and challenges for locals. Successful, smart urban planning is required in the re-building of the fracking areas. Large industries should set up closer to the source of the resources, making the entire operation more cost viable. The climatic conditions of the Karoo too must be taken into account. Based on IPCC (2015) forecasts, this research suggests recommendations for the Karoo towns to become cities of the future based on the high-tech model of Masdar City in the UAE (Masdar.com, 2019) as well as the UNESCO peace initiative of Auroville, Chennai in India.

4.5.2.5 Local Content and Capacity Development

The Karoo, South Africa, as described by Glazewski (2016), is a place of 'niks' (Esterhuyse and Glazewski, 2016 p.3). A recent research pilot in an endeavour to build capacity in Jansensville amongst 40 youth aged 18 – 35 years, presented many challenges. Critical requirements such as internet facilities and infrastructure to conduct, a free online higher learning programme was not available. Therefore, based on the Glazewski description, planning should start with an open canvas which allows for a more excellent opportunity as a whole city of the future must be constructed and which could reverse the trend of migration from rural areas to urban areas. The definition of the dance would determine the resource allocation to the regional governments to design and implement policies and projects to support capacity, which relates primarily to human capital but also refers to financial resources.

4.5.2.6 Local First and City-to-City Co-operation

All these research methods, against all the target audiences in the Delphi studies, the interviews, the focus groups as well as the Sarkar game, yielded a sense of 'belonging' and the need for regaining autonomy. Respondents were vocal on the various initiatives currently in the towns whereby the locals were not part of the initiatives and believed that the new shale exploration offered an opportunity to give privileges to 'locals first'. City-to-city cooperation on a grander scale refers to the sources of products and services from the larger town as well as other provinces. However, in this case, the policy of Local First is suggested strongly by all respondents.

4.5.2.7 Roles of Government, the Private Sector, labour Unions and Civil Society

Fakir (2015) of WWF comments that with the change of government and the move to a more democratised society came the policy of black economic empowerment. Government over the years placed more obligations on the private sector with the broad-based black economic empowerment (BBBEE) scorecard becoming almost a licence to operate in South Africa. The private sector wishing to engage in business with the state organisations and large private companies need to ensure compliance to this scorecard. Within this important discourse the research examines the current dependency of rural communities on extractive companies. The research attempts to investigate new ways, in which the rural communities of the future can gain agency and charter new futures by diversifying and being less dependent on the extractive companies.

4.5.2.7.1 Government and the Private Sector

South Africa, 25 years on into its new democracy, still grapples with its legacy of the past. BBBEE displays a slow track record which was initially window dressing and now benefiting the elite minority and, therefore, the democracy faces new challenges in 2018, with the youth via the Economic Freedom Front (EFF) calling for the nationalisation of mines and the banking system. Attacks on white farmers caused reactions from the U.S. and Australia, straining international relations between both countries and South Africa. The U.K. stated support if the process is conducted in an orderly manner. The industry requires significant infrastructural development that must be quantified and funded (ASSAf, 2017). Even though South Africa boasts a robust mining sector, mining in South Africa leaves many areas for improvement. South Africans can also learn from other global mining experience.

4.5.2.7.2 Black Business Origins in South Africa

The following section illustrates the transition of black ownership in the mining sector of South Africa from the informal appeasement of the tribal chiefs to the more formal equity ownership under the BBBEE scheme. This scheme was a strategic economic policy instrument to transfer ownership from white-owned companies into the hands of the black populace during a peaceful transition. The reality is of a few black elite families currently wielding considerable power in the coal and energy sector and presenting barriers to the renewable energy and shale exploration as the setup of these new sectors (Burton *et al*., 2019; Gard & Kitson, 2015).

In the context of 'social licence to operate' (SLO), a common parlance in mining, it is interesting to track this trajectory in South African mining, as global mining houses instituted specific policies in South Africa, whereby actions led to the appeasement of tribal chiefs and this corrupt system saw the self-sufficient black farmers become slave-workers on the mines (Fakir, 2015). The tribal leaders were then replaced by the so-called BBBEE partners, of which Ramaphosa earned a seat on the Board of Lonmin mines, as the non-executive director after the negotiations for a peaceful transition from apartheid to the new South Africa with co-colleague Rolf Meyer (1994).

Within this trajectory lies an exciting account of the 'rags to riches' of not only Ramaphosa but the black elite. An ANC anti-apartheid activist, mine worker union shop-steward, chief negotiator in the road to South Africa's democracy, Cyril Ramaphosa (2018), at that time of Marikana, was the head of the National Union of Mines, the non-executive director of Lonmin and the Deputy President of South Africa and if prosecution started, the ANC plan for the presidential successor would fail. Ramaphosa was no stranger to the sector. A man of the people, let alone a presidential hopeful, Ramaphosa would have been equipped, more than any other South African to manage a mining labour conflict as intense as Marikana (Farlam, Commission, 2016). The Marikana incident is not an account of 'black' and 'white, racist history, which is common place in the context of South Africa. This was a 'black on black' tragedy, as all the actors of state, police, corporate and civil society were black.

4.5.2.7.3 Government and the Trade Unions

The following section pays detailed attention to the labour conflicts in the mining sector of South Africa. Civil conflict, arising from systemic causes, is an important wildcard, which plays up at various intervals towards 2055. Civil dis-satisfaction, arising from employment and poverty, manifests itself in South Africa, through issues such as land expropriation without compensation, gender-based violence and xenophobia. The labour unions in South Africa play an important, influencing role in the energy sector of South Africa and with the coal mines being a stable source of jobs, unions almost rely on the coal mines to maintain existing power bases, particularly with the workers. The history of unions in South Africa is of incredible importance to the freedom trajectory of the nation as the freedom stalwarts, whilst in exile and on Robben Island, dreamed of a free and fair society, in which blacks would be liberated from sufferings as a result of inequality which was legitimised in 1948, through the regime of Apartheid (Saul & Bond, 2014).

This history is tracked through the most recent accounts of Winnie Mandela, being one of the last surviving elders of the Mandela era. Nomzamo Winifred Zanyiwe Madikizela's funeral in 2018, was another opportunity for South Africans to be reminded of the scourges of Marikana and apartheid. The explanation of apartheid is relevant in the context of the shale discourse. Even though international governments denounced the regime, international mining houses benefitted from the corruption of apartheid through the licence agreements. License agreements are the same instruments which are being offered for the shale exploration. While, it is accepted after discussion with the shale commentators, that in 2011-12 when shale contracts were initially being discussed with Shell, other types of new petroleum contracts were still being discussed in other developing countries.

The re-addressing of Marikana at the funeral placed the renewed focus of the role of government and interaction with civil society, in the sector. According to Statistics South Africa (StatsSA, 2017), income generated by the mining industry rose from R393.4 billion in 2012 to R419.5 billion in 2017. Furthermore, the mining industry reported growth coming from energy and non-energy sectors of coal and lignite (R21.9 billion), manganese (R6.8 billion) and diamonds, including alluvial diamonds (R6.4

billion). Significant decreases were reported for platinum group metal ore (R15.5 billion), iron ore (R7.4 billion) and gold and uranium ore (R3.3 billion) (StatsSA, 2017).

Mining is a very important sector to rural areas in South Africa. Mpumalanga province derived the most substantial income from sales of goods in the mining industry in 2015 with R114.4 billion (or 28.8 per cent of the industry total). The province with the second largest income from sales of goods was North West (R84.7 billion or 21.3 per cent). This province was followed by the Northern Cape (R69.5 billion or 17.5 per cent), Limpopo (R45.3 billion or 11.4 per cent) and Gauteng (R44.9 billion or 11.3 per cent). North West had the most substantial income in 2012, followed by Mpumalanga, Northern Cape and Gauteng (StatsSA 2018).

Mining in South Africa provides an essential source of labour and this labour system is the migrant labour system. However, what is interesting is that the towns of the Karoo, one of the most impoverished areas in the country are not part of the list, nor is migrant labour a construct of Karoo lifestyle and community. A critical benefit of UOG extraction is that large deposits are confined to the Karoo, but there is a likelihood of migrant labour as well numbers start to rapidly develop away from main towns.

In a separate research exercise undertaken by this researcher on the subject of renewable energy, a noteworthy finding was that there exists a widespread perception that renewable energy, being technological, would replace jobs in the coal mining sector and lead to higher unemployment in the country. Respondents, mainly from the labour unions, believed that coal was the stable provider of jobs and that the sector should be protected. When the researcher probed on issues of prices between the coal-generated power and renewable energy, insights revealed that even senior respondents within the unions were not sufficiently informed on the subject matter and yet put forth negative assumptions.

In the focus groups, the youth respondents in the area of Graaff-Reinet, a ‘sweet-spot’ town in the Karoo for fracking, showed very little awareness of the employment potential of the UOG extraction or the renewable energy projects in the region. However, after the brief introduction on the background of the energy sector, respondents, through the Sarkar game, manifested technological skills, knowledge on the application of technological equipment, interest in acquiring technology skills and interest in implementing technology and smart skills in the workplace to reduce the dependence on manual labour.

Forty-five per cent of the youth respondents had already acquired technological skills, while 25 per cent of the respondents had passed the second year of higher learning programmes at university level, leading to a degree qualification. The focus groups took place in the town of Jansensville with has a total population of 10200 (StatsSa 2012). 7500 of this population falls within the age 12 – 35 years old (StatsSA 2017).

The above-mentioned uncertainties highlight the challenges and the risks of the UOG extraction of the Karoo, South Africa and South Africa is not ready for the exploration (Glazewski and Esterhuyse, 2016). The time-frame that is indicated by the authors allows that if the state takes responsive action, and carefully considers the operation, backed by academia and the private sector, appropriate measures could be put forth, allowing the industry to move forward, in processes similar to those followed by the U.K. and the German governments (Green, 2016).

The manufacturing and supply industry require commitment and contractual agreements to upscale and support the industry, which thereby requires certainty and commitment from government to create an enabling environment, ensuring that the structures in place provide an efficient implementation of the UOG extraction (ASSAf, 2017; IDC Report, 2018). Manufacturing suppliers must be compliant with local and international standards. In order for local content to become an actual reality, with local communities being upskilled to benefit from this exploration, on an equity basis, this should be a requirement legislated by the government, providing clear directives to the developers and other stakeholders in the shale industry (ASSAf, 2016).

The relationship between the government and the labor unions is an important one. On the one hand, the labor unions may be better at appeasing the workers. However, in the case of Marikana, this was not evident. Given the risk of civil conflict, the South African government must ensure that energy policies must be fit-for-purpose for the modern South Africa. This is examined in the section below.

4.5.2.7.4 Government and Civil Society?

In respects to the UOG extraction in South Africa, the data gathering process included two focus groups of forty respondents each. A brief induction enlightened and informed the group of the shale discourse. The Delphi method, (using “yes, no and maybe” questions), gathered necessary information from the group and this enabled a common understanding of the research topic. After that, role-playing using the Sarkar Game, visioning and backcasting techniques were introduced. During the informal discussions, respondents were very aware of the interaction of the private sector and communities, as well as the level of support the state had promised since 1994. Respondents cited the Marikana incident without any probing indicators. The research offers the reader, a brief background to this watershed moment in South African mining history.

The Marikana massacre was the turning point of mining in South Africa. On 16 August 2012, the South African police startled the world, both in the manner and period in which it happened, as it was almost 20 years after apartheid. It evoked memories of the past and raised questions about the post-apartheid, socio-economic and political order, the integrity of industrial relations between unions and workers and how the State dealt with such matters.

On the road to Marikana, one passes the beautiful Hartebeespoort Dam, where an elitist suburb was created for the rich whites, mainly Afrikaners, to escape the blistering heat of the Johannesburg summers. One then enters the shacks of the township of Marikana. The views of the beautiful Hartebeespoort Dam metaphorically depict, the rosiness of the UOG extraction at initial face value. It is an example of an incident that must be avoided at all costs. The respondents noted that the Marikana tragedy culminated in a wave of riot activity that had kicked off in January 2012 at Impala platinum mine following action by disgruntled rock drill operators.

Given the risk factors associated with the wildcard of civil unrest, the research attempts to use the Marikana case and dissect the anatomy of civil conflict, analysing the systemic causes at the beginning and how these manifest across the industry, firstly, into the domestic environment and then vented onto other races groups and foreign nationals. Therefore, according to Pondy (1967), an expert in conflict management, who wrote extensively on mining conflict, this early phase of conflict would be referred to as 'latent conflict' in the stages of conflict development (Sarininen *et al*., 2017).

This period may be characterised as having no open conflict, but with potential for future conflict because of several latent factors. Marikana is referenced as a prime example of mining conflict. This conflict started, when the workers, in class-action, filed a grievance when the retention allowance awarded to mine blasters was withheld by the company. What started as perceived conflict, later spread beyond the platinum sector, which was characterised by similar claims. Violence and repertoires were followed by the workers, who then made uncompromising demands, such as the minimum salary being raised to R12 500 per month, which was rejected by the National Union of Mineworkers (NUM). This initiated what Pondy (1967) refers to as the 'felt conflict' which resulted in the manifested conflict. This stage involved the confrontation between the police and the mine workers, in an incident, where one policeman died. Returning to the focus group, it did not take much probing before the dis-satisfaction of the youth came through strongly in the research discussion.

Whilst the first group used the Marikana incident to illustrate certain concerns, the youth respondents of the second group in Graaff-Reinet cited grievances against the ANC government. Respondents cited the lack of service delivery, the false promises of the ruling party's manifesto of 1994. In 1994, this majority of respondents would have been ten years old, making decisions regarding study choices. As the result of the poverty levels and the lack of essential services of connectivity, these respondents remain unemployed, serving in low-end job-creation programmes, designed by local government to keep individuals occupied and to be awarded a basic stipend. The respondents displayed all the all characteristics of Pondy's (1967) latent conflict stage.

The role of government concerning civil society is to play the part of a regulator, as well as a public protector, specifically of the most vulnerable i.e. the poorest of the poor, the women, the aids orphans and all other marginalised groups of the Karoo, South Africa. The South African Constitution (RSA 1994) provides all the necessary legal provisions to ensure this protection including the human right to water. Manifestation of the Constitution is seen in institutional and sectorial manifestos and charters, such as the Mining Charter (2018). Ramaphosa citing the Mining Charter, refers to the mining industry as “a sunshine industry that is able to generate significant wealth, jobs and re-dress the issues of the past” (SONA, 2018).

Ramaphosa understood conflict, which is inevitable in human existence and a necessary part of human life (Bukari, 2011). Conflict is also a characteristic of human endeavour which cannot be prevented completely (Issifu, 2014). Oyeniyi (2011) maintains that conflict cannot be avoided in social life, but it can only be contained (Oyeniyi, 2011). Oyeniyi (2011) further argues that conflict might be at the class level, local government level, state or even international level and occurs primarily as a result of a clash of interests in the relationship between parties, groups or states, pursuing opposing or incompatible goals.

In the focus groups, the respondents felt that if the president then in the private sector, as a director of Lonmin, was not able to diffuse the problem, then there would be the likelihood of civil conflict during the UOG extraction when critical life-giving resources such as water is likely to be tampered. The respondents then criticised the indifference on the part of the private sector concerning the welfare of the people of Jansensville and Graaff-Reinet, both groups citing specific cases where local corporates recruited the staff from Port Elizabeth, Gauteng and Cape Town, even though available workers were available locally.

Furthermore, respondents cited industries which operated in the sourcing of raw materials, which are harvested using cheap manual labour in the Karoo, and whose products were finished in the larger cities. Respondents pointed out that higher financial proceeds from the finished products, originating from the Karoo were never fully realised in the Karoo. Similar sentiments were echoed in individual interviews with the head of the farmer’s union, the head of the black business forum as well as local political parties in the two towns. This was concluded as systemic problem which results in the impoverished state of Karoo towns.

Usually, conflict is assumed to be present when two or more parties perceive that their interests are incompatible and express hostile attitudes or pursue interests through actions that cause harm or damage to the other parties. Conflict is customarily assumed to have occurred when individuals fail to live according to perceived values or when individual values are threatened (Kendie, 2010). Coser (1956) also defines social conflict as a struggle over values or claims to status, power and scarce resources in which the aims of the conflicting parties are not only to gain the desired values but also to neutralise, injure or eliminate the rivals (Kendie, 2010). While structures are being put in place for the shale exploration in the Karoo, the country has time to examine the systemic causes of civil conflict and address these with haste.

4.5.3 Increased Energy Demand and Drivers for Change

In Chapter Four, the environmental scan examined the countries that explore for shale. The main reason is attaining energy security and reducing reliance on other countries, as the source of oil is being depleted and becomes physically scarce in the next decades and beyond. In terms of climate management, finding other feedstock substitutes for coal to reduce emission becomes critical. There is also the need to reduce energy poverty, which hinders the stimulation of industrialisation. This urgency for development according to Wakeford (2016) prevents countries from being vigilant about the emissions into the environment (Wakeford, 2016).

4.5.3.1 The South African Energy Sector

This section examines the readiness of the South African government and uses the broad insights from the U.S. example. The research first examines the role of the South African central government as regulator and facilitator in the energy sector. The research then questions the role that the government currently plays in the energy sector and proposes the appropriate role that government should play in the future in order to support an effective energy policy in light of the new climate change management agenda (Escudero, 2017).

Coming out of political isolation, the South African government, in an attempt to gain favour in the world, embraced international legal frameworks to such an extent that many international treaties were ratified. South Africa was allowed membership into many international bodies such as the United National General Assembly (UNGA), International Criminal Court (ICC), the International Court of Justice (ICJ), The World Trade Organisation (WTO) and, most recently, the United Nations Framework Convention on Climate Change (UNFCCC) and thereby seeing ascension into the Paris Agreement (PA) of 2015, which is most relevant to the UOG extraction in South

Africa. Thus, the central government provides an essential link between the climate action NGOs and the regional local government within the nine provinces in South Africa (Glazewski *et al*., 2016). The regional governments of South Africa are also formalised into the South African Local Government Association (SALGA), which is affiliated to the United Cities and Local Governments (UNLG), of which a South African is the president, thereby adding a higher affinity to global frameworks, institutions and alignment, especially in the area of climate change (personal interview with President Tau. 2018).

The primary role of the state in the energy sector is to be a regulator providing a conducive environment for all stakeholders, in the promulgation of laws that protect all parties, to monitor all operations and to provide infrastructure and services (Glazewski & Esterhuyse, 2016). The examination of subsidies pinpoints the obligations of the state as enshrined in the WTO Principles (1985). The WTO, also provides the guiding principles of international trade. Local investors and foreign investors can refer to WTO provisions in the upcoming shale exploration in the Karoo, South Africa (Talus, 2017). According to Glazewski (2016), South Africa has yet to review its concessionary framework in the light of the developments within WTO, in the shale and renewables sector (Glazewski, 1994 b; Glazewski, 2016). Respondents from the CEF pointed out that public debate and investigation should probe the intellectual property (IP) of coal-to-liquid technology, which was passed on to SASOL at no cost. The company still translates this IP into massive profits from which the public realises no benefit (CEF, 2018; IGas, 2018).

4.5.3.2 Comparative Analysis Between U.S., the U.K. and South Africa

In this section, the mapping tool critically evaluates the South Africa government's readiness for shale exploration by assessing the political will and the robustness of the energy policy. This section provides critical data for the assumptions in the second scenario, which is the worst-case scenario. For comparative purposes, the research benchmarks against the U.S. cases and tracks the early successes as well as the pitfalls. The U.K case, which developed along the lines of the U.S, oil and gas trajectory over the same number of years, exercised greater caution by examining the short-coming of the early shale rush in Williston, Texas. According to Green (2016), the U.S. example demonstrates critical, avoidable mishaps. The above insights and the conclusions have come from the literature review, the numerous interviews and discussions with the developers, small fracking companies, shale consultants, and chemical suppliers in the U.S.

4.5.3.2.1 Establishing Strong Regulatory and Policy Frameworks

The U.S. government, in attempting to prepare for the exploration, started to modify the existing oil and gas legislation and other processes. Supplies of natural, now economically recoverable, gas from shale in the United States accommodates the country's domestic demand for natural gas at the current levels of consumption for more than a hundred years, providing an economic and strategic boom and an important stepping stone toward lower carbon greener energy (Lu and McElroy, 2013).

Starting in the late nineteen seventies, the U.S. government adopted a series of policies to promote the development of new sources of natural gas, including unconventional sources. The U.S. government encouraged the development of small entrepreneurs as 'frackers', and offered credits and incentives to the private sector (personal interview with Bulltail, at Stanford University, 17 June 2018; Jackson, 2017; Krupnick & Wang 2013). This endeavour developed the supply chain and the overall exploration. However, incompetent suppliers took shortcuts and this resulted in accidents. Small developers do not have all the core competencies required for such a hazardous exploration activity. Small developers neither have the worry of having to safeguard company reputation as global corporations do. The new exploration reported many hazardous incidents in the early days of Williston fracking and these were mainly related to human negligence and poor waste water management. The monitoring of methane leakage, a critical concern was almost not considered by the small developers (personal interview with Bulltail at Stanford University, 2018; Jackson, 2017; Krupnick & Wang 2013).

4.5.3.2.2 Assessing Capacity

The U.S. in support this new growth opportunity, possessed a cohesive understanding of all inter-related process that were required. This is known as 'upstream' and 'downstream' processes in the oil and gas sector. Exploration and development refer to all of the upstream infrastructural activities that are required to find new oil and natural gas reserves and to develop them to the point of readiness to be produced by developers. These developers, usually the IOCs, have the capacity and capital resources to withstand the challenges of upstream activity (Gard & Kitson, 2015). More upstream activities are undertaken to replace existing reserves, which become depleted as exploration continues (Bohi,1988).

The U.S., in 1977, created the Department of Energy (DOE) to consolidate into one agency the responsibilities for energy policy and R&D programme and which included ERDA and the energy-related responsibilities of the U.S. Departments of Agriculture, Commerce, Housing and Urban Development (Krupnick & Wang, 2013). Section 107 makes provision for incentive pricing for high-cost natural gas from the Devonian shale, coal seams, geo-pressured brines and any other gas, that the Federal Energy Regulatory Commission (FERC) determined would incur high extraction costs.

4.5.3.2.3 How U.S. Legal-frames Transformed in Favour of Gas?

The shortage of gas, led to the passage of the Natural Gas Policy Act of 1978 (NGPA), which required a phased removal of wellhead price controls and provided incentive pricing for developing new natural gas, including gas from unconventional sources. To provide financial support, U.S. policies for credits and incentives had been purposefully created. Furthermore, federal agencies started to establish a R&D programme on unconventional natural gas which was supported by the universities, who provided the scientific back-up. The extraction was operationally administered by the developers, such as Devon and Michelle Energies, in association with Halliburton and other notable additives and fluids suppliers (Bohi, 1998), The collaborative workings of all these stakeholders resulted in several significant studies which were commissioned by the Federal Power Commission, The Energy Research and Development Administration (ERDA), and the U.S. Department of Energy (DOE) in the seventies, which put forth strong motivation that shale exploration should be encouraged and subsidised (Krupnick & Wang, 2013).

The energy crisis during the 1973 oil embargo, provided the broader context for policies on unconventional natural gas. Federal law in 1974, created the ERDA by merging several separate research programmes, including those of the technology research centres of the Bureau of Mines, the fossil energy R&D programme under the

U.S. Department of the Interior, and the system of national laboratories under the Atomic Energy Commission (Krupnick & Wang, 2013).

The 1979 oil crisis, led to the passage of the Crude Oil Windfall Profit Tax Act in 1980. Part of this tax provides tax credits for producing unconventional fuels. Tax credits were implemented under Section 29 of the Internal Revenue Code, and applied not only to unconventional gas from Devonian shale, coal seams, and tight gas but also to biomass, geo-pressured brines, oil from shale and tar sands as well as to some other fuels (Bulltail, 2018; Jackson, 2018; Krupnick & Wang 2013). While these credits were in place, in reality, Mitchell Energy, benefitted very little from these credits, but at least saw benefits, from Government instituted R&D programmes. Table 4.17 below continues the line of enquiry of Chapter 3.

Table 4.17: Inayatullah's Questions (2015) in the Context of the Economic Question

Inayatullah's Questions	**Data on the Economic Question**
What stays the same?	Reliance on the abundant, cheaper coal for the foreseeable future as confirmed in the personal interview with Minister Mantashe (2019)
What are the key trends?	The use of modern petroleum contracts, which safeguard sovereign assets. The questioning of the support offered to fossil fuels. The use of technology and the addressing of all forms of inertia, which have been high-lighted by Murthi (2019) and which affect effective implementation. The use of Development Diplomacy to negotiate a common ground for all stakeholders, as there are certainly perception barriers regarding the extraction.
What are the main processes of change?	A cooperative government, acting as a regulator, which is less reliant on the financial muscle of the IOCs. Minister Mboweni's new economic plan (2019) for economic recovery, requires a greater focus on the oil and gas sector. Collectively, the new plan will set the economy on the path of economic recovery. The delay in the formalisation of the new legislation, which will set out the new terms for the OUG, allows for an investigation into the potent change from licence agreement to production sharing agreements.

Inayatullah's Questions	Data on the Economic Question
What are the new issues in the pipeline?	The IEA (2018) projections for gas prove that there is a great global appetite for this commodity. Technological breakthroughs which result in safe water management in OUG extraction. The Minister of Human Settlements, Water and Sanitation on 26 November 2019, launched a new plan for efficient use of water for drinking and sanitation. This follows the guidelines of the United Nations Two Water Conventions, which places more emphasis of the human right to water. This new legislation will go far in ensuring the protection of water resources in the Karoo. Advances in technology, such as the use of the modern capacitors, further galvanises the transition to RE, making the third scenario, which considers that renewable energy forms could become a reality.
What are the sources and hope?	This chapter concludes that UOG extraction could follow other markets and South Africa could witness an economic game-changer. The research has highlighted the Williston and the Lancastershire success factors. What does become apparent, is that these outlying areas, have experienced a boom and positively have affected the rest of the economies. The real beneficiaries of the UOG extraction in the Karoo, are identified. Greater accountability is placed on the government to safe-guard sovereign assets, ensure environment protection, promulgate laws and institute policies which ensure the sustained well-being of the population.

(Source: Researcher's Construction, 2019)

4.6 CONCLUSION

While the previous chapter presented the evidence-based research from other jurisdictions and presented the reservations on the level of safety of fracking in the Karoo, South Africa, in Chapter Four, this research also concludes that UOG extraction could potentially be an economic game-changer for the South African economy. Furthermore, change drivers emerge through the PESTLE analysis, and indicate how the Triple Challenge may be addressed and in doing so it attempts to answer the question in Chapter Four; Is UOG extraction an economic game-changer for the country? The business case, illustrates that UOG shale could provide the boost or the 'silver bullet', that is required to jump-start the Karoo and as well as the economy, as illustrated in the case of Lancaster-shire (Refer to Table 4.7). The economy requires many spurts in order to galvanise the economy to reach the GRP growth levels which are experienced by the African neighbours.

However, at the heart of the UOG debate of the Karoo, lies the environment and the issue of climate risks. Therefore, the decision to extract or not does not lie in economic reasons. If it were, then the impacts of the second scenario would be felt. With renewables becoming increasing cost-effective, one set of options could take the economy down the renewables route. This is the result of fresh thinking on FFSR, on a global level, which is an agenda that is being strongly furthered by the IISD, through strong proposal to the WTO at the next conference in 2020 (personal interview with Wooders, 2018). The lower cost of RE hardware and the latest commercialisation of capacitors also fast tracks the transition to sustainable energy futures.

In most oil and gas explorations, governments and civil societies around the globe are held to ransom by the international oil giants, not only for the finances but also for the expertise lies with the developers. In the case of UOG extractive, the problem is more acute. Based on a sound business case, countries may access finance through international lending institutions and large-scale private investors. Modern petroleum contracts, covered in Section 4.4.2. provide for more innovative solutions which better service a wider array of problems. Therefore, it is here that the principles of development diplomacy, kick in, illustrating that the art of negotiation is able to ensure that all stakeholders work towards the common good.

The above problem is experience by all developing countries and, therefore, the question arises as to how other governments are handing similar problems? The study of modern petroleum contracts then becomes very relevant. If South Africa, like Canada, adopts a cautious ‘wait and see’ approach, or like Australia, which embarked on coal-bed methane first and then progressed in shale extraction, UOG extraction is likely to see better long-term successes in the Karoo, taking all the stakeholders along in the decision-making process. The instituting of safety controls which are geared to mitigate water contamination, would go far towards eliminate civil society’s worries around the extraction. With the alignment of a solid business case, international funds may be lent to the South Africa government, not only by the traditional lending sources by also by large investors whose core competency is trading only. New narratives that trouble civil society, such as land expropriation without compensation and the nationalising of mines, could be overcome by the review of the current licence agreements and the consideration of more innovative contractual provisions.

The following section, after summarising the essence of the drivers for change stemming from economic growth, posits some preliminary recommendations. Notwithstanding the poverty levels of the Karoo towns, the millennials in the focus groups expressed the need for higher education. Twenty per cent of the group of 40 had already attained the second year at a tertiary institution. Understanding the concept of economic modernisation, the respondents expressed the limitation of connectivity, relying on technology for communications locally as well as internationally. Respondents spoke about their ambitions of using technology to work less but smarter. The highly technical extraction of UOG extracting using mapping and exploration technically sparked interest among the youth to develop competencies to participate actively in the extraction.

In terms of income growth and distribution, AfDB 2017 figures indicate that 61 per cent earn below USD 2.00 per day. As of 2019, South Africa has introduced the new basic minimum wage of USD 10.00 per day. Whilst not fully implemented in the informal labour sector, the accepted norm is generally USD 7, 5 per day. The millennials in the focus group during the visioning process saw societies living in more prosperous and clean environments than living on the bread line.

At the recent World Food Export Conference, held in Addis Ababa, Ethiopia, 2019, African leaders encouraged SMEs to conceive good ideas for start-ups, before applying for funding (Chizema, 2019; Gonzalez, 2019; Ononwuegbuzie, 2019). The leaders were alluding to development finances which were in the pipelines from central banking institutions like the AfDB and the BRICS Development Bank, which aimed at large scale industrialisation of Africa’s agricultural sector. A similar sentiment was echoed by the South African Minister of Small Business Development, Minister Khumbudzon Ntshavheni (2019).

A buffer between central government incurs additional expenditure and institutes an overload on the resources of the central government. International NGOs may be able to bypass complex central government bureaucracy when attempting to implement initiatives toward more efficient energy systems. However, the government’s involvement as a regulator in exploration and development is crucial to mineral exploration. In order to provide an attractive investment environment, government must seek to level the playing fields for all actors and assign and grant agency to local and regional governments to administer tasks.

On fiscal transparency, the planning process requires the participation of all stakeholders including civil society. Civil society then gains agency to charter the futures, the millennials play an important role in this process, accommodating the longevity of the monitoring process. UOG extraction is viewed as a conduit towards more sustainable energy futures. In the U.S. and the U.K, UOG extraction is a fast extraction process, and as described by Maugeri (2012) compares to actions of guerrilla groups as such, there is a faster stream of a new sustainable cash – flow. Whilst UOG revenues generate wealth, the pitfalls of Williston must be examined so that the planning process considers long-term options of a diversified energy model, with a diversified business sector, along a path towards sustainable, surprise-free futures towards 2055. Therefore, effective urban planning and environment policy is critical.

Local content in many new industries and sector is an African challenge (Gonzales, 2019). However, in this place of "niks" lies considerable talent amongst the youth, and which is not being utilised, even in government projects. A policy review is necessary and large- scale capacity development is required to develop local content. The millennials in the focus group cited many examples of jobs being allocated to individuals from far-flung towns, which caused a fair amount of animosity and civil discontent. While the respondents, accepted that the extraction would generate many jobs, the group coined the term 'Local First, City to City Co-operation Second'. This sentiment should not be trivialised as the underlying meaning points to rural area independence.

For the building of cohesive and inclusive societies, the collaboration of all stakeholders is paramount to the success of the UOG extraction in the Karoo. Currently, the policy makers, private sector, white commercial farmers, unions, international NGOs and the civil society (namely the women and youth) remain polarised along various lines of discourses. The research examined the engagements, drawing on many examples based on historic events. Recommendations for the various stakeholders are presented in Chapter Eight.

The following section, in summarising the essence of the drivers for change stemming from economic growth, suggests some preliminary recommendations. The South African government must, therefore, set up strong regulatory frameworks that support an increased demand for energy. These would entail green financial mechanisms with strong fiscal benefits that support the water- energy- food nexus approach. South Africa may benefit from the U.S. example of the consolidation of UOG extraction under the U.S. Department of Energy. Currently main ministries have a say in the UOG discourse (Glazewski *et al*., 2016).

The South African government can be criticised for indiscriminately allowing SMEs to develop in sectors widespread across the economy. The lack of capacity for this specialised exploration technique, could result in environmental incidents in the UOG extraction. As with the U.S. greater cohesion is required between all stakeholders in South Africa. The government, as a regulator, needs to spearhead the exercise, by detailing the ‘upstream’ and the ‘downstream’ activities, prioritising these activities against the competencies after accessing capacity. A fair mix of tasks must be assigned to IOCs, who should be obligated to sub-contract to SMEs in the region. In a spirit of inclusion, critical mistakes could be avoided if IOCs are obligated to carry out capacity-building programmes to empower the women and the youth.

When posing the question; For whom exactly, is it an economic game-changer? the discussion places the focus on what UOG extraction would do for the local GRP of Karoo towns. If government is committed to the re-vitalisation and development of rural areas, and global climate organisations are intent in furthering a de-centralised energy model, UOG extraction may be the only silver bullet for the Karoo, South Africa. Chapter 5 Investigates this question in further detail.

CHAPTER FIVE

5 EXTRACTIVE COMPANIES AND SOCIETY

5.1 INTRODUCTION

Chapter Five is a three-part chapter that concludes the mapping phase of this research and prepares the data for the development of the scenarios. The purpose of the environmental scan in this chapter, as defined by Conway (2009), will assist policy-makers, developers and other key stakeholders to form a strategic standpoint, which can deal with external forces over which there is little or no influence; but which would have a significant impact on the future development of the sector and the interaction with society for the many years to come (Conway, 2009). The environmental scan in this chapter continues the use of the classic PESTLE model, as in Chapters Three and Four, but now focuses on the social, ethical issues and equitable access to resources.

Part One summaries the megatrends which specifically impact on the social discourse. The discussion of the megatrends attempts to unravel the main governance drivers, such as energy, climate and urban planning policy. Part Two focuses on the Triple Challenge of poverty, unemployment and social inequality. Within the context of these three discourses, the research weighs the governance drivers and the society's response to the 'pulls' of the future. Part Three discusses the critical uncertainties and drivers for change. This chapter closes on key learnings which are incorporated in the conclusion of this research. This research continues in this chapter, as part of the environmental scan, following the same line of questioning as set forth out by Inayatullah (2015): What stays the same? What are the key trends? What are the main processes of change? What are the most important problems and issues? What are the new issues in the pipeline? What are the sources and hope?

The question; Is UOG extraction safe in the Karoo, South Africa? impacts upon the social question with respect to the health and livelihood of people. The questions; Is UOG extraction, an economic game-changer and for whom is it an economic game-changer? impacts upon ownership and the solution of the problem. Coined in 2012, the notion of 'Triple Challenge', refers to South Africa's equally important issues of poverty, unemployment and inequality. The Triple Challenge question is impacted on by population growth, which requires economic development to service the needs of a rising global population. Increased economic development requires industrialisation and this requires increased energy consumption. The chapter addressed RQ3a and RQ3b, and in doing so, this research unpacks the various layers of causes, by further examining the impact of megatrends on the social question.

Government, since 2012, referred to shale as an economic game-changer (Shabangu, 2012, SONA, 2014). The authors, Esterhuyse, Glazewski and De Lange (2016) pose the question; For whom is UOG extraction in the Karoo, South Africa, an economic game-changer? This research takes an investigative look in order to unpack The Triple Challenge of South Africa in the context of that question. This research simultaneously unpacks issues aligned to the views of Green (2016), that the South African government has committed hastily to UOG extraction. It then became the burden of the environmentalists and civil society to gather empirical evidence to challenge the government's intention to approve UOG extraction.

Hydraulic fracturing, arguably, has been accompanied by great environmental, social and health-related impacts (Glazewski & Esterhuyse, 2016). In a fair amount of litigation, which included the *Robinson Township and Others vs Commonwealth of Pennsylvania and others,* the courts found that:

By any responsible account, the exploitation of the Marcellus Shale Formation will produce a detrimental effect on the environment, on the people, the children and the future generations, and potentially on the public purse, perhaps rivalling the environmental effects of the coal extraction (Glazewski & Esterhuyse, 2016).

The authors, Green and Glazewski (2016), go on to elaborate that mounting evidence testifies to environmental damage in the early days of hydraulic fracturing in Pennsylvania (personal interview was conducted with Green (2016). Kijko, Kahle, Smit, Esterhuyse and Glazewski (2016) provide a correlated account of hydraulic fracturing and seismic activity in those areas questioning whether economic benefits outweigh the risks. The Kijko *et al (*2016) report further alleges that even though the activity is not the same in all regions, seismic similarities exist. Similar concerns in 2017, caused downtime in Lancaster-shire, UK. Great emphasis was placed on the accounts of environmental damage caused in the U.S., which documented plaintiffs' presentations, complaints to courts, peer-reviewed reports, in-depth reports by journalists, as well as documentaries made by the various filmmakers. The basis of Green's (2016) argument stems from the scientific evidence presented in the Vengosh *et al,* (2013) report which is a widely referenced account of U.S. UOG extraction. This report is sharply criticised by Green (2016) and the researcher took up these criticisms and investigated the legitimacy of the claims in the many engagements with Jackson (2018), who was one of the report's authors.

Lall, Hendersen and Venables (2017) present compelling arguments in favour of African cities, in *African Cities, Opening Doors to the World,* stating that African cities typically share the commonality of being overcrowded. Investments in infrastructure and industrial commercial structures have not kept pace with the density of people. Townships are formed by a conglomeration of informal neighbourhoods. These lack reliable transport, have limited job opportunities for the masses and are costly for households and firms, especially in regionally and internationally tradeable sectors (Lall *et al.,* 2017). Future Energy Scenarios for African Cities, developed for EUEI PDF (2017), by authors Escudero, Savage, Kravva and Steeds (2017) provide a compelling and pointed focus on the energy requirements of the Africa cities towards 2050. The report cites similarities of the make-up of African cities and lists five megatrends; urban population growth, economic growth, rising energy demands and climate risks, education and unemployment and health.

The literature review has largely informed this sector. This research evaluates to what extent, these megatrends affect the Karoo towns and what would be the energy requirements. This research then seeks to examine how shale exploration could introduce a positive impact on the problems of rural communities. Reports from Green Cape, a Cape-based NGO focusing on the utility and renewable energies sector in South Africa throughout 2016-2018, provide alternatives towards a de-centralised energy source (Green Cape Report, 2017). These reports, together with the ever-growing database of literature, expand the issues plaguing Eskom and its net hijacking effect of the economy (Cedley, Fine, Rustomjee, 2000; Gard & Kitson, 2015; Lott *et al*., 2016).

Together with the above-mentioned literature, the data for this section was also supplemented by the further interviews with many experts. Collectively the insights provided direction for the researcher to examine the issues of governance. The experts were associated with the CEF, IGas, PetroSA, PASA, SAOGA, the Unions, Black Business Forums, the Afrikaner Farmers Unions and civil society. Various independent economists and consultants, were consulted. Landman (2018) Malherbe (2018) Koornef (2018) have been consulted throughout the megatrend verification process, whereby the global megatrends have been thoroughly accessed against the societal context of the Karoo, South Africa.

Academics from several South African universities and U.S. universities focusing on shale research, verified the insights when the date was synthesised. Academics focusing on the environmental and legal aspects on climate change and policy from European universities and research institutions provided feedback which framed and influenced the four scenarios. Finally, the findings of this research were communicated to the stakeholders of Dr Beyer's Naudé municipality for verification and alignment. At this last stage of the fieldwork, it was identified that 'someone was missing in the room'. The stake-holders of the future were not being heard and the youth focus groups were conducted. Scenario art, using local and international creative talent, allowed for the creation of memorable scenario story-lines in which key messages are communicated for possible hydraulic futures for South Africa towards 2055.

In July 2015, the researcher delivered a presentation at The All African Women's Energy Conference in Johannesburg. Feedback of the challenges faced by women in the energy sector provided useful angles of inquiry for this chapter. In October 2019, at a mining conference held in Cape Town, the researcher presented four scenarios for the future of the extractive sector and the role that the extractive sector can play in assisting communities attain the SDGs. Similarly, the presentation also framed the new approaches whereby communities start to take charge and use the business from the extractive sector to transform and diversify into multiple business sectors. The conference held for the fourth time, in Cape Town, by the religious groups, sponsored by the Anglican church, entitled 'Days of Conscientious Discussions, 2019', is an example of how non-state actors are starting to take charge to determine better futures for all.

The game-changing business case in Chapter Four, for the UOG extraction in the Karoo, South Africa, illustrates that there will be significant socio-economic impact on the lives of the people. In the opportunities and threats assessment, critical societal challenges were identified (ASSAf, 2016; Heiden *et al,* 2012; PwC, 2016; Wait and Roussouw, 2013). Given the collective insights, the research was then able to identify the critical gaps in governance structures and policy frameworks (ASSAf, 2016; Glazewski and Esterhuyse, 2016).

5.2 PART ONE: MEGATREND MANIFESTATION

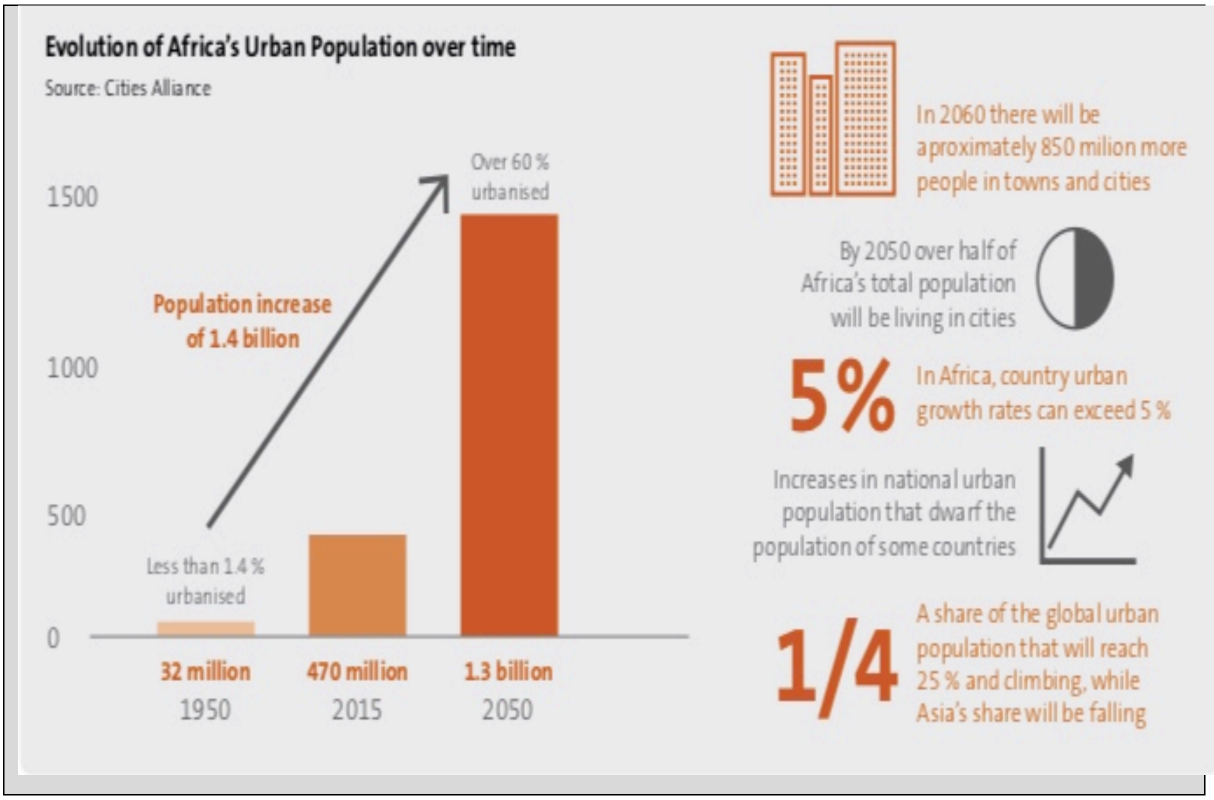
In this section, this research examines the impacts of the megatrends of increased urban population, education and unemployment and health issues which impact upon the Triple Challenge facing the Karoo, South Africa. The 'governance' drivers for change are examined.

5.2.1 Megatrend Manifestation One: Urban Population Growth

By 2030, the world projects 43 megacities with more than 10 million inhabitants each. These megacities will be formed primarily in the developing regions with many located in Asia and Africa (UNDESA, 2018). The UN Population Division (2017) predicts that the urban population will more than triple between 2015 and 2050. There is an expected marked increase in East and West Africa. All African governments assume that the urban proportion of the population is projected to rise from under 50 per cent in 1990 to over 70 per cent in 2050, resulting in marked variations in migration, life expectancy and fertility rates, all of which will continue to fluctuate and will affect and influence the outcome in the various cities (Hedden, Cilliers, Hughes and Moyer, 2011; Escudero, 2017).

The expected implications are that urban populations will place significant pressures on resources, economic systems and public services, creating an imperative for policy-makers to plan strategies, which will make cities more sustainable and resilient. It is further assumed that rapid urban population growth will continue until 2050 and that the number of working-age people in cities will increase (Escudero, 2017). In 2014, only 37 per cent of sub-Sharan populations lived in urban areas and, according to Brahmbatt *et al*., (2016), and this figure will rise to 55 per cent, which translates into 800 million people by 2050 (Brahmbatt *et al*., 2016). The growth of urban populations in African cities between 1980 and 2014 has been an average 4.4 per cent per annum. Figure 5.1 refers to a growth rate not witnessed by any western country in history.

Figure 5.1: Urbanisation in Sub-Saharan Africa



(Source: UNDESA, 2010)

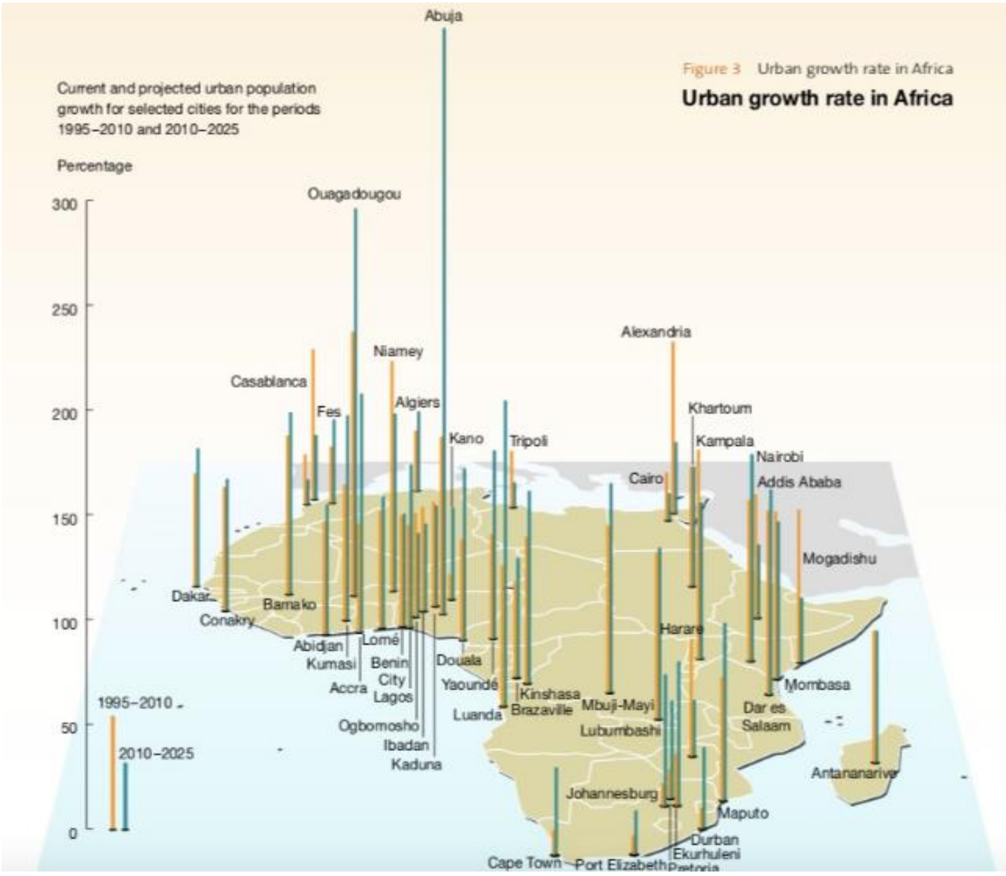
Projections show further urbanisation, with a move of younger people from rural areas to the cities for employment, leaving the aged behind in rural communities. This phenomenon, combined with the overall growth of the world's population, could add another 2.5 billion people to urban areas by 2050 (Ernst & Young, 2010). According to United Nations data, 90 per cent of this global trend is taking place in Asia and Africa (UNDESA, 2016). Sustainable urbanisation is the cornerstone to the successful development, and the understanding thereof is crucial to the 2030 Agenda for Sustainable Development. Cities face challenges in the areas of housing, transportation, energy systems employment and basic services such as education and health care.

Some cities of low fertility in Asia and Europe have shown a further decrease in fertility rates, resulting from a stagnant or declining population as well as from economic contraction and natural disasters. With fertility rates in decline, mortality rates across the board are dropping (IGAS, 2018). Aids-related deaths are showing a decline through the anti-retroviral programmes. Throughout the past decade, South Africa's population has been growing and the economy, growing at the rate of 1.5 per cent per annum, cannot adequately sustain this growth. Figure 5.2: provides a snapshot of urban growth in African cities.

Rural populations in the world have grown slowly since 1950 and are now close to 3.4 billion people in total. These rural constituencies are expected to rise slightly and then will likely show a decline to 3.1 billion people by 2050 (Bernstein and Hansen, 2006; Cilliers, 2010; UNDESA, 2016). Asia and Africa were home to nearly 90 per cent of the world's rural population in 2018, with India's rural population of 893 million people and China at 578 million people (UNDESA, 2018). Urban inhabitants in Tokyo, the world's largest city, sees a total of 37 million inhabitants, followed by New Delhi with 29 million. However, in Nagasaki, Japan and in Busan, Korea, populations declined between 2000 and 2018. Similar trends are noted in Poland, Romania, the Russian Federation and Ukraine.

Landman (2018), noting that South Africa is now in the 4th year of recession, and attributes this growth to the attractiveness and cosmopolitan lifestyle of South Africa's main centres of Gauteng and the Western Cape. This attraction draws more than one million immigrants from the continent as well as internationally (Landman, 2018). Urbanisation results in de-forestation, which affects the ecological balance, harms the environment and results in global warming. With almost 80 per cent of greenhouse gases emanating from urban areas, central governments and local municipalities are becoming increasingly concerned and are starting to play a proactive role in climate management. Figure 5.2. refers to the urban growth rate in Africa's cities.

Figure 5.2: Urban Growth Rate in African Cities

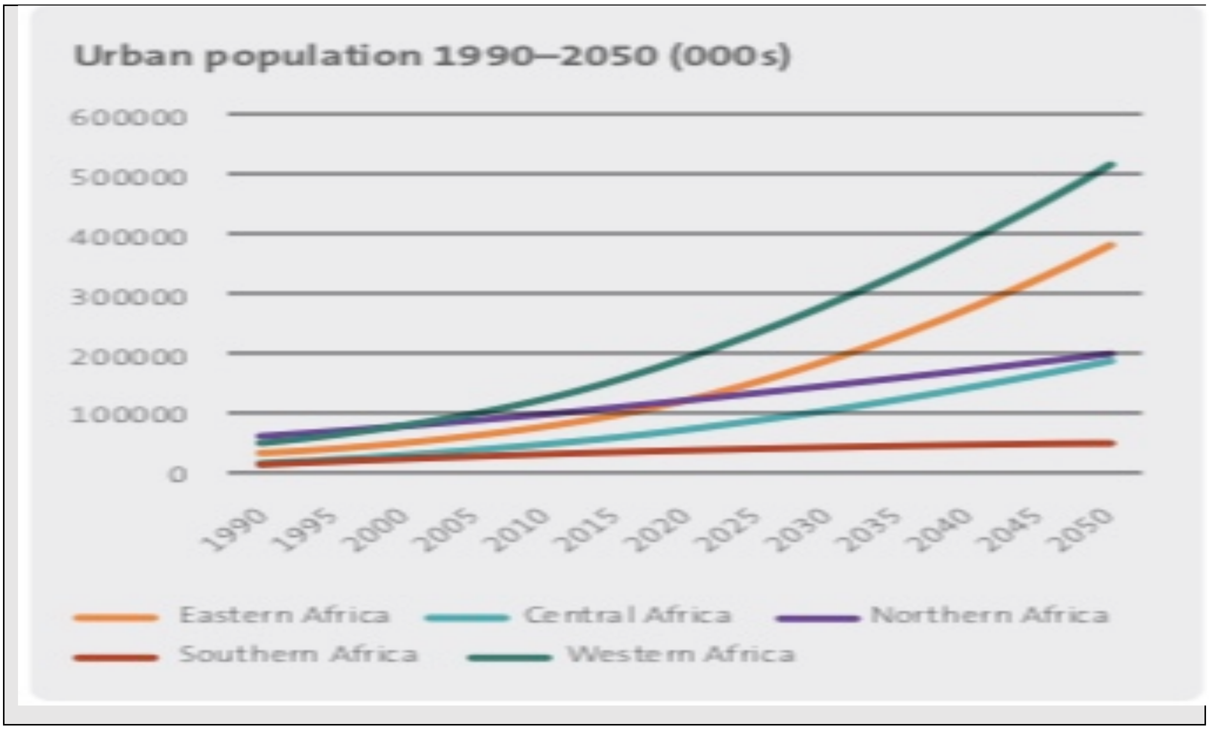


(Source: UNDESA, 2010)

In Africa, the Paris Agreement (PA) (2015) not only marked a new era for governments, but it also highlighted the greater participation of local, regional governments and municipalities in its bottom-up approach. Figure 5.2 above illustrates an expected increase in population in all parts of Africa, whilst Figure 5.3. illustrates the growth areas of east and west Africa, as those economies show positive growth. Africa sees the coming of the Continental Free Trade Agreement (CFTA) in 2020. The Agreement aims firstly to address the current imbalances facing Africa. However, in its current form, the CFTA, does not adequate cover the SDGs and it is agreed that this gap will be shortly address (personal interviews with Barrow, Chizema, Oyelaran-Oyeyinka and Sabatucci 2019). It has been confirmed, in a further discussion, with Sabatucci, (2019), head of the delegation of the European Union to the African Union, that there is a need for greater harmonisation of the policies between the two blocks for better implementation of climate action and other trade policies. Barrow, (2019), Director of the Joint Secretariat Support Office (JSSO), also head of the African

Development Bank (AfDB) endorses this view, pledging the bank's commitment. Figure 5.3 projects the urban growth rates in African cities.

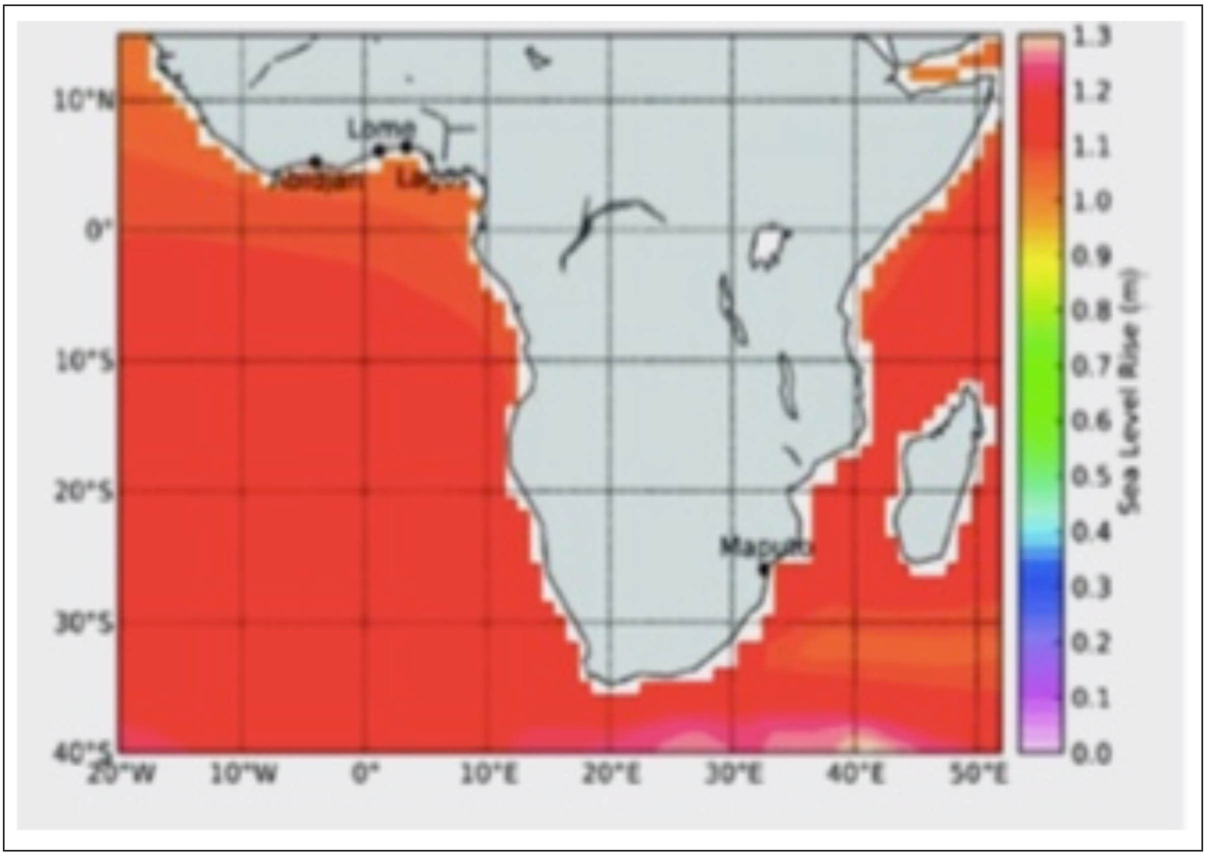
Figure 5.3: Urban Population in Africa



(Source: EUEI PD, 2017, p 39)

The current global energy mix is carbon intensive, which leads to climate risks affecting humans and the planet. With the growing population and unhealthy air environments, the health of humans and animals is compromised. Two-thirds of the NDCs which were submitted under the PA of 2015 consider climate action in cities and regions, given a projected growth of 800 million people towards 2050. This increase requires economic growth, which in turn requires increased energy (Petterson, 2013). Africa operates at less than 30 per cent of its energy producing capacity, and given the projected increase, effective climate management is required to conserve the finite natural resources such as water and to manage air quality levels, given increased emission levels. A holistic approach is required to rectify the situation, whereby 70 per cent of the existing populations in Africa, are living in informal settlements in slum conditions. Urbanisation can only be achieved if stakeholder needs are addressed in a participative manner (Bryson, 2004; Cilliers, et al, 2011; Petterson, 2017). Figure 5.4 refers to climate risks impacts on Africa.

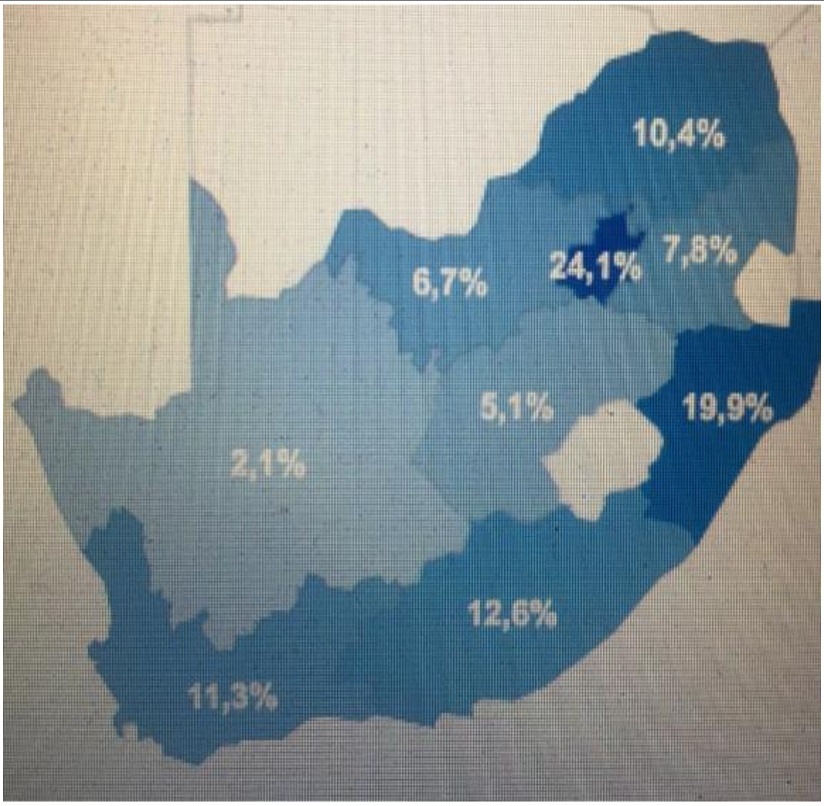
Figure 5.4: Climate Risk and Sea Level Rise



(Source: The World Bank, 2013, p 42)

Urban population results in greater levels of energy being used in cities. A coal-dominated energy system has resulted in the country's high carbon footprint. At a time of reviewing its economic policy as well as the energy policy, South Africa must think seriously regarding the bailing out of the ailing SEO, Eskom (Mboweni, 2019). Mboweni (2019) put forth a new economic policy for public commentary in July of 2019, and in which a glaring omission was that of the oil and gas sector. Speaking at the Days of Committed Consciousness Mining Conference, 2019), Mantashe (2019), on the eve of the media briefing on the new Independent Power Producers Bill, IPP 2019, still showed commitment to the coal sector (personal interview with Mantashe, 2019). Mantashe (2019) publicly criticised Mboweni's 2019 plan, given the clear omission on consideration of the support for the energy sector in general and more specifically the support for the renewable energy sector. Discussed in Parliament in 2012, for the first time, the Bill coming into being in 2019, was hailed as a watershed moment for the renewables energy sector. Figure 5.5 represents the current population distribution.

Figure 5.5: Population of 58.8m (2019) Represented in Geographical Cities



(Source: StatsSA, 2019)

5.2.2 Megatrend Manifestation Two: Unemployment and Education

The EUEI PDF Report (2016), assumes that educational improvements will continue in urban areas and will outperform rural areas, causing inequalities. This phenomenon will exacerbate rural-urban migration and which will highlight discrepancies in literacy levels. The development of 'human capital' will witness an imbalance and may give rise to civil conflict. Therefore, education is critical for sustainable job and wealth creation. Development in rural areas will assist in maintaining the balance in job numbers between urban and rural areas. Energy usage will also be balanced and this can only be achieved by a de-centralised energy model.

The past decade saw the creation of 2.6 million jobs by the State (StatsSa, 2018). This figure is not enough to alleviate poverty, reduce the numbers of unemployed and inequality, as the immigration numbers are dramatically increasing. The current rate of 200 000 jobs being created per annum, is only 50 per cent of the total number of jobs that are required to manage the immigrant influx (Landman, 2018). The Karoo is home to less than 12 per cent of the country's total population and this factor is an important consideration in the final recommendation of this research.

Urban population growth, the first social megatrend impacts upon unemployment and education and see a growing number of young people moving into the working sector, currently in urban areas, causing rural-urban migration. Liability is placed on the South African government to grow the economy and create jobs for the increasingly growing nation of South Africans, as well as the one million foreigners who have entered into the country over the past ten years. This period has seen the ANC government creating 200 000 jobs per annum (Cronje, 2012).

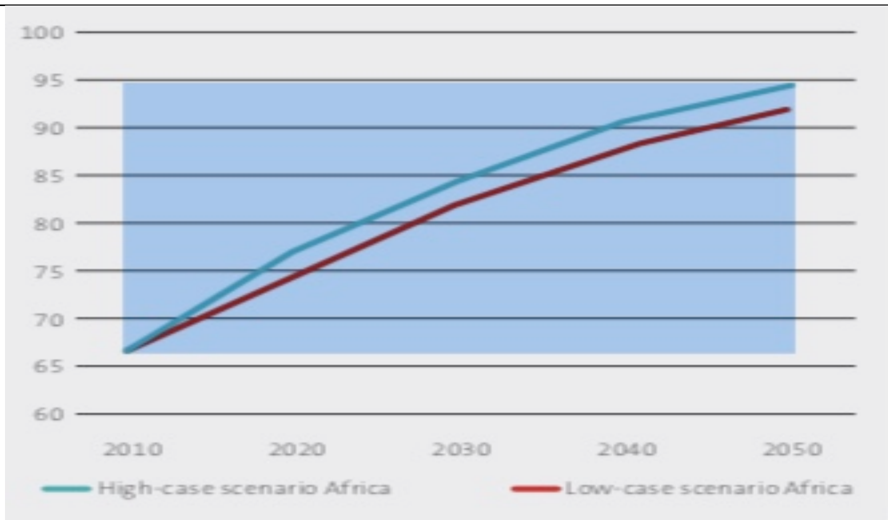
Rural-urban migration is a key change driver highlighted in this research and it is expected that the UOG opportunity in the Karoo will create much-needed jobs in the Karoo and stem the migration to urban areas. The Karoo case should be seen as a pilot case to develop regional economies and lead to de-centralisation of the current energy model. For de-centralisation to occur, a de-centralised energy model is necessary, as energy is required for large-scale industrialisation.

The petrochemical sector of South Africa is the least empowered sector of the South African economy (Shabangu, 2011). It is expected that the 700 000 new jobs from UOG extraction will address this problem and create the much-needed jobs in rural areas. Specific high-level skills are required for the UOG industry. Capacity building with a focus on environmental protection, remains a high area of priority. An assessment of skills for the UOG extraction is required and which will entail a capacity-building programme for high-level skills, as well as the upskilling of artisans into more specific, technical skills which are required for shale exploration. This plan needs to be fully resourced and implemented within realistic timeframes (ASSAf, 2016; CEF, 2018; Glazewski and Esterhuyse, 2016; SAOGO, 2018).

According to the AfDB, investment in education should see the current trend of literacy rates continue (EUEI PDF, 2017). These levels reach around 92-94 per cent, in 2050 from 67 per cent in 2010. Life expectancy also increases to 70 years in 2060, compared to 56 years in 2010. The implications of higher literacy levels would increase the likelihood of advancing economic development and consequently, the creation of higher-value employment. Better education systems will hasten the pace of technological breakthroughs, which reduces the impact of communicable diseases (Berman, 2006; Hernandez, 2009).

Education in the Karoo is stagnant. Focus groups in the Karoo towns provided invaluable insights supporting this statement and at the same time informing this research of how this problem might be resolved. A specific workshop was held to understand the issues and requirements of large-scale capacity building. Following an in-depth investigation into the subject, this researcher has written a BRICS Policy Brief on Capacity Building. A curriculum on energy studies for higher learning institutions, based on the Finnish model, was recommended for implementation into BRICS universities. South Africa, over the past 24 years, has witnessed the increased numbers of youth but without adequate planning for the creation of capacity development. Figure 5.6 illustrates the projected African literacy rates as put forth by the bank.

Figure 5.6: Projected African Literacy Rates (%)



(Source: AfDB, 2011, p 43)

5.2.3 Megatrend Manifestation Three: Health

The rising emission levels impact upon and increase climate risks and manifest further in water scarcity, in the already water-stressed Karoo (Avenant *et al*, 2016). Extreme weather conditions harm the homes of the Karoo and greater impact is felt by the elderly. In a personal interview with Mayor De Vos, the Honourable Mayor articulated:

…that it gets so hot in the Karoo, that people want to leave their houses and run…but where to? As it is hot everywhere, and there are no trees to hide under. (De Vos, 2018)

The Mayor's sentiment underscores the idea of Glazewski (2016) concept of 'niks'. Improvements in health influence the demand for energy as life expectancy levels are increased (EUEI PDF, 2017). Raised health levels and income levels would increase the demands for services. Improved economic opportunities may also reduce the likelihood of civil conflict. The town of Jansenville consists of a population of 10 000 people, living in dire poverty. Public services are at the barest minimum. The population relies on the small local hospital which lacks modern equipment and is under-staffed. One the respondents, in the focus group, a handicapped young three-year law student, who was unable to completed the programme through the lack of financial resources, suddenly took ill and after delays in reaching quality medical cover, was dead on arrival.

5.2.4 Wild Card Manifestation: Climate Risks, Civil Conflict and Technological Breakthroughs

The EUEI-PDF Report (2016), on African cities, lists climate risks and civil unrest as wild cards which face African futures and impacts upon humans. Civil unrest is a critical and real emerging trend which manifests itself in forms of increased gender-based violence and xenophobia. Advances in technology have commercial benefits, but could hamper local municipalities and civil society at large. The addressing of the 'Triple Challenge' in the Karoo is vital, and failure to address these problems will result in the wild card of civil unrest, which is manifesting widely across the world, from the Arab spring uprising to the recent events in Hong Kong in 2019. In South Africa, the problems of gender-based violence have occupied media centre-stage between 2017-2019. The seeds of xenophobia which were planted in 2012, manifested periodically over the years and reached a tipping point in 2019.

The wildcard manifestation of technological advances is expected to manifest itself in the Karoo, South Africa. Technology is advancing at a rapid pace and could change the course of business and how humans live. In the case of UOG extraction, technological advancements enable safer exploration practices as well as greater efficiencies. StatsSA (2019) provides vital statistics of the low literacy and skills in the

Karoo. The following sections motivate the extent of technology that drives the UOG extraction and presents critical challenges to all strata of the workforce and community. It is, therefore, necessary that the process that determines the selection of particular innovations, and the effects on industrial structures, are examined and addressed (Dosi, 1988). The above section, together with Chapters Three and Four, concludes the introduction of the megatrends which impact upon the potential UOG extraction in The Karoo. The following section discusses the drivers for change which have specific impacts on the social question.

5.3 PART TWO: KEY UNCERTAINTIES AND DRIVERS FOR CHANGE

Bamberger et al. (2012), maintains that communities living near hydrocarbon gas drilling operations have become de facto laboratories for the study of environmental toxicology. (Bamberger et al. 2012, p.30).

Such notions are reinforced by South Africa and U.S. authors (Esterhuyse and Glazewski, 2016), throwing light on the critical adoption of the precautionary principle the UOG extraction, with specific considerations to water usage and administration. The focus groups, the experts and representatives of the various community groups, expressed concern about the current dire state of poverty and unemployment in the Karoo, South Africa. Under these conditions, in desperate need for employment may sacrifice public well-being.

Respondents in the youth focus groups spoke of the unfair treatment of locals when employed in the local factories. Preference is sometimes, given to more competent individuals from large cities such as Port Elizabeth, situated 350 kilometres away. The government experimental farm, a job creation pilot project, recruited individuals from outside the rural towns. Glazewski (2016) maintains that the Karoo is an expansive beauty and home to many unique species of plant life and organisms, but for the 80 respondents of the focus groups, the Karoo is a very different place and it is hard to see the world as a place of pristine beauty, when people live from hand-to-mouth and in desolate conditions. Table 5.1 below, refers to the key drivers for change by the social megatrends of poverty, unemployment and social inequality.

Table 5.1: Key Drivers for Change Driven by Social Megatrends of Poverty, Unemployment and Social Inequality

Key Drivers for Change Driven by Social Megatrends of Poverty, Unemployment and Social Inequality
Climate policy which manifests in community-driven projects Poverty Alleviation and WEF Nexus approach Unemployment Social Inequality and Inclusion. Addressing xenophobia and gender-based violence Urban planning policy Infrastructure: Urban planning and transportation Technological impacts on society UOG extraction R&D and civil society participation Education and Capacity building The extractive sector and communities (How the private sector can assist society to attain the SDGs). Transparency and public scrutiny Implementation capacity Informal settlements Gender equality – "leave no-one behind" Urban planning policy that support energy efficiency and low emissions Local land rights Urban Transport Smart governance City to city collaboration Addressing Inertia (Capability, capacity and data inertia)

(Source: Researcher's Construction, 2019)

5.3.1 Climate Policy and Society

According to Escudero, (2017), African cities are limited in capacity by competences and resources. This point was further interrogated in a personal interview with Tau held in Johannesburg on the 20 June 2018 (personal interview with Tau, 2018). Tau, previous mayor of the City of Johannesburg and now the president of the United Nations Local Government Association, (UNLGA), delved further into the independence of rural municipalities. The president was asked to elaborate why South Africa has not participated in the CDM programme. It was concluded that this has been a missed opportunity for South African communities. This led to the researcher's mine rehabilitation and carbon sinks programme.

Carbon trading programmes would benefit communities while contributing to climate change management. As a transition towards a lower carbon society, such UNFCCC (1992) programmes, run mainly in China (50 per cent) and India (30 per cent) in the 2016-17 period, assist in sensitising civil society to the need for sustainability programmes and for care for the environment (Van Asselt, 2017; Pizmony-Levy, 2011).

The capacity of local government in African cities, amidst the current state of financial worries, is challenged when trying to raise finance and manage and implement change programmes, being reliant on the central government. With the South African municipalities' low resources and the lack of capacity this makes autonomy almost impossible (Glazewski *et al*., 2016). South African municipalities tend to have a formal electricity agreement with Eskom, with local regional municipalities and departments of electricity purchasing and selling on to users.

There are currently situations such as in the municipality of Maluti-a-Phofung, in the Free State province, which is so heavily indebted to Eskom, that industries in the local Special Economic Zone (SEZ) face a blackout for months, having to rely on generators to power factories (Osman, 2018). South African municipalities under the auspices of the SALGA allocates the responsibility for the administration of newly introduced green building regulations (Escudero, 2016).

5.3.2 Poverty Alleviation

Poverty alleviation is reduced by the growth of the middle-class and which is achieved through the effective implementation of education and capacity-building programmes which in turn result in increased employment. Top of the socio-economic agenda in the towns of Graaff-Reinet and Jansensville is job creation which will lead to poverty alleviation. One of the respondents in the focus groups summarises it as follows:

We are not interested in democracy and equality, (that) has failed us, we just want a job. (Focus Group, Jansenville, 2017).

Job statistics per well, in the U.S., illustrate that UOG extraction, providing an alternative source of employment in the area, can also bring infrastructural development and billions of rand in revenue (PwC Report, 2014). Furthermore, on a national scale, the envisaged ripple effect of socio-economic development from UOG extraction would help redress the country's current inability to meet the SDG1 which addresses poverty reduction.

5.3.3 Unemployment

The South Africa government since 1994, has implemented many job creation initiatives. Whilst the programmes may have been successful, irresponsible actions like the firing of Finance Minister Nene in 2016 resulted in 140 000 jobs being lost. There is expected loss of 7000 jobs in 2025, when Eskom plants will be shut down and such occurrences are problematic to the government. The country must also face the challenges of the unplanned influx of one million immigrants from Africa.

South Africa in the long-term needs to create direct and indirect jobs, across the various sectors in the economy. These would emerge as a positive contribution to the development of other sustainable prospects of cheaper energy and which would help to reduce production costs in a range of industries, all of which are envisaged to develop near a close, cheaper source of energy. These cost-benefits would be passed on to consumers, resulting in lower inflation levels (Du Toit, 2016; Glazewski, 2016; Wakeford, 2016). The job figures from Lancashire, UK, prove that greater numbers in employment were created for the UK nationally, than for the town alone. However, in both the U.S. and the U.K. there has been widespread concern that labour attracted to the shale exploration would result in a dearth in other sectors. The case of the Karoo is different, as there are no other high performing sectors.

5.3.4 Social Inequality and Inclusion

'If you educate a woman, you educate a family (nation)' is a famous saying that is attributed to Ghanaian scholar, Kwegyir-Aggrey (1927-1987) (afriprov.org. 2019). This research cites the various women respondents in the focus groups and whose comments as participants in the Sarkar Game were highlighted. A striking insight was the emphasis that women of the group placed on the education of children, as well as leading the household as single mothers. The women visualised the years towards 2055 as a prosperous period with family life being comfortable, powered by a world-class education with health and other social systems, instituted by the regional government.

South Africa's Constitution (1994) celebrates diversity and the active empowerment of not only women but of all the marginalised peoples of South Africa. These include trans-genders, homosexual, physically-challenged individuals and further addresses all racial inequalities. The term 'gender equality' in this research refers specifically to the equal economic, political and social status of both men and women (Esterhuyse and Glazewski, 2016). The issues of land reform discussed in Chapter Four impact upon the subject matter of this chapter as social inclusion is addressed on a strategic level through land reform. The land reform policy in South Africa seeks to re-address the levels of inequality at a very strategic level.

The recruitment of respondents and interviewees paid special attention to this key driver for economic liberation and provided accurate sampling for the arrival at accurate assumptive purposes. A PricewaterHouse Coopers (PwC) (2012) study in the U.S., revealed that in 2009, the oil and gas industry supported 9.2 million jobs and contributed 7.7 per cent to the GDP. According to the UOG Market Report 2012-2022, the global UOG market is lucrative, having been valued at USD 36.95 billion in 2012, which at the time, compelled many markets to begin examining the potential of UOG extraction (Du Toit, 2015). In light of these statistical indicators, this research in Chapter Four, mapped out the scope of possible jobs which will benefit all genders groups of the Karoo, as well as the rest of South Africa (Du Toit, 2015; Economist Intelligence Unit, 2016).

5.3.5 Technological Impacts on Society

The Global Entrepreneurship Monitor (2015) concluded that Botswana and South Africa out of 60 countries in Africa are best placed to support technological innovation. This can be attributed to the infrastructure of the leading independent mobile service providers of MTN, Vodafone and Cell C as well as the state-owned Telkom. The level of electrification in South Africa, could also be a contributing factor. Low electrical output hampers connectivity in Zimbabwe, DRC and Sudan (Escudero, 2016).

Technologically, the world is progressing at an unprecedented rate and South Africa is one of the more advanced countries in Africa. Technological uncertainties in this context as a driver for change, refer to the extent of domestic technological innovation, the implementation of modern innovative, imported energy technologies, technologies promoting economic growth and technological advancements in education (Escudero, 2016). In Africa, the World Bank has sponsored hubs, resulting in Nairobi harnessing this opportunity and becoming a centre for technological advancement and innovation. In 2014, an estimated penetration rate of 56 per cent of mobile technology was evident. In 2010, 480 per 1000 on average, had a mobile phone subscription, and this figure is expected to rise to 1045 per 1000 by 2060 (AfDB, 2011; Escudero, 2016). ICT broadband usage has also increased in the past five years, from 0.1 per cent in 2005 to 7 per cent in 2010 and projections reveal a sharply rising trend to 99 per cent of the population by 2060 (EUEI PDF, 2017).

The factors most responsible for recent productivity improvements are technological (Bohi, 1998). The fundamentals of science and technology should not be confused, as according to Dosi *et al*. (1988), both possess borderline similarities (Dosi, 1982; Dosi, 1984). These factors may be conducive to, or may be of hindrance to the development of new processes of production as well as municipal administration. Technological paradigms follow precise trajectories which are governed by the sciences, particurlarly with reference to emission and climate action. Smart governance refers to the use of smart technology. Specific systems may be designed to gather data on traffic patterns and resource use, which can influence the design of the energy usage of the cities. These systems allow civil society to participate in the decision-making situation.

5.3.6 UOG extraction R&D and the Participation of Civil Society

The seeds of the UOG boom were planted in the late 1970s when the US government decided to fund R&D programmes and provide tax credits (and incentive pricing) for developing unconventional natural gas in response to the severe natural gas shortage at the time (Bohi, 1998, Krupnick and Wang 2013). These policies were justified because private firms did not have the incentive to make large and risky R&D investments in developing the technologies necessary for extracting unconventional natural gas (Krupnick and Wang, 2013). The early days of the extraction did not see much participation of the civil society. Only the land-owners engaged in real estate rentals and sales to developers.

South Africa spent approximately USD 1,8 million between 2013 and 2016 before the announcement of the Government's expressed intent for a pilot exploration (De Wit, 2015; Linol *et al*., 2017). In South Africa, no national pool of intelligence or state-owned instruments exists, thereby enabling the Government to conduct its independent research (De Wit 2011). At the time when shale engaged the inhabitants of the Karoo, civil society was largely uninformed and this led to the highly reductionist view of the government that shale exploration would be allowed, even though sufficient investigation had not been carried out (Green, 2016; Fakir and Davies, 2016).

U.S. Government policies stimulated the development of UOG in the Appalachian and Michigan Basins by assisting in the development of key technologies, such as micro-seismic fracture mapping and horizontal drilling (Bohi, 1998; Krupnick et al., 2014; Linol, et al, 2017). The private entrepreneurship from Mitchell Energy and Development (ME&D) played a primary role in developing the Barnett play in Texas. The successful development of the Barnett play jump-started the UOG boom, which positively impacted upon communities (Krupnick *et al.,* 2014).

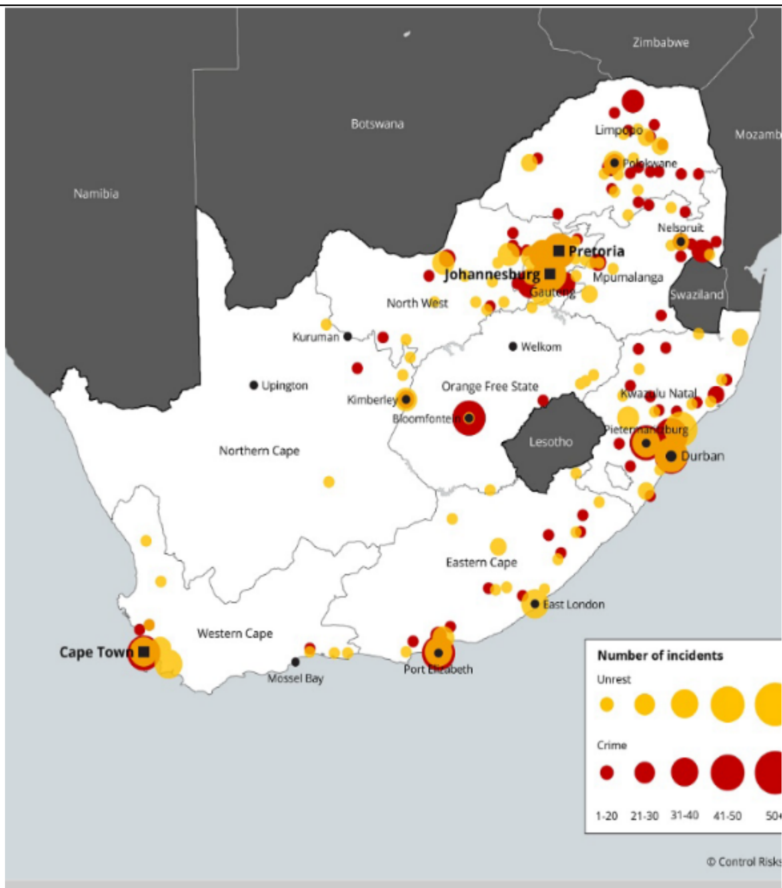
The NRC assessed the most important technological developments in the eighties and nineties and the role of the DOE in developing these technologies. Parallel to government spending, skills development of the people first started on an *ad hoc* basis and later became formalised. Institutions developed to support communities in a formal supply network, ranging from private accommodation, to restaurants and other leisure activities (Jackson, 2018). In the U.S., the three technologies have been critical to the U.S, shale exploration: horizontal drilling, 3-D seismic drilling and 3-D seismic imaging and fracturing technology (Dosi, 1998 Krupnick *et al.,* 2014b). The method that was used was low cost, simple and effective, as the shales of the Devonian areas are shallow and easily accessible (Krupnick *et al*., 2014b). These functions were mainly confined to the scientific communities, which migrated from other parts of the country. However much later in the exploration, communities were upskilled in technologically advanced jobs and this ensured a high calibre workforce engaged in better paid jobs.

Media coverage did not help the shale case as the widely referenced ‘Tap of Fire’ (YouTube, 2015) showed gas being flared by a Texas resident. In a personal interview, this researcher questioned Jackson on the 20 June 2018 at Stanford University, and it was confirmed that the methane in that case, was not from shale exploration. However, this discourse with Jackson (2018) led to a greater investigation of the air quality samples at Stanford University, after which this research began a new line of questioning into methane and other GHGs. However, the ‘Fire on tap’ investigation confirmed the concerns of Green (2016). The shale industry started a USD 4,5 million lawsuit on the resident for defamation. The rest of the neighbourhood, understanding the support of the U.S. government via the EPA, realised that power of the IOCs. In South Africa, the shale debate has been emotional. Apart from civil society being aware of the real risks of the extraction, even the environmental pressure groups are not discussing complex issues such as methane leakage and air quality.

5.3.7 Instability and Inclusion

Instability and inclusion refer to political ideologies that could impact upon society and the effectiveness of the UOG operation of the Karoo, South Africa. UN-Habitat describes African cities as highly segregated along the lines of class and ethnicity. South Africa in 2012, witnessed the worst xenophobic attacks in Africa and which shocked African governments and the world. Similar incidents occurred in July 2019, causing Ramaphosa to cancel an engagement at the New York Climate Change Summit (2019).

Figure 5.7: Crime and Unrest 1 July 2017 – 1 July 2018



(Source: Control Risk, 2018)

Greater inclusion and tolerance are needed and which would consider gender, the physically challenged and ethnic minority groups. Rural areas are categorised by a significant number of foreign entrepreneurs, in specific sectors, such as Pakistani nationals in mobile phones, Somalians in corner shops and convenience stores and Chinese in independent motor spares shops, hardware, retail clothing outlets. Figure 5.7 refers to the crime statistics in 2017-18.

5.3.8 Education and Capacity Building

The Centre for Risk Analysis (CRA) at the Institute of Race Relations (IRR) published a report entitled *Education, the single greatest obstacle to socio-economic advancement in South Africa* (2018). The report concluded that South Africa's deficient education system is replicating the patterns of unemployment, poverty and inequality (News24, 2018) and that a new approach to education is urgently needed:

…on the strength of our experience and analysis, the quickest way to a much-improved education system would be to greatly strengthen the scope for School Governing Bodies and communities to control and exert the influence in the interest of the children (Cronje, 2018)

Black higher education participation is just 15.6 per cent, whereas that for Indian and White people (aged 20-24) is 49.3 per cent and 52.8 per cent respectively. Cronje (2018) notes that the data makes it clear that the lack of education is the primary indicator that determines the trajectory of the young South Africans, and that it is futile to think that middle-class expansion, let alone a demographic transformation, will take place as long as statistics for Black learners prevail. It is, therefore, necessary that all types of education, which can be adjudicated against an agreed framework is on par with international learning institutes, and be made available to learners of rural areas.

Cronje (2018) concurs with the IRR, that education is the single greatest obstacle to socio-economic advancement in South Africa and that urgent intervention is required. The experiences from other BRICS countries should be implemented in the South African higher learning system. While there is intent on the part of learners, technological infra-structure and lengthy bureaucratic timelines, through the institutional approval system, are barriers to effective implementation. The researcher conducted a capacity-building workshop in 2018, under the auspices of the BRICS Academic Forum. The workshop led to the development of a university degree programme aimed at graduate level. The degree content is centred around environmental law and policy. The energy sector requires specific capacity-building in the area of potential breakthroughs in power storage, renewable energy developments, information and telecommunications technology (Cilliers et al. 2011; Escudero, 2016).

Respondents expressed the dire need for capacity development in the sector of sustainable energy. A university accredited online programme under the auspices of Coursera, was made available free of charge to the community of Jansensville to assist the youth. Jansensville is a town of 10 200 inhabitants and 7 300 are within this target age group and of which only 750 are gainfully employed (StatsSa, 2018). The programme could not be executed due to the challenge of connectivity. According to a local supplier, the possibility of a dedicated antenna would be only foreseeable in the following 48 months. In order to implement such a programme successfully in rural areas, the project planner needs to be plan and resource initiatives off a zero platform. As seen in other parts of Africa, investment in technology has been driven by the private sector to support core functions (Herbst and Mills, 2003). In the case of UOG extraction, or the development of large-scale renewable energy, households and industries would be required to tap into power storage using the latest technology envisaged for that time towards 2050. It is therefore critical that users are upskilled.

5.3.9 Infrastructure: Urban planning and Transportation

African cities are in critical need of infrastructural development to support increased population and increased energy demand (Hernandez, 2009). Surveys across 36 African countries found that on average 40 per cent of households were not connected to a central, nationalised grid, that 35 per cent had intermittent connection and only 25 per cent had a connection that always worked (Escudero, 2016). In South Africa, rolling blackouts have categorised the electricity situation since 2010, and the cost of electricity from Eskom is higher than the renewable energy sources and which sees Eskom buying and reselling on to industry and domestic households (Eskom, 2017).

The Karoo is uniquely situated and possesses the necessary components for UOG extraction, wind and solar energy (Atangana and Van Tonder, 2014; Godeke and Hoossain, 2012.). Given the distance away from surrounding large towns, the benefits should outweigh the costs and the most likely scenario will see a decentralised energy model for the Karoo, whereby industries would be set up close to the source of the resource (Glazewski *et al*., 2016; Wakeford, 2016). However, this strategy only becomes commercially viable based on shale gas, during a limited period of exploration and provides a transition towards more sustainable energy forms of solar and wind technologies. The growth of an economy relies on increased industrialisation, which in turn relies on increased freight and inland logistics, growth in passenger vehicles as well as public transport (Glazewski and Collier, 2012). These means of locomotion, coupled with the increased electrification of towns and cities, increases pressure and demand on energy supplies and which in turn increases climate risks (Hertwich and Peters 2009). Apart from the number of trucks envisaged on the Karoo roads, more cars will be required as individuals gain wealth (Glazewski & Esterhuyse, 2016; Gregory *et al,* 2007).

The Masdar Scientific Institute (2018) in Abu Dhabi, United Arab Emirates has been the subject of study since the inception of this doctoral research in an attempt to keep up to date with the developments and opportunities for research collaboration and implementation of certain key innovations which could be easily implemented in the Karoo. Masdar boasts of 40 000 inhabitants living in a society exclusively powered by renewable energy and of buildings which, by design, work with the atmospheric conditions to create modern, pedestrian, vehicle-less environments and whereby the only vehicles are driverless cars which are electrified and powered by renewable energy forms (Kapros, 2016; Masdar.ae, 2016). Another example for collective living in a sustainable environment is UNESCO's Auroville in Chennai, India, which will provide subject matter for further discussion and recommendations for the Karoo, South Africa, towards 2055.

5.3.10 Extractive Companies and Communities

Across Africa, the private sector is pivotal in playing a role as provider or investor of electricity as well as being a customer to the state across the continent, according to Escudero (2017). Approximately, USD 7.2 billion of investment in energy infrastructure with approximate 4 GW of capacity produced by independent power providers (IPP) in Africa (Escudero, 2017). The exact figure for South Africa remains unclear due to non-disclosure of subsidies in the coal sector (Burton et al, 2019; Fine and Rustomjee; 2016; Gard & Kitson, 2015). The changeover from apartheid to the new South African government saw the rise of black investors. These investors are engaged in coal mining and all subsidiary functions and enjoy ever-green contracts from the state. There are also multiple concessions and subsidies which provided additional support and benefits. With a move to a lower carbon society, many of the same investors are transiting to renewable energy. None of these investors, to date has considered the UOG sector (IGas, 2018; CEF, 2018).

5.3.11 Transparency and Public Scrutiny

Transparency at the central and local government level is critical. Civil society may actively play a part in the monitoring of targets and objectives. The Economist's Intelligence Unit Democracy Index during the years 2006 to 2015, shows very little improvement in levels of democracy (Economist, 2015). However, the transfer of power in many African regimes caused few shocks in the recent history. The Ramaphosa case may be referenced, as China being one the most significant investors expressed anxiety at the changing of the guard from Zuma to Ramaphosa, in early 2018 (CEF, 2018; IGas, 2018). A transparency index listed and analysed 23 African countries as authoritarian regimes (Escudero, 2018; controlrisks.com, 2018).

5.3.12 Implementation Capacity

Accordingly, to Escudero *et al.,* (2016) implementation capacity refers to the legislative and judicial competence, the resources and organisational processes and the policies and the structures that have been instituted by central and local government to effectively administer the extraction of the UOG resources in the Karoo, South Africa. Four dimensions of city power are suggested, namely; the ownership and operation of assets, the ability to set and enforce policies, the control and spending of budgets and the ability to set and achieve visions. The authors further state that weaknesses exist in financial transfers, revenue-raising powers, human resources and citizen participation. The South Africa Reserve Bank (SARB) plays a pivotal role in monitoring of inbound and outbound forex transactions (Investec Reports, 2017).

5.3.13 Informal Settlements

In Africa, between 50 – 80 per cent of the urban population live in informal settlements. South Africa, with the continued influx of African nationals, is under pressure to grow economically and provide jobs. Drivers which enforce the informal settlements and informal economy are poorly enforced with overlapping systems of land rights (Escudero *et a*l., 2016). South Africa experiences this phenomenon. Since October 2017, the EFF, with the majority consensus of the disgruntled youth with no further confidence in the ANC, the ruling party, has voiced sentiments in favour of land expropriation, without compensation and the nationalising of mines in South Africa. Part Three presented the wildcard manifestation, critical uncertainties and drivers for change. Table 5.2. continues the line of enquiry in Chapters Three and Four and continues the same line of questioning, from a social perspective.

The research has summarised the latest trends and development in the changing society. If these factors are given the due attention, society is likely to be more comfortable with the planning of UOG extraction on the doorstep. Following the line of questioning in the previous two chapters and Table 5.2 recaps the main questions which have been put forth by Inayatullah (2015).

Table 5.2: Inayatullah's Questions (2015) in the Context of the Extractive Companies and Society

Inayatullah's Questions	Data on the Social Question
What stays the same?	Civil conflict, gender-based violence and xenophobia increases after 2012. There is a continued influx of people, both locals and foreigners into urban areas from rural areas. There is a lack of inclusion and this results in societal instability.
What are the key trends?	Technological advancement requires intense capacity-building programmes to ensure that civil society participates in economic opportunities. There is a greater appetite for sustain energy solutions and the public shows Interest in CDM projects. Greater awareness of gender-based violence and xenophobia results in higher acceptance and tolerance of all groups.
What are the main processes of change?	Greater access to electricity and connectivity, which results in better health and education programmes. Innovation in power storage will advance the development of renewable energy forms, which in turn will lead to better livelihoods and will reduce civil conflict.
What are the new issues in the pipeline?	Increased income per capita. Emergence of a black middle-class and more social benefits for the poor. Greater emphasis is being placed on strategies to attain the SDGs.
What are the sources and hope?	A well-balanced participative society working together with the private sector and a cooperative government. African governments unite under regional organisations, working together to generate wealth and prosperity for the youth and women.

(Source: Researcher's Construction, 2019)

5.4 CONCLUSION

The megatrends were presented in the first part of this chapter and in the second part, the complexities of the Triple Challenge were discussed. The data analysed in this chapter is critical for the understanding of societal issues which must be addressed in order for the successful implementation of the UOG extraction in the Karoo.

If society has to be re-configured and go through the pains of such an exploration, then society dwellers must be the real beneficiaries. The question, "For whom exactly, is it UOG extraction an economical game-changer?" becomes more hard-hitting. Conway (2009) put forth that the data in the environmental scan would lead to strong policies which benefit society in the long term. According the recent studies, emanating from Columbia university on how extractive companies can assist communities to be less reliant on a single extractive company, the community of the Karoo, in on the correct path of optimizing UOG extraction, up a point that this necessary to spearhead the transition towards sustainable energy futures. Leaving as much fossil fuel reserves in the ground is the task of the new, modern and responsible generation. The data in this chapter has allowed for the new generation of policy-makers to form a strategic standpoint, putting humans, plants and animals on the planet at the fore, then looking at the sustainability of livelihoods, while meeting economic objectives.

The narrative of extractive companies assisting communities is extended to attaining the SDG's. In this manner, the unemployed find jobs in CDM projects which support strong climate action. Once the well-heads are closed and the developers have moved on to new wells, in the "guerrilla-fashion" as explained by Maugeri (2012), rehabilitation of the land, now in the ownership of landowners are able to start re-forestation projects. In these projects, there is greater inclusion of women and the previous workers, who have been part of the UOG extraction. Education and capacity programmes which are envisaged should encompass not only the training for UOG extraction, but look further beyond the forty-year period, to sustain the renewable energy sector.

Plans for infrastructure, urban planning and transportation should look further than the five-hundred trucks per day on the Karoo roads, but rather trade corridors are envisaged to support multi-sectoral activities, which includes large scale agriculture. The data provides salient information on the number of jobs that would be created and from that information, future population figures may be assumed. On the basis of this information, the South African government should set aside investment and plan on the construction of long-term homesteads, which are fashioned along the lines of modern building techniques, which provide better protection from the severe environmental conditions. Addressing energy from this standpoint, starting from the abundance of a unique resource, de-centralised economic models will emerge which will stem the migration from rural to urban areas.

The next chapter provided an introduction to the scenarios and the methodological steps in scenario development. The chapter is a culmination and the crystallisation of the data which follows Choo's (1993) environmental scanning approach. The story-telling part and the development of the scenarios are elaborated in Chapter Seven.

CHAPTER SIX

6 SCENARIO DEVELOPMENT

6.1 INTRODUCTION: CAUSAL LAYERED ANALYSIS IN SUPPORT OF SCENARIOS

Inayatullah (2005) places CLA within what is considered critical futures research:

This tradition is less concerned with the disinterested pursuit of knowledge, as in the empirical, or with creating mutual understanding, as in the interpretive, but with creating distance from current categories. This distance allows us to see current social practices as fragile, as particular and not as universal categories of thought. They are seen as discourse, a term similar to the paradigm, but inclusive of epistemological assumptions. Through establishing distance and introducing different ways of knowing, the problem can be redefined. Redefining the problem allows for the exploration of new and alternative possibilities, ideas, and solutions while testing validity against the norms and values of society (Inayatullah, 2005).

As previously stated CLA consists of four layers, each a step deeper than the previous one. Although CLA has been elaborated in previous chapters. The commentary in this chapter drills further and analyses the manner in which the scenarios have been developed (Godet, 2001; Godet and Roubelat, 1996; Graves, 2012; Heijden, 2010). The first or litany layer is concerned with obvious trends. The second explores social causes, the third drills into the discourse or worldviews and the fourth examines the hidden stories or myths or metaphors (Inayatullah, 2005). Quantitative trends and problems characterise the Litany Layer, exploited by politicians and the media and creating high visibility for these trends (Inayatullah, 2005). Due to its political nature, these trends or problems also tend to quickly fall out of fashion as some new hot topic replaces them. Little to no analysis is done, and trends and data are accepted as fact.

The second layer, called Systemic Causes, is also characterised by quantitative trends and data such as economic, political and historical factors. Unlike the litany level, the second level explores the trends and data to develop an understanding through interpretation rather than blind acceptance. This layer is characterised by the application of specialised techniques and models built on a strong academic foundation (Inayatullah, 2005). The third layer, called Worldview, goes even deeper and endeavours to explore the world views underlying the trends and problem definitions in the second layer. This layer allows for the opportunity to redefine the problem in the litany layer through not only understanding how the different discourses cause and sustain the trends but now also through legitimising and reinforcing them. This level is less about the technical analysis, but rather about how factors such as culture, political views and religion influence views about the world. This layer, unlike the second layer with its strong technical grounding, uses language as a key for unlocking the meanings and different ways of knowing (Inayatullah, 2005). The fourth layer explores what is termed the Myth or Metaphor layer. This layer is about the discovery of the deeply rooted, unarticulated, highly emotional and unconscious stories behind the story. This layer attempts to deconstruct the world view into images which can transcend into other structures of interpretation. Images become the key to this layer due to the limitations of language (Inayatullah, 2005).

The richness that CLA brings to scenarios follows from moving up and down and within layers, providing different perspectives on the problem. CLA even challenges whether or not the right question or problem is being considered. CLA questions the ownership of the problem and thereby opens up a multitude of alternative solutions (Inayatullah, 2005). CLA, a post-structural future-oriented methodology which is post-structural, seeks to problematise existing future-oriented thinking by exploring the assumptions, ideologies, worldviews, episteme, myths and metaphors that already are embedded in images, statements or policy-oriented research about the future. CLA has also developed as a way of opening up spaces for alternative futures. These alternative futures are not based on extrapolating trends or tweaking the assumptions in a systems model, as is common in scenario building, but through deconstructing and reconstructing, critical assumptions about the way that the world is constituted are questioned (Inayatullah, 2005).

6.2 THE FUTURES TRIANGLE

The following questions are asked in the assessment of the futures triangle.

6.2.1 What Stays the Same? The Push of the Past

Intent on following the NDP 2030, government continues the centralised energy model, through Eskom and the energy model is dominated by coal (SONA, 2019). Since 2012, civil conflict which manifests in gender-based violence and xenophobia continues and reaches a tipping point in 2019, which leads to strained international relations with African governments. The influx of immigrants continues, creating greater informal settlements in the urban areas. Rural urban migration continues as there is a lack of employment in the rural areas. Many industries in rural areas move towards the urban areas to consolidate warehouse space as economic challenges increase and a demand for goods and services decreases. Societies become more polarised along racial lines as the land expropriation without compensation leads to serious considerations by political parties to amend Section 25 of the Constitution.

6.2.1.1 What are the Key Trends? The Pull of the Future

Technological breakthroughs advance renewable energy storage capabilities. The WTO (1985) recognises that fossil fuel subsidy reform has been a missed opportunity to advance the transition of RE and there is a focused attempted by international organisations to assist in gathering data to fast-track the decision-making process to introduce new legal provisions within the WTO (1985). The equalising of the playing fields for RE and FF alike, results in better and more competitive prices in the RE sector.

The suitability of modern petroleum contracts, such as production-sharing agreements assist in partnerships being developed between the government, communities and the private sector. Advances in technology are embraced tangibly, as areas of inertia with regards to capacity, capability and data are addressed and capacity building programmes, specifically, train communities for the future. A better understanding of the needs of millennials leads to modern approaches, that see more peer-to-peer learning, greater inclusion and tolerance as the implementation of initiatives adopt a bottom up approach through new disciplines, such as development diplomacy. Adaptation and mitigation of climate risks become widespread. Rural communities start to take charge and start to diversify outside extractive sectors and being entrenched in sustainability, seek to develop carbon sinks through re-forestation and the rehabilitation of the disused coal mines, heralding the end of the age of coal.

6.2.1.2 What are the Main Processes of Change? The Pull of the Future

The main change catalysts are manifested through policy development which is implemented through strong regulatory mechanisms. At a global, climate change level, the South African NDC, a commitment to the Paris Agreement (2015), obligates the state to adhere to climate action initiatives towards mitigation and adaptation. Communities, therefore, have agency and are able to apply pressure on the central government for increase autonomy.

Solid regulatory frameworks are linked to economic, energy and labour policy implementation. Such significant interventions comprise of the introduction of a decentralised energy model which is the pull toward future cleaner energy and low-carbon models which are well suited to achieve the 1,5 degrees C trajectory, which sees near zero GHG emissions. There is also better management of human rights issues such as the management of water affairs, education, health, gender and other social rights which promote greater tolerance and inclusion. Large-scale capacity building programmes for communities geared around poverty alleviation, also favour of sustainability. through green financial mechanisms favouring CDM, projects which eventually are linked to the ETS. On the UOG extraction commercial level, the review of alternative petroleum agreements could see better utilisation and conservation of sovereign assets and natural resources.

6.2.1.3 What are the New Issues in the Pipeline? The Pull of the Future

The introduction of new provisions at the WTO (1985) level, and envisaged after the 2020 Conference, are expected to provide better support for the global RE sector. Technological breakthroughs result in safe water management and galvanise the transition to RE and innovative and cost-efficient means for the storage of RE. Through UOG extraction, rural communities will witness increased income per capita and see the greater emergence of a black middle-class and more social benefits for the poor.

6.2.1.4 What are the Sources and Hope? The Pull of the Future

Strong, implemented climate action, which follows the 1,5 degrees C trajectory, will normalise the levels of GHG emissions. The transition towards renewables, facilitated by UOG extraction in the Karoo, will see cheaper and cleaner energy. The commercial value of the UOG extraction is seen as an economic game-changer for the inhabitants of the Karoo, specifically. as job creation is expected in the Karoo, as well as in the rest of the country. The real beneficiaries of the UOG extraction in the Karoo, are identified.

6.3 SCENARIO DEVELOPMENT

Scenarios are a way of producing alternative futures based on various mixtures of assumptions, facts, trends and areas where further understanding is needed for a particular scenario project (Herbst & Mills, 2006). These mixtures are called scenarios because scenarios are similar to scenes in the theatre – a series of differing views or presentations on a similar common topic (Hughes *et al.,* 2003).

The aim of researchers and decision-makers alike, is to see several scenarios at the same time in order to comprehend better the various options or possibilities. A very good set of scenarios should leave the reader questioning which option is more likely or probable, thus causing the reader to think more (Herbst & Mills, 2006). That being the whole point of the scenario method, researchers should, therefore, structure and develop scenarios to arguably educate and not to postulate the preferred future (Carpenter, Bennett & Peterson, 2006). Scenario planners in corporate companies believe that scenarios should be numbers-based. This research attempted at quantification in order to numerically assess the economic feasibility of the extraction and to test the game-changing potential for the Karoo, South Africa (personal interview with Ngcukana, 2018).

Scenarios should not only find alternative routes out of the present but should also seek to configure the present differently, using foreign and unfamiliar notions of the future. The task is not only to imagine alternative futures but also to rethink governance, power and structure in general, calling into question how current notions of social and political life are framed and organised (Inayatullah, 2001). Moll (2000) points out that these future scenarios can never truly foresee complex future events and that is impossible to pinpoint exactly how the future will unfold in any specific way.

Researchers assert that these scenarios attempt to help detect, avoid and overcome possible dangers that may lie ahead and scenarios inform individuals by considering fragments of possible developments and the options and dangers that may arise. Such researchers emphasise that exploring these alternative futures should be done to improve the welfare of mankind and the sustainability of the earth (Bell, 1957; Moll, 2000). Bell (2017b) indicates that any future is a consequence of the present actions of people. The present day is constantly being reconstructed as people act, react and interact. Therefore, to understand how these consequences might unfold, this researcher must understand another's actions and reactions and the forces beyond control of the given situation (Bell, 2003).

As a result of this, researchers contribute to inform in the present day by studying possible future scenarios and by distinguishing between possible, probable and preferable future scenarios (Bell, 2017a). A scenario-based strategic foresight methodology has been used to develop four scenarios to support medium to long-term strategic visioning and planning and which reflect the range of views of consulted experts regarding the fundamental factors influencing the future. *Possible hydraulic fracturing futures for South Africa towards 2055* operates against the backdrop of the global energy sector, the BRICS countries, the cities of Africa and eventually the elements of the energy basket in South Africa. This research notes that the resource examined has a finite timeframe; 495 TCF or 93 years based on current consumption levels.

In 2050, the African population will grow to an expected high of 2.5 billion from 1 billion in 2010 according to the UN medium scenario (UN, 2017) and despite the decrease in fertility, this trend of African population increase is due to births outnumbering deaths. Cities globally consume up to 80 per cent of the total global energy production and release about 75 per cent of the global CO2 emissions. In the case of Africa, the urban population is projected to rise from 400 million to 1, 26 billion between 2010 and 2050 (EUEI PDF, 2017; The EU Energy Initiative Partnership Dialogue Facility (EUEI PDF) through its strategic Energy Advisory and Dialogue Services (SEADS) in 2016, developed a study that explores energy scenarios in sub-Saharan Africa until 2050 and, which have informed this study from an Africa energy perspective.

This study extensively referenced the EUEI PDF, to map out the similarities between Africa cities and South African cities in order to, to assess to what extent the towns of the Karoo face similar challenges. Based on this platform of insights, this research can focus on the core issues which specifically address the UOG extraction of the Karoo, South Africa, and can present four scenarios. Before this research starts the back-casting of each scenario, Scenario One: 'Frack Off!' And Scenario Three: 'No Shale, what now?' require further background information to provide a clearer understanding for the reader.

6.3.1 Scenario Development Stages

The first step in scenario development was to establish a baseline. The literature review and the ongoing dialogue with all the experts informed this process. Figure 6.1. below using the critical drivers for change to illustrates the high degree of uncertainty. The drivers were categorised as follows:

- Megatrends: These are trends which are normally global in nature and are considered outside of one's control when planning. The research has identified climate risk, urban population growth, economic growth, increased demand for energy, health and education as the megatrends which impact upon the lives of the inhabitants of the Karoo, South Africa and the proposed UOG extraction in the region (Escudero, 2016).
- Critical uncertainties: These are the most significant and relatively uncertain factors which have a significant impact on the research matter (Escudero, 2016).
- Wild cards: These are low probability drivers but at manifestation could lead to a radical change in the energy future of the Karoo. Often referred to as 'shocks', these drivers could impact at various stages of the scenario period. The scenario period is between 2015 and 2055. Given the relatively long period within a dynamic sector, the scenarios break up into relevant trajectories, most within a decade. Adopting this approach allows the data to be more precise. The scenarios are then able to pin-point a more precise

timeframe in which the real fruits of the UOG extraction is likely to manifest. The fourth scenario in the Trajectory 2035 – 2044, shows the optimum manifestation of the UOG extraction and therein emerges the vision of the energy future of the Karoo, South towards 2055, where UOG extraction is a game-changer, first for the inhabitants of the Karoo, and then for the rest of South Africa (Escudero, 2016).

6.3.1.1 Stage 1 - Framing the Scenarios

The scenarios were all framed by the literature review on the global UOG markets, and which have been explored to date, and which placed specific attention on the U.S. and on the U.K. and Australia to a lesser extent. The 20 interviews conducted with the experts from a broad spectrum also validated the applicability of the megatrends. Once verified, the wild cards were categorised and a rate of probability was established.

6.3.1.2 Stage 2 - Identifying Scenario Dimensions

6.3.1.2.1 Expert Review and Validation

Part of the identification of the scenario dimension process included the expert review and validation process. This allowed for a multi-disciplinary process which started at the beginning of the research with the literature review of the earliest shale commentaries by De Wit (2010), Maugeri (2012), Salameh (2013) and Fakir (2015). The SEA commissioned through the CSIR, consisted of sixteen researchers, across the UOG and subsidiary disciplines. The experts from CEF, IGAS, PetroSA and other SOEs, provided commentary on all the various appropriate stages. The developers were represented by the South African Oil and Gas Alliance. In terms of the UOG extraction regulations and the IRP, the Minister of Minerals and Energy, The Honourable Minister Mantashe was interviewed.

The focus groups amongst the youth of Jansensville and Graaf Reniet, provided useful caveats for the vision of the future. The Sarkar Game assisted in deconstructing lock-in paradigms, in the first round. In the second, third and fourth rounds, respondents were able to see the future in multiple dimensions. Back-casting allowed the respondents to travel back in time from the year 2055.

6.3.1.2.2 **Categorisation of Drivers for Change**

The objective of this stage was firstly to identify all the drivers of change within the context of the megatrends. The environmental scan deliberately scanned over Chapters Three, Four and Five, with each treating very specific discourses, is reframed in this chapter using the Inayatullah questions as a guide and which find complementarity with the insights required to inform the Futures Triangle.

The 52 drivers are then distilled into eleven themes which impact upon the UOG extraction and the climate action discourses. The eleven themes are used for the pair testing of the scenarios. The probability of the wild cards is also taken into account and plays out in specific trajectories of the four scenarios.

6.3.1.2.3 **Conducting Pair Tests**

The clustering method of the drivers into the eleven assists the objective of developing differentiated scenarios. The method that was used attempted at a categorisation of the drivers for change, noting the three cohorts of the environmental, economic and social impacts. Each driver for change was paired with the opposite hypothesis, for example the de-centralised energy model was evaluated considering the three cohorts against the current high- emitting centralised energy model that is provided by the SOE, Eskom.

Inayatullah (2018) forecasts five major social trends towards the years 2055. Williams (2019), principal at SAMI Consulting, describes similar megatrends that forward-thinking professionals should keep in mind while planning for the future of organisations (Williams, 2019). A total of 54 drivers has been identified. A few of the themes manifest several times under the various megatrends. These are considered individually, as the themes have a different impact on the environment, the economy and communities of the Karoo, South Africa. However, for the purposes of the scenarios, the various drivers are re-grouped into broad themes or key trends which have been crystallised by leading futurists such as Inayatullah (2018), Adendorff (2018) and Williams (2019).

6.3.1.3 Stage 3: Testing Scenario Matrices

The objective of this stage was to identify the most relevant scenario matrices, taking into account the manifestation of the wild cards. The method that was employed was a criteria-based selection. The criteria can be described as:

- Plausibility – The scenarios must be capable of manifesting themselves.
- Differentiation – The scenarios must the structurally different and must be supported by quantifiable or verified data.
- Consistency – The scenarios must be developed on the logic of the data. The same variables must be applicable to all four scenarios.
- Decision-making utility – Each scenario should possess insights which could indicate future trends and decision-making.
- Challenge – The scenarios should challenge and question the future. This could result in the creation of new paradigms.

6.3.1.4 Stage 4: Selecting the Four Scenarios

The objective of this stage is to identify the most probable, plausible and surprise-free scenarios. The method that was employed was to engage experts who had the core expertise scenario. For example, scenario three which puts forth energy futures for the Karoo and employing only renewable energy drew commentary from the CEF, SOAGA and the renewables sector.

6.3.1.5 Stage 5: Identifying Scenario Implications as Assessing the Probable Impacts of the Wild Cards

The objective is to test the sensitivity of the four scenarios by weighting out the manifestation of the four wild cards. These would consider the intensity of each wild card, two pairs of wild cards and, collectively, all the wild cards. The creation of 'time trajectories' became useful and relevant. The wild cards identified in this research are oil price shocks, 4° Celsius warming, technological breakthroughs and civil conflict.

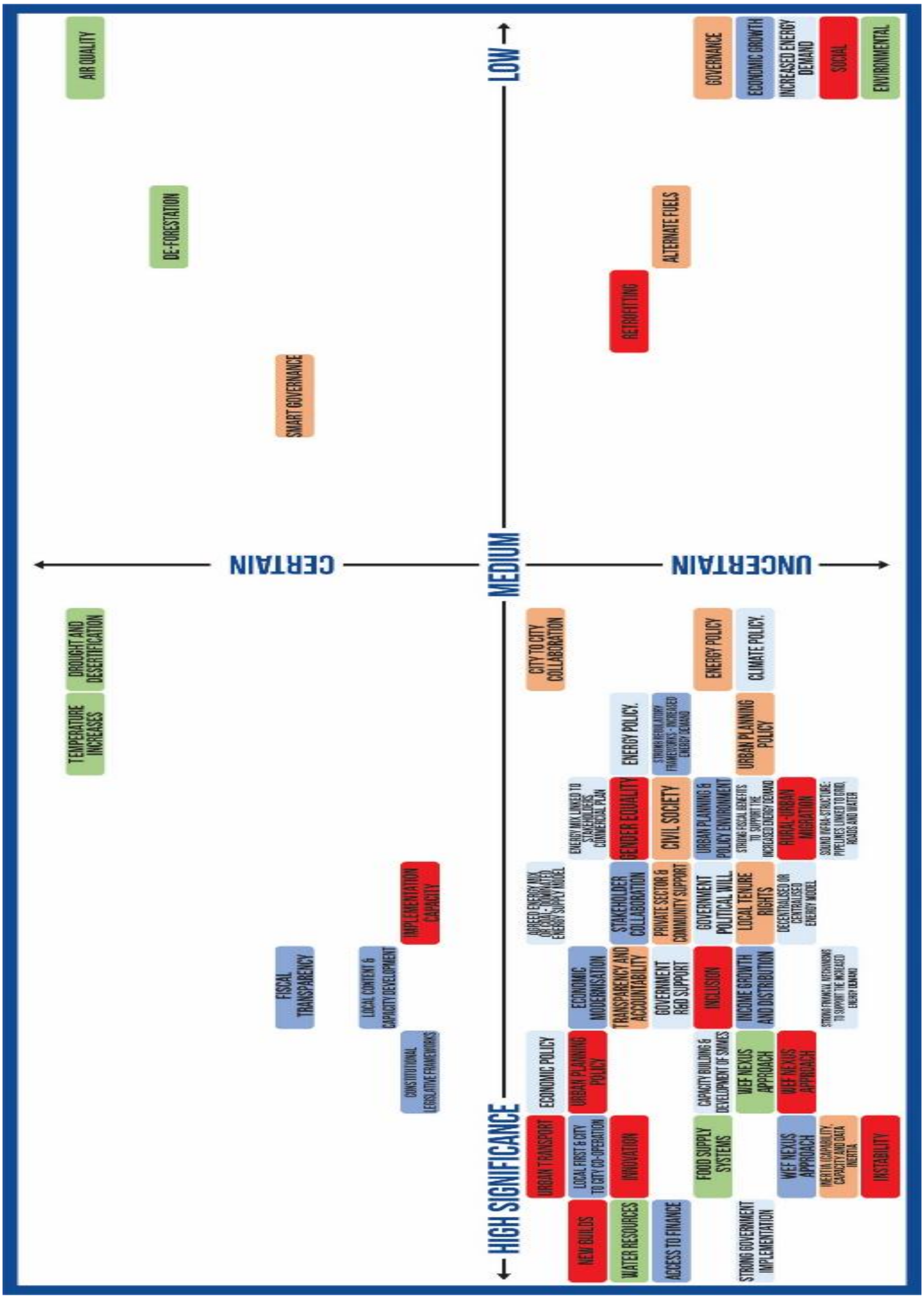
Oil price shocks: the recent attack on Iran's oil industry demonstrated that South Africa is familiar with the volatility of the global oil prices and is agile and managing the 'booms and busts' of the oil and gas industry. Therefore, the current low oil price, should not have a devastating effect of the UOG extraction, from a pricing point of view and which is the Salameh (2015) argument. South Africa is currently tracking the 4° Celsius trajectory. The situation can only be positively impacted upon by a cleaner burning fuel source such as shale gas. The game-changing commercial properties of the UOG extraction could provide the much-needed revenues to the fast track the transition to futures of renewable energy.

6.4 SCENARIO IMPLICATIONS

The objective is to assess the implications of the scenarios on the central research question. A further objective is to identify the strategic direction for decision makers which could lead to effective implementation of the OUG extraction. The method used in this process was the implication analyses method. The various trajectories towards 2055 were considered in great detail, paying specific attention to the intensity of the manifestation of the various wild cards. The literature review and the engagements with the experts played a critical role in identifying the key implications. For each scenario, the research considered the actions for each of the stakeholders, but only put forth the actions for the integrated scenario which manifests the vision of the Karoo towards 2055 in the third trajectory. The stakeholder groups are as follows:

- Central and regional governments
- The private sector which consist of the developers and the service providers in the UOG extraction.
- Civil society which represents the citizens. In this group the unions are also considered as the unions represent the labour interests of the working communities.
- The donor community which considers primarily the environment cohort of concerns, of which the human rights to water, the socio-economic impacts of water, GHG leakage, air quality, seismic activity and the impacts on the flora and fauna of the Karoo form vital aspects.

Figure 6.1: Categorisation of Drivers for Change



(Source: Researcher's Construction, 2019)

The following are key drivers for change, which are driven by megatrends of climate risk, urban population growth, economic growth, increased demand for energy, health and education. Table 6.1. illustrates the megatrends and the drivers.

Table 6.1: Critical Uncertainties Facing the UOG Extraction in the Karoo, South Africa

Megatrend and SGD Support	**Associated Drivers**
Climate Risk SDG 13: Climate Action	1. Temperature increases 2. Drought and de-forestation 3. Air quality 4. Bio-diversity and ecology 5. Water resources 6. Food supply systems 7. WEF Nexus approach
Urban Population Growth SDG 8: Decent Work and Economic Growth	1. Population growth 2. Urban planning and policy environment 3. Urban – rural migration 4. Urban transport 5. Inclusive communities
Economic Growth SDG 9: Industry, Innovation and Infra-structure	1. Economic modernisation 2. Income growth and distribution 3. Access to finance 4. Constitutional and national legislative frameworks 5. Fiscal transparency 6. Local content and capacity development 7. Local first and city to city co-operation 8. Stakeholder collaboration: State and non-state actors (private sector, unions, NGOs and civil society)
Increased Energy Demand SDG 7: Affordable and Clean Energy	1. Government political will. Climate policy. Energy policy. Economic policy 2. Decentralised or centralised energy model 3. Agreed energy mix or coal-dominated energy supply model 4. Energy mix linked to stakeholders and commercial plan and grid 5. Sound infra-structure: pipelines linked to grid, roads and water 6. Government R&D support 7. Capacity building and development of local SME support

Megatrend and SGD Support	Associated Drivers
	8. Strong government implementation and monitoring support. 9. Strong regulatory frameworks to support the increased energy demand 10. Strong fiscal benefits to support the increased energy demand 11. Strong financial mechanisms to support the increased energy demand
Health and Education SDG 3: Good Health and Well-Being SDG 4: Quality Education SDG 10: Reduced Inequalities	1. Climate policy which manifests in community-driven projects 2. Poverty Alleviation and WEF Nexus approach 3. Unemployment 4. Social Inequality and Inclusion 5. Addressing xenophobia and gender-based violence 6. Urban planning policy 7. Infrastructure: Urban planning and transportation 8. Technological impacts on society 9. UOG extraction R&D and civil society participation 10. Education and Capacity building 11. The extractive sector and communities (How the private sector can assist society to attain the SDGs). 12. Transparency and public scrutiny 13. Implementation capacity 14. Informal settlements 15. Gender equality – “leave no-one behind” 16. Urban planning policy that support energy efficiency and low emissions

Williams (2019) Ten Broad Drivers for Change

Megatrend and SGD Support	Associated Drivers
Climate change Economic Growth and Inequality Rural – Urban Migration Technological Advancement Social Cohesion Urbanisation Energy sources and policy development Multi-polar Worlds Water, Energy, Food Nexus Changing Values Across Generations	

(Source: Researcher's Construction, 2019)

6.5 THE WILLIAM'S (2020) TEN BROAD DRIVERS FOR CHANGE

In Table 6.1 above, the drivers for change manifest differently over the three discourses, but collectively may be distilled into ten broad drivers, each still assessing impacts on the safety, the economic and the social discourse. When impacted by the four wild cards, the further varied outcomes are achieved. The best futures are manifested in third trajectory of the fourth scenario. Refer to Section 7.5.4.3.

6.5.1 Climate Change

The IPCC (2016), being the key scientific influencer of the Climate Action Tracker, suggested that the Paris Climate Agreement would lead to a global temperature rise of between 2.2 degrees C and 3.4 degrees C. The authors Gregory, Stocker, Lemke and Blindoff (2007) forecasted that the Tracker would assume that all signatories will hit the NDC targets. The 1.5 degrees C target requires virtually zero emissions, which is possible with the correct political will of global governments (Gregory *et al*, 2007). The discourse of climate change encompasses climate risks such as temperature increases, drought and de-forestation, air quality, bio-diversity and ecology, with an emphasis of the flora and fauna of the Karoo, socio-economic impacts of water and food supply systems, all within the context of the WEF nexus approach (Glazewski, 2016; Glazewski and Collier, 2012). The research borrows important insights from Europe Union economic policy of which sustainable development is the cornerstone policy (Rompennen, 2017). The authors Jordan, Huitema, Van Asselt, Rayner and Berkhout (2010) make insightful arguments confronting the dilemma of mitigation and adaptation.

6.5.2 Urbanisation

The United Nations indicators forecast that between 2017 and 2030, nearly all global population growth will be absorbed by cities with 1.1 billion new urbanites expected over the next 13 years (Escudero, 2017). The attractiveness of urban cities will continue to offer economies of scale in supplying infrastructure services to people and thereby creating huge social, economic and environmental opportunities and threats. The discourse of urbanisation will encompass, population growth as the result of the attractiveness of the UOG extraction in the Karoo, the stemming of rural-urban migration, urban transport systems, both for consumer as well as for commercial UOG extraction, air quality and the integration of communities.

6.5.3 Economic Growth and Inequality

OECD markets see increasing returns on capital, which results at the expense of labour and increased inequality levels within countries. Technological innovations and breakthroughs and the advances in artificial intelligence (AI) sees the coming of the 'gig economy'. Part-time working and zero-hours contracts become more prevalent, as well as an increase in the grey economy which puts a strain on tax receipts and social communities (Susskind and Susskind, 2016). Inayatullah (2018) also speaks of greater equality and the rise of the status of women in the future (Agarwal and Robeyns 2005; Baker, 2011; Milojevic, 2015). Globally, there is decreasing inequality between countries as poorer countries start to align policies to the developed countries Khan, 2010; Hernandez, 2009). The discourse on economic growth and inequality would encompass economic modernisation, income growth and distribution, access to finance and fiscal transparency and capacity building with the preference for the local inhabitants first, all within the context of the WEF nexus approach (Hernandez, 2009; Jordan *et al,* 2010).

6.5.4 Energy Sources and Policy Development

Sources of energy are diversifying with more renewables and less fossil fuels (Harleman and Weber, 2017). Diversified energy sources will redistribute the current economic-political power among countries reducing the geopolitical importance of oil-producing areas such as Saudi Arabia, and Texas and Alaska in the US. Intermittency of renewables leads to the need for innovative ways of storing energy (batteries, flow batteries, biofuels, hydrogen) and decentralised generation forces changes to the grid (Hao, Zou, Lu, 2003). The discourse of energy sources and policy development would encompass firstly, all the policies such as economic, climate and food policies within the context of the WEF nexus approach (Esterhuyse *et al,* 2018). Furthermore, there would strong regulatory frameworks to support the increased energy demands which govern green finance and fiscal transparency (Glazewski, 1994a). Government support of R&D will empower communities to assess and understand the game-changing opportunities of the UOG extraction. The participation of communities will empower communities to use the UOG extraction as the catalyst as a conduit to the transition of more lasting, clean and sustainable energy forms, such as wind and collar technologies. This research has been informed by the authors French, Bell and Zawacki (2006) on organisation, transformation and development of communities. Gervais, Voirin, Beatty and Bulltail (2017) provide useful guidelines on leaving no-one behind, by citing critical success factors which led to the incorporation of native American women in the UOG extraction in the U.S. Similar examples are quoted in Australia. An equitable split of the power-base and profits is required to ensure satisfied businesses and communities (French *et al*, 2006; Gervais et al, 2017; Grimble and Welland, 1997; Hall, 2004).

6.5.5 Migration

Since 2015 Europe has witnessed approximately one million migrants a year arriving, mostly from Syria, Afghanistan and Iraq. Seen against the European population of about 750 million, the overall demographic impact of migrants is limited, but politically it becomes an issue. Increased global warming causes increased migration and which in turn causes societal tensions and civil conflict. In the South Africa context, xenophobia is manifested and magnified. The discourse of migration would encompass social Inequality and Inclusion which addresses xenophobia and gender-based violence, the development of informal settlements and local land rights (Crush, 1989).

6.5.6 Multi-polar Worlds

Williams (2019), quoting the European Parliamentary Research Service, Global Trends Unit, notes a shift in the global economic centre of gravity from West to East and to the South (especially Africa, but also Russia and China). This view is consistent with Inayatullah (2018). Williams (2019) further maintains that in the medium-term, developing countries will aggressively attempt to raise standards. Developed countries will seek to engage with these markets. The BRICS block will strengthen commercial relations internally, facilitated by the BRICS bank and other bi-lateral commercial agreements with BRICS governments. The formation of the BRICS Plus countries is an initiative to becoming more African-inclusive. The discourse of a new multi-polar will touch on the impact of migration patterns, capacity building and the transfer of skills and mobility training with the countries of BRICS as well as with the BRICS PLUS countries.

6.5.7 Technological Advancement

The world becomes increasingly interconnected and witness rapid developments of autonomous vehicles, as seen in Masdar in 2014 with the rise of virtual reality and augmented reality occurring. 'Industry 4.0' manufacturing, 3D printing and decentralised, localised 'just-in-time' goods production, which emphasises design and intellectual property profits, rather than production profits, becomes more widespread. Cybercrime and privacy issues present increasing risks to the future generation. Blue-collar and routine white-collar jobs are adversely affected by artificial intelligence (AI). Susskind and Susskind (2016) point out that in the legal profession, AI-driven chatbots are already prevalent and there will the 'hollowing out' of the profession, as lower and middle-rank roles are automated. It is further expected that AI will transform knowledge work, replacing much of the human decision-making, which result in greater equity for empathy and other human-soft skills. While new jobs may be created, disruption to industries is likely Susskind and Susskind, 2016).

6.5.8 Food Production, Water Efficiency and Reduced Energy Consumption

Trends in bio-age emerge and which take place in personal medicine, manufacturing in fermentation vats, bio-engineered chemical production and bio-data storage, to quote a few examples. There are innovative strides in genome editing (CRISPR) which transport the traditional attitudes and behaviour to food production, health, medicine, lifestyle and longevity (Doudna, 2019). These contribute to more efficient use of water and production of food for humans (Susskind and Susskind, 2016).

6.5.9 Social Cohesion

Rising inequality, imbalances in economic opportunity, worsening economic conditions, the inability of governments in dealing with increasing immigration and diversity in societies, witnesses the deterioration of social cohesion. Manifestation of this trend, is witnessed in the rise of populist and polarised political ideologies which call to close borders, thereby increasing alienation among groups. The discourse of social cohesion will encompass inclusiveness and xenophobia, housing informality and the development of inclusive rural communities which through technological advances and connectivity, address the rural-urban migration issues. Gender equality, the arresting of gender-based violence and the acceptance of all sexual identities are core challenges which are tackled in the discourse of social cohesion.

6.5.10 seesc

Millennials are exhibiting a shift from consumerism to collectivism, demonstrating a value shift across generations and this results in the growing conflict with the ‘outmoded perspectives’ of the older generation who still hold on to power. It is not clear if this is just a phase (Williams, 2019). Generation Z refers to people born between the mid-1990s to the early 2000s, who tend to smoke less, drink less alcohol and have less underage sex, with a great persuasion and increasing acceptance of sexual diversity such as trans, non-binary, gender-fluid. Millennials display patterns of behaviour with results in obesity, and experience increased mental health issues. The discourse of changing values and the new desires of the millennials builds on their open-mindedness, but seeks also to address gaps in lifestyle and leisure choice in the effort to develop healthy future communities and the management on communicable diseases (Williams, 2019).

6.6 METHODS AND ASSUMPTIONS IN SCENARIO DEVELOPMENT

The method used in the gathering of data is explained for each scenario. For each scenario, a set of assumptions is motivated.

6.6.1 Scenario One: Business as Usual

The first scenario is based on the South African government's decision to continue down the coal dominated energy path based on The NDP 2030.

6.6.1.1 Methods and Assumptions

The literature review, as well as The NDP 2030, informed this 'business as usual' scenario. This scenario assumes that the South African government will continue on the plan that was conceived in 2005, which weakly considers the climate mandates of the Kyoto Protocol (1997) which was considered ineffective because of the top-down approach. The plan is heavily reliant on coal as a primary source of energy in its current form. The plan does not consider, nor put forth, the notion of cleaner coal technology.

Scenario One, which is the business as usual scenario, is set against the National Development Plan (NDP) for 2030. The NDP makes a weak reference to gas. The experts in the industry interpreted that gas in this case referred to locally produced gas or gas from neighbouring countries (personal interview with executives of CEF, 2018). The NDP maintains that coal remains the dominant energy source for the foreseeable future (NDP, 2030; personal interview with Minister Mantashe, 2019). The NDP is a long-term vision put forth by the ANC government based on a macro-economic policy to address unemployment, inequality, poverty and wealth redistribution, and covers the period up to 2030. The output of the plan is to create a further 11 million jobs by 2030. Currently, the population is 58.8 million (StatsSA, 2019; tradingeconomics.com. 2019). The NDP assumes that the Gini coefficient should fall from 0.69 to 0.6 by 2030. The plan seeks to achieve this target by stamping out corruption, exercising good governance and operating on the highest level of transparency to all South Africans.

Scenario One is based on NDP 2030, taking into account recent changes in the energy sector and assumes the following for the economic assessment. Table 6.2 describes scenario one.

Table 6.2: Scenario One Assumptions Based on NDP 2030

Scenario One Assumptions based on NDP 2030
• Using the NDP 2030 as the basis for this scenario, the research projects the continued dominance of coal, albeit the use of cleaner coal technology, gas solar and wind technologies. • Up until October 2019, when the Integrated Renewable Plan (2019) came into force, renewables contracts eliminated licences for small energy producers, as the result, growth in the sector remained at a very low pace; • The requirements for, or the provision of gas, remains unclear as it does not specify natural gas or shale gas. Given the current situation in terms of timing and implementation, this research assumes the use of the limited domestic produced natural gas, or imported gas from neighbouring countries; • If it assumes imported natural gas, then it is further unclear if this refers to piped gas from Mozambique or Namibia; and infrastructure does not exist; • It is assumed that the NDP does not refer to UOG, as at the time UOG was not seriously considered in South Africa. The discourse was only initiated in 2010 (De Witt, 2010)

(Source: Researcher's Construction, 2019)

6.6.2 Scenario Two: Environmental Degradation

This scenario, is based in UOG futures, which results in negative surprises to the environment, the economy and civil society.

6.6.2.1 Methods and Assumptions

The literature review and interviews with the experts as part of the IISD research informed this section regarding the various policy developments. This research acknowledges the government's progress made since 1994, as well as the debt that was inherited from the apartheid government. Post-1994 shows periods of economic stability, increased access to health and education, improvements in social security and increased job creation. Viewed against the backdrop of increasing immigration of approximately one million people entering the country, mainly from Africa, the research acknowledges the challenges faced by the government in providing water, housing and energy for a growing populace (National Planning Commission, 2013).

The ANC promulgated certain Acts through its democratisation and de-racialisation policies by adopting legislation such as the Employment Equity Act, 1998 and the B-BBEE (2003). It is argued in many circles that redistribution never took place and that enrichment resulted amongst the few BEE deal-makers, in cohesion with the ANC government pushing reformism, and not radical economic transformation, as the country assumed, at the time of negotiations (Bendile, 2015, Emkes, 2012). The government anticipates that UOG extraction may be an opportunity for Black investors to engage in extractive activities. The Council for Geoscience of South Africa, has undertaken to start exploratory drilling, near the town of Beaufort West, in the Karoo region. The project which was meant to start in April 2019, only sees the possibility commencing a year later (personal interview with Mabusa, 2019).

UOG extraction is unlike mining, which dispels the myth that and The Council has been severely challenged by the mandates of the B-BBEE (2003) to find competent suppliers in the country. In line with the inertia, which exists in environmental discourses that both Murthi (2019) and De Wit (2010) speak about, the UOG extraction in the Karoo is unlikely within the first trajectory to see large scale, skilled job creation, owing to the inertia of capacity, as well as a lack of reliable scientific data.

The second scenario is named as the 'Frack and Go' scenario. It is worth reminding the reader that the wells are fracked very rapidly and finances are generated. A tired investor may abandon operation at any time, recovering costs and moving on, a phenomenon which has been evidenced several times in America between 2005 and 2012. The Black 'dealmakers' who currently control the coal mining sector, may be encouraged to move certain investments into the UOG sector and which will see severe short-comings and possibly widespread damage to the above-the-surface and below-the-surface water resources, owing to the lack of UOG extractive experience. The research presents the second scenario, as a high risk one.

There are two primary reasons for high risk. Responsible governments, notably the British, German, and Australian, have carefully considered the extraction and have concluded that UOG extraction may be safe, if the extraction follows a carefully monitored programme along strong regulatory frameworks (Harleman and Weber, 2017; Koester, 2016). Firstly, according to some experts, the large developers are bridled by shareholder and community reputation mandates and strongly adhere to environmental mandates whereas new comers to the sector are likely to cut corners, when the ‘guerrilla’ approach and ‘factory-type’ exploration is underway (Maugeri, 2012). The slowness of the government to react and intervene in crisis situations will lead to further frustrations for the international developers, who start to incur enormous loss, mid-stream in the exploration. The maverick manners of the new comers, caused wide spread disruptions, and industries and agencies which arose to support the extraction start to fail.

6.6.3 Scenario Three: A Scenario with no UOG Extraction but Only Renewables

This scenario, is based in a direct path to sustainable energy forms, which whilst favours the environment, is not sustainable based on economic reasons.

6.6.3.1 Methods and Assumptions

The methods of gathering data for this scenario comprised of the UEF International Law and Policy courses, the legal internship with IISD and an interview with Minister of Minerals and Energy of South Africa after the announcement IRP, 2019 and the various interviews with the panels of experts.

By its very nature, the oil and gas sector are historically marred by controversy (Atangana and Van Tonder, 2014). At a time, when great focus is placed on climate action, the world seeks an accelerated path towards renewable energy. The driving of the global agenda, requires a mix of the command and control mechanisms which presents challenges, as well as the community-led approach (bottom-up). The global stage needs to be set, addressing as many factors as possible to entice governments to move towards renewables and which could be facilitated through international commercial and legal frameworks. Interventions are necessary to equalise the playing fields, between the fossil fuel companies and renewable energy companies. It was necessary for the researcher to understand the sources of concern which led to the global UOG controversy. In the first part of the last decade, shale researchers referenced the U.S. case. However, over the past five years, more focus was on the local conditions of the new markets which have seriously considered the exploration.

By 2014, it became an undisputed fact the UOG extraction was beginning to positively impact upon the U.S. economy, setting the U.S. on a clear path to energy security. However, the environmental and social impacts required greater, in-depth scrutiny. The courses undertaken at UEF, provided for the in-depth understanding of the SDGs, and the role that SGDs played in tackling wicked problems, associated with the management of the WEF nexus. The courses delved into all the current and future legal and policy interventions which were in the pipeline and which would support the direct, global transition towards the future of renewables.

The eight-month legal internship undertaken at the International Institute of Sustainable Development (IISD), at the Geneva offices, informed this research on the interventions that were required to address the road blocks towards a fossil fuel-free society. The researcher was part a team of researchers which made recommendations on global fossil fuel reform which will be proposed to the WTO at the forthcoming meeting in Kazakhstan in 2020. The next major impediment towards the sustainability of renewables is the storage capacity for the renewable energy. Over the past two years, there has been remarkable strides in the invention of large-scale capacitors. Capacitors could be a seen as a wild card which could provide a tipping-point towards renewables globally. However, in South Africa, there is a lack of political will, given the ongoing investments and bailouts for the coal industry.

The assumption in this scenario is that despite the promulgation of the IRP (2019) on 4 November 2019, and the fact that the South Africa government has announced commitment to all forms of energy, but also has stressed the emphasis on the continued reliance on coal as a primary source for the foreseeable future. Although, it may be argued by the Treasury that the infrastructure for renewables is not currently available, it is more the lack of political will on the part of the government, that hampers the swift transition towards renewables.

6.6.4 Scenario Four: The Integrated Scenario

This is the integrated scenario which manifests optimal outcomes in the third trajectory.

6.6.4.1 Methods and Assumptions

The methods used to gather the data to inform the integrated scenario are all the methods mentioned for the previous scenarios. However, the knowledge acquired for the questioning of current petroleum contracts, provides a new and original line of enquiry for the integrated scenario. Furthermore, the enquiry into FFSR, and the proposals which have been presented to the WTO (1985) allow for a step change and a tippling point for renewables in the integrated scenario, allowing RE to play an equal role to shale, as well as the rest of the fossil fuels players. The UEF courses, specifically on petroleum contracts, allow for the research to motivate a pure contribution to the existing approaches of licence agreements have not yet been awarded to developers.

The researcher's master's thesis, which was submitted in 2019 to UEF, which treated the socio-economic impacts and the human right to water in the UOG extraction in Karoo, South Africa, specifically examined the shale regulations which currently are situated in the MPRDA. Along with other experts calling for the separation of the shale regulations from MPRDA, the research also identifies significant legal gaps in the current shale regulations. This scenario further assumes that even the new president could retain a further interest in mineral exploration through the new local developers, having frustrated the main developer into considering an exit from the exploration. This scenario considers that incompetent investors, which could be a mix of both local and international, could explore irresponsibly without concern for corporate reputational harm or harm to the environment and will merely explore, retain the spoils and repatriate the earnings, adopting a frack and go approach, i.e. 'cowboy style' exploration as seen in the early days of Williston North Dakota.

The scenario includes renewable energy and has been deliberately tested by this research to answer the questions from that part of the nation who are sceptical about the exploration. The question is often asked as to whether UOG extraction cannot be avoided and that, instead, there could simply be a moving towards the development of renewable energy forms. Therefore, it is a great scenario which must be used as a specific option or tool to test the validity of that question and it must seek to understand to what extent the nation can bypass the shale operation.

6.7 NAMING AND DESCRIBING SCENARIOS

Inayatullah (2001) points out that scenarios clarify alternative futures and goes on to state that scenarios have four dimensions, the first of which assumes that the present will remain unchanged and that present conditions will continue. This is commonly referred to as the 'business as usual' scenario which in this research is called the 'Frack Off' scenario. The second scenario results when the system cannot sustain growth. The current conditions lead to internal collapse. This second scenario takes into account the level of political interference which were prevalent in the apartheid system and which has filtered into the new democracy, through the new black elite investor or BEE dealmakers. In Scenario Two, if 120 TCF is realised the net gain to the country will be that the GDP will be realised in just eight months with UOG extraction. In Scenario Three, there is no shale exploration; therefore, there is no revenue from shale. In Scenario Four, the South African annual GDP is realised 3,37 times over during the shale exploration period in the Karoo, South Africa. These assumptive indicators prove that UOG extraction in the Karoo, South Africa is an economic game-changer.

The following provides a brief description of the four scenarios:

- Scenario 1: No Shale; business as usual and coal dominates along to RDP 2030.
- Scenario 2: UOG extraction starts in 2025 and extracts 40 TCF in the 10 years and faces severe challenges.
- Scenario 3: Coal projections continue in 2030. This scenario also puts forth the use of renewable energy.
- Scenario 4: UOG extraction attains readiness in 2025 and full-scale exploration provides 350 - 495 TCF; this erring on the conservative side in the estimate.

In Scenario One, the 2030 Plan accounts for gas usage and this research assumes that the gas will be imported as at the drafting of the plan, shale was not yet a global phenomenon. Therefore, there is a likely loss of revenue to the country and it must be viewed as an outward payment which will be subject to currency fluctuations. If South Africa were to investigate the exploration of the gas in Scenario One, at even the most conservative extractive level of 40 TCF, then the South African annual GDP could be realised from shale in three years. The calculations also provide for other strategic decision-making. In order to balance the economic/environment debate, South Africa can decide, under the guidance of the definition of sustainable development, what level of resources should be extracted. The figures have been verified by the auditing company, PwC in Cape Town, South Africa, as well as having been developed with some participants of this research's expert panel, namely SOAGA and the WWF. This research offers these calculations as a contribution to the decision-making of the UOG extraction in the Karoo, South Africa.

6.8 RECAPPING THE RESEARCH QUESTIONS

The various mixtures of assumptions, facts, trends and areas help answer these research questions through the set research objectives as laid out below. The reader may expect the following flow in the development of each scenario. Creating a timeline over the foresight period acts as an important framework to evaluate the effectiveness of each scenario to solve problems and challenges. Wherever relevant the scenarios have been broken down into a ten-year trajectory. When attempting to pin-point the time when scenarios are most impactful, the key trajectory becomes evident. The reader may look out for the Trajectory 2034 – 2044, in the Integrated Scenario, to understand how the key elements of the UOG extraction in the Karoo, South Africa may start to play out. Table 6.4 provides a framework for all four scenarios.

Table 6.3: Summary of Scenario Elements

Section	Description
Scenario overview	This section provides a description of each scenario and provides two key dimensions, motivating why this scenario has the plausibility to happen. The dynamics, influencers, and causality underpinning each scenario is explained, highlight the key implications.
Trajectory 2050	Given the dynamics of the exploration and the four wildcards at play, the 40 - year scenario period has been broken down into four trajectories of ten years each. Therefore, not only can the various scenarios highlight displayed strengths and weakness, the combination of the drivers within a specific time trajectory, can be identified. The 'trajectory' approach is simply used as a framework and varies according to the relevance of the drivers for change in each scenario.
Key issues	A summary of key issues of the scenarios is identified and these require action from the key stakeholders. These key issues form the basis of the recommendations to stakeholders.
Strategic direction for decision-makers	Chapter 7 is dedicated to the recommended actions for each stakeholder for the integrated scenario.

(Source: Researcher's Construction, 2019)

6.9 CONCLUSION

Lakoff and Johnson (1980) argue that metaphors go beyond language. Metaphors pervade ones thoughts. The manner in which people think, perceive and act is metaphorical by nature. The conceptual system is metaphorical with people experiencing the world in metaphors (Lakoff & Johnson, 1980). Metaphors are not just figures of speech, but ways of interpreting and conceptualising the world (Larif, 2015). This strengthens the many reasons why metaphors are grounded in physiology (Lakoff & Johnson, 1980).

Inayutullah (2014), in the six pillars approach to creating alternative and preferred futures, describes narratives as "insight into the internal and external stories of persons and organisations" (Inayutullah 2014 p.12). Inayatullah argues that if people or organisations want to create new stories (or visions) of the future, there needs to be an understanding of the real stories about themselves, society and the future (Inayutullah, 2014). Therefore, casual layered analysis is a methodology that analyses issues at four different conceptual levels, all of which Inayutullah (2014) considers vital for policy and social change (Larif, 2015). The UOG extraction is a good example of a case within the South African energy policy which requires change and a practical implementation which will bring about lasting socially preferred futures.

In Chapter Two, the research explained the intrinsic of CLA methodology and where-ever appropriate drew on the commentary of the various authors on the manner and purpose of the gathering of data. The futures triangle was applied, pulling together all the forces which were identified in the environmental scan. The drivers for change and the manifestation of the wild cards were considered in the context of each set of drivers within each environmental scanning chapter. Williams's (2019) list of ten broad trends crystallised the indicators for the evaluation of the scenarios. The framework of questions contextualised the findings of the three chapters of the environmental scanning. In Chapter Seven the scenarios were elaborated.

CHAPTER SEVEN:

7 THE SCENARIOS

7.1 INTRODUCTION

This research motivates the Integrated scenario, which reflects a fundamental change and which may be influenced or powered by economic, political or other factors or a combination of forces (Inayatullah, 2001). This integrated scenario is based on the principles of sustainable development. Shale gas is viewed as a stepping stone towards the development of renewable energy, which provides clean, green, and cheap energy which is readily at the disposal of all populations, operating on a decentralised model, which leaves no-one behind. In the mantra of Hubert, the era of global shale is not expected to end because of environmental externalities, but because world populations are aligned to more palatable energy solution.

This research subject poses complicated and challenging research questions, which at first glance if taking a biased view, may seem simple. However, in an attempt to seek validation, the research in the development of this scenario is guided by the definition, as set forth by *Our Common Future*, also known as the Brundtland Report (1987) and 30 years later, is more relevant for the most controversial mineral exploration ever undertaken by humankind:

Sustainable development is a development that meets the needs of the present, without compromising the ability of future generations to meet their own needs (Our Common Future, A/42/427,1987).

Over the past five years, the researcher has discussed the topic in many sustainability-specific forums. The discussions and forums held by the following institutions are worthy of mention: International Institute of Sustainable Development, IRENA; the class lectures of University of Eastern Finland master's degree programme in Environmental Law and Policy; the 4th EU PhD Summer school Programme on Sustainability the University of Basel, Switzerland; the Summer school on Renewable Energy and the Retro-fitting of European Homesteads at Delft Technical University, School of Architecture in The Netherlands; the IEA, Q4 Gas Projection held at Columbia University, in November, 2018, The presentation of post-doctoral candidates on Sustainability of the Earth Institute at Columbia University, in

September 2018, the participation at workshop held by the masters students on the topic: Sustainability at New York Schools, at Columbia University, in July 2018.

These debates contained institutional or personal views of experts from the academic fraternity, and which included many environmental lawyers such as Professor Glazewski from the University of the Western Cape, Professor Van Asselt, Lecturer on climate change law Head of the UEF Law School Programme and drafter of the Paris Agreement (2015). Other lawyers include Professor Talus, Director of OCIEL Energy Centre, UEF, lawyer acting for the EU against Finland on Energy, Professor Honkenen, UEF, Lecturer on International Environmental Law and Professor Sandberg, UEF, Lecturer on Public International Law.

Scientists included Professor Wolf of Oregon State University on water diplomacy, Professor Berlinskij, professor of the module on International Water Law, at UEF, Finland, Professor Jackson of Stanford University on carbon and methane, Professor Maugeri, Belfer Centre, Harvard University, on shale exploration in the U.S., Professor Christiansen, Swiss Scientist on IPCC, Professor Howarth of Cornell University on methane leakage, Professor De Wit, of the OEON Institute, NMU and Dr Scholes, CSIR, South Africa, who led the SEA, commissioned by the South African government.

Other academic practitioners, who contributed significantly to the scenario development process are Ambassador Therese Adams, board member of the International Institute of Sustainable Development, Winnipeg, head developer of SDG 17, Professor Inayatullah, UNESCO Chair: Future Studies, Professor Adendorff, Africa's leading futurist, Professor Pizmony-Levy, Columbia University and Silvia Escudero of EUEI PDF, the lead author on Future Energy Scenarios for African Cities. These forums provided an informed flow of knowledge and further ensured that the economic debate on shale exploration in the Karoo, South Africa was always discussed within the context of sustainable development.

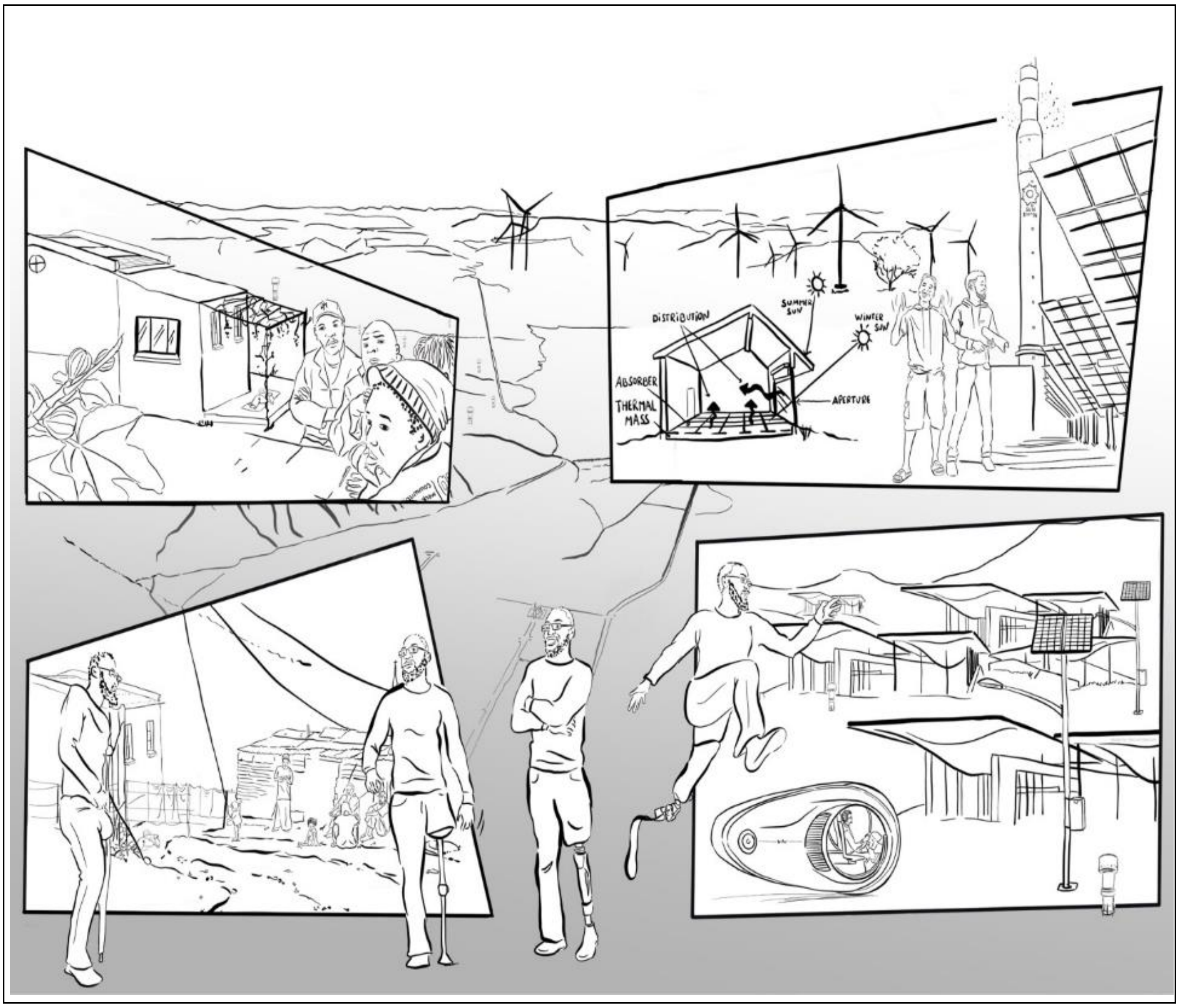
When sharing these scenarios with a wide range of individuals, the name of the last scenario 'Fracking with a smile on my face! ☺' drew widespread curiosity, cynicism and criticism from respondents, both on the international and domestic fronts. The round of focus groups in the towns on Jansenville and Graaff-Reinet exposed dire stories from the youth, who have tried to excel despite the harsh conditions of poverty, unemployment and extreme weather conditions. There is a sad sense of 'niks' or 'nothingness' which permeates the Karoo. In modern society, 'Wi-Fi' is commonplace and a critical pre-requisite for socialising. In Karoo towns, broadband infrastructure is not likely to be available for at least another two years, if there is no intervention. A scholarship of a Coursera on Energy and Sustainability for the 80 learners who participated in the focus groups was made available by Duke University of Illinois, USA. Owing to the lack of connectivity, the programme was never administered. When this narrative is related to those who are curious, cynical and critical, the acute plight of the Karoo, South Africa is highlighted, not as an exaggerated developing country problem but as a critical reality of developing country problems.

This research maintains that whilst markets with shale reserves may exercise other economic options, South Africa possesses very few options which could be seen as the silver bullet. The research presents the 'Fracking with the smile on my face'

scenario, with the conviction that beyond 93 years, South Africa, following the recommendations of these scenarios, will result in possible, plausible, surprise-free futures for all South Africans. It is the best solution under current circumstances of the economy and one which will see the UOG extraction of the Karoo, South Africa, as the stepping-stone towards the more effective transition and integration of renewable energy forms into the South African energy mix. This pathway is relatively inexpensive and is available to all South Africans.

Shabangu's (2012) comment that shale is a "God-given right and should be exploited in the best interest of the people of South Africa", was the subject of jeer in many circles (Glazewski *et al.,* 2016, p.1). It is however, the only single bullet of hope for the Karoo. Figure 7 refers to the Scenario art, which has been developed as part of the scenario development in this research. Scenario art is a new but rapidly growing expression of Future Studies methodology. Each scenario in Figure 7.1 is depicted separately. Scenario One (bottom left) Scenario Two (top left) Scenario Three (top right) and Scenario Four (bottom right) collectively compose the tableau. Together the scenes create an expression from 'niks' to pleasurable, surprise-free futures, for the towns of Jansenville and Graaff-Reinet which encapsulates the spirit of Denzel.

Figure 7.1: The Spirit of Denzel



(Source: Sezen, 2018)

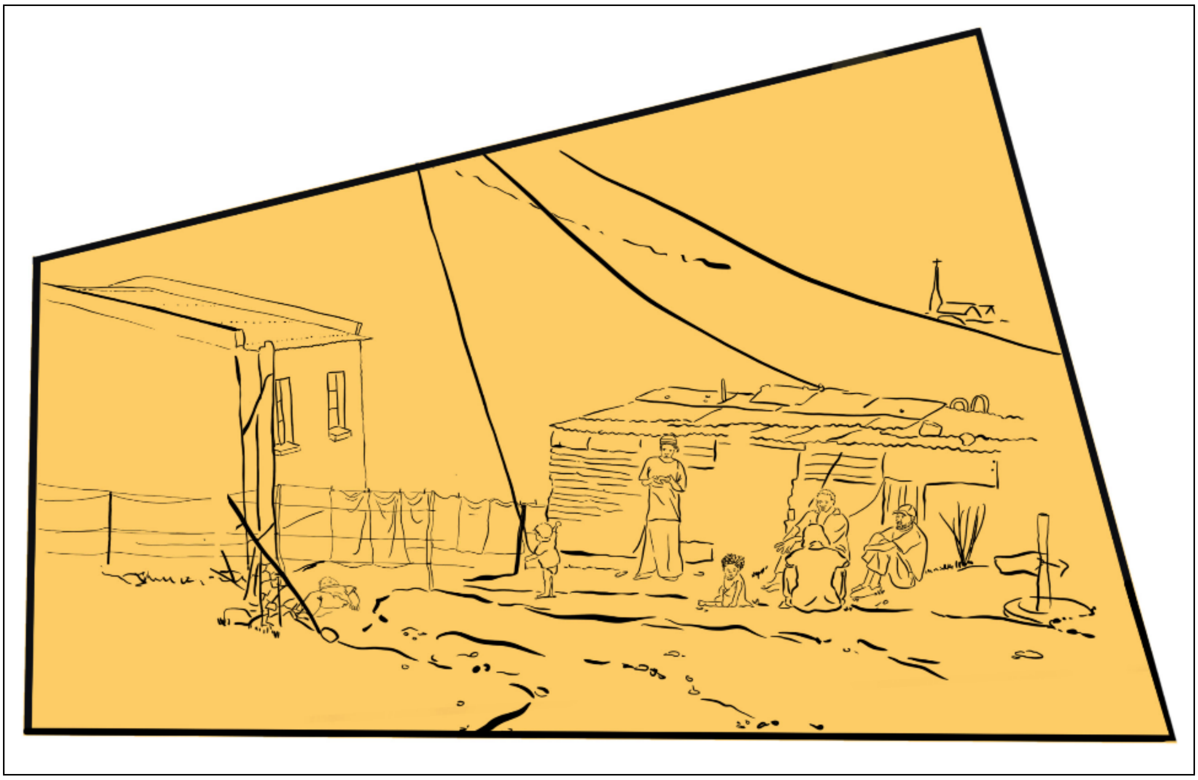
7.2 SCENARIO ONE: FRACK OFF!

The following sections describes and explains the development of each scenario.

7.2.1 Scenario Description

The following graphic (Fig. 7.2) depicts the homesteads of the Karoo in the Frack-Off scenario. This scenario tracks the current energy policy as per the NDP towards 2030, which has no game-changing potential, to change the lives of rural South Africans. The main drivers which are indicated, manifest at different levels during each trajectory. The manifestation of all four wild-cards is also noted. Urban growth policy is poorly administrated and can be attributed to weak government capacity.

Figure 7.2: Art Depicting Images of Scenario 1



(Source: Sezen, 2018)

A coal-dominated, centralised energy model in this scenario persists and there are already the signs of civil society restlessness. The economy has no protection against the oil shocks which intensify over the forty-year period. This tableau provides a snapshot of the current scenario which plays out in small Karoo towns, and which is categorised by centralised energy supply and weak implementation capacity. With urban growth, comes the need for increased energy. In this case, electricity is required mainly for informal residents. Nearly all of the houses of this township, receive electricity through illegal means. The municipality itself, which is under administration owes Eskom, tens of millions of rands, which is the result of residents not paying rates and electricity bills.

Urban decay is witnessed in the growing number of potholes in all streets. There is also evidence of refuse that has not been collected for over seven months. The houses are constructed from corrugated iron which provides no insulation for the heat or cold temperatures, in a region which has seen lows of minus sixteen degrees Celsius. The key issues which stand out in this scenario, are the economic model that is energy intensive and inefficient, lack of policy implementation due to poor administration and the lack of investment in major infrastructure to support the private sector. All of these culminate in social and economic inequalities which are linked to energy inequality and will pose a threat to public stability.

7.2.2 Trajectories and Wildcard Manifestation

This scenario encounters a break-through in technology. This technological manifestation spurs the decision to explore, but the slowness of government to respond results in a lost opportunity. The oil prices cause ripple effects on the economy which remains hostage to imported fossil fuels and which suffer from a series of disruptive shocks. Gender-based violence and xenophobic attacks on African nationals stun the world. The ruling party loses reputation internationally. The opposition party loses prominence to the radical black movement, the EFF. Climate risks are further on the increase with the economy tracking 4 degrees above pre-industrialised times. The manifestation of each wildcard affects the drivers for change at various levels of impact towards 2055.

7.2.2.1 Trajectory 2015 – 2030

In the 'Frack Not!' Scenario South Africa has limited resources and relies on the private sector. The trimmings of apartheid have cleverly incorporated, through Mandela's incoming government to a point where a few black elite families have developed 'under the noses' of 58.8 million people without realisation. The black elite, with investments firmly rooted in the coal mining sector, maintains an unhealthy commercial relationship with the government. Coal remains a dominant feedstock of energy supply. As can be referenced in many developing countries, the political economy is prevalent, and the South African government interferes too much in the energy sector. The opening of the markets, through BRICS dialogues, allows for the free flow of trade. Chinese and Indian suppliers drive down the price of electricity in the earliest rounds of the independent power producers programme, given the infra-structural support rendered by domestic governments and which leads to the local content suppliers having to exit the sectors.

At this turning point, the government still provides centralised supply through Eskom and this leads to increased coal emissions. The reliance on fossil fuels leads to further sluggishness in the economy as the oil shocks of 2014 – 2016 impact upon the currency. The currency is further under pressure by the political instability towards the end of the Zuma era. The Zuma era was a severe drawback to the energy policy given the influence of the Russians and the driving of nuclear as an alternative energy source. Scandals during the tenure have been categorised with the arms deal, as well as the close ties with the Indian Gupta family, leading to state capture and the loss of the billions out of the state coffers. The Steinhoff debacle places further devastating consequences on the pension funds of the poor. The mining sector, a sector of middle-income jobs, come under fire with the call for the nationalisation of the mines by the disgruntled youth.

The government states its role as a regulator but in essence is still prone to corruption as the BEE deal-makers are still in power and hold on to the evergreen, lucrative contracts that the coal industry provides. Eskom, at the early stages of bankruptcy, starts to commission the shut-down of the coal-fired plants which face rapid degradation and become a public hazard. This announcement on closure estimates job losses of 7000 people in 2024 and is the cause of consternation to the unions and the start of unprecedented strikes.

The unions battle to retain the power base, preferring a comfortable investment in the evergreen contracts in the coal sector. Unions do not support the transition to renewable energy, owing to the anticipated, decreasing number of jobs in the coal sector. The various rounds of bidding are also fraught with corruption and delays which lead many local suppliers into cash-flow traps. Twenty-five years later, the youth are disgruntled and under the auspices of the EFF, the youth attain 10.80 per cent of the 2019 vote after the DA at 20.77 per cent. During this trajectory, Malema opens the wounds of Marikana at the funeral of Winnie Mandela. The courts exonerate the new president for involvement in the mining tragedy which was caused by police brutality and which shocked the world. The EFF party furthers the call for land reform and are supported by the ANC and DA for the expropriation of land from the white farmers without compensation.

7.2.2.2 Trajectory 2031 - 2040

South Africa has inherited apartheid and into the years 2040, traits of racism, xenophobia and inequality sees it as an isolated nation on the lines of both race and wealth, becoming a "mythical" rainbow nation. This myth is evidenced in the increased murders of white farmers. The discourse on land expropriation without compensation is venting along the lines of races, indicating that the 'Truth and Reconciliation' process highlighted and buried issues, and did not deal with the systemic causes which led to a spattering of whites living in the country by 2055 as the rainbow nation turns Black.

Around the world, urban areas enjoy preferential treatment for legitimate reasons such as wealth and the taxes are generated there. Central governments spend proportionately from taxes to the municipalities of urban and rural areas. However, with increased FDI, the government is required to attract investors on many levels. Urban areas are generally set up to host world-class accommodation standards, food, living conditions, education and entertainment. These still lack in rural areas on a large scale.

Rural-urban migration occurs on an *ad-hoc* and unplanned basis. Settlements on marginal land outside of urban centres, gives rise to informal development and micro-cities. These micro-cities lack electrification and rely on coal and fossil fuels (paraffin) for heating and cooking. Apart from respiratory issues stemming from these hazards and the added atmospheric emissions, domestic fires are frequent.

To be closer to urban areas, there is wide-scale migration to urban areas and this results in the growth of informal settlements. Owing to urban density, two trends continue to emerge in South Africa. The poor live close to work, in cities or informal settlements and the elite live in high-walled residential areas with decentralised retail spaces based on international eco-spaces, with schools, and gyms. The *ad hoc* development of cities requires all modes on informal transportation which increases the demands for energy and in this case, the increased dependency on fossil fuels.

In an attempt to decentralise FDI and localise investment, the South African government, sets up Special Economic Zones (SEZs) (or free zones) near ports, poverty nodes and rural areas lacking the underlying infrastructure for international expatriates. Local, regional government do not have the autonomy and remain dependent on the central government and do not benefit from international NGOs. The Executive Committee of Sarah Baartman in the Eastern Cape, confirmed that local government was challenged by legal obligations to the central government and, therefore, many fracking initiatives could not be structurally advanced.

Modern energy forms become smarter and thus rely on smart technology. Therefore, throughout the 'Frack Not!' scenario, government investments, which are already constrained, are centred around modern technology which is expensive to implement. The costs of maintenance are even higher as the IT software and hardware have short life-cycles. Government is required to maintain connectivity, not only for local needs but, also to maintain contact with the rest of the globe, as technological tools are used to manage the environment. Energy too, is necessary for these functions as big data and connectivity is required to be supported. In the rural areas, local municipalities do not have the necessary digital infrastructure such as broadband antennae. This constraint stifles all types of modern development and entrepreneurship.

7.2.2.3 Trajectory 2041 to 2050

By 2055, South Africa grows at a steady rate and the lack of immigration controls sees greater African diaspora. As African temperatures soar and deplete water and food resources, Africans become climate migrants and move south for better prosperity. Africa's population in 2055 is now almost 2,5 billion. South African cities expand and there is wide-scale growth in population density.

7.2.2.4 Causal Layered Analysis for Scenario One

A mini-CLA has been provided for each of the four scenarios. Table 7.2 provides the CLA for Scenario One which is named as Frack Off!

Table 7.1: CLA Scenario 1 – Frack Off!

CLA Layers	Commentary
Litany	Government follows the Integrated Resources Plan (2030). Radebe (2018) simply implements the plan from the predecessor, focusing on the rescue of Eskom. There is forced interference by the Minister of Public Works, who motivates the Eskom bailout. There is very little movement towards energy security. The nation becomes accustomed to rolling blackouts.
Systemic Causes	South Africa continues an historic trajectory. The Ramaphosa (2019) administration continues with the coal-based energy policy from Apartheid. A few black investors benefit as there is no visible change. The economy grows at slow pace.
Worldview	All the wildcards manifest: Oil shocks are caused by Iran – Saudi actions; technological opportunities arises yet there is incapacity to optimise these opportunities and cities and populations are ravaged by climate-related issues and impacts of the Triple Challenge result in gender-based violence, in domestic residences. Externally, anger is vented on foreign nationals. Given the overall mood of land expropriation without compensation, international investors and the nation feel disappointed and hope is lost. Citizens look to leave the country. Ramaphosa (2018) makes a desperate effort to calm the international investing community. The ANC government uses land reform as an election manifesto cornerstone which distracts the populace from more important issues such as health and education. ANC supporters lose confidence but the EFF and DA are not possible alternatives. The country is leading to a stalemate and early indications of a failed state are starting to manifest.
Myth/ Metaphor	Live for Today. Keep the lights on at any cost. Keep the rating agencies happy. Borrow and bail at any cost.

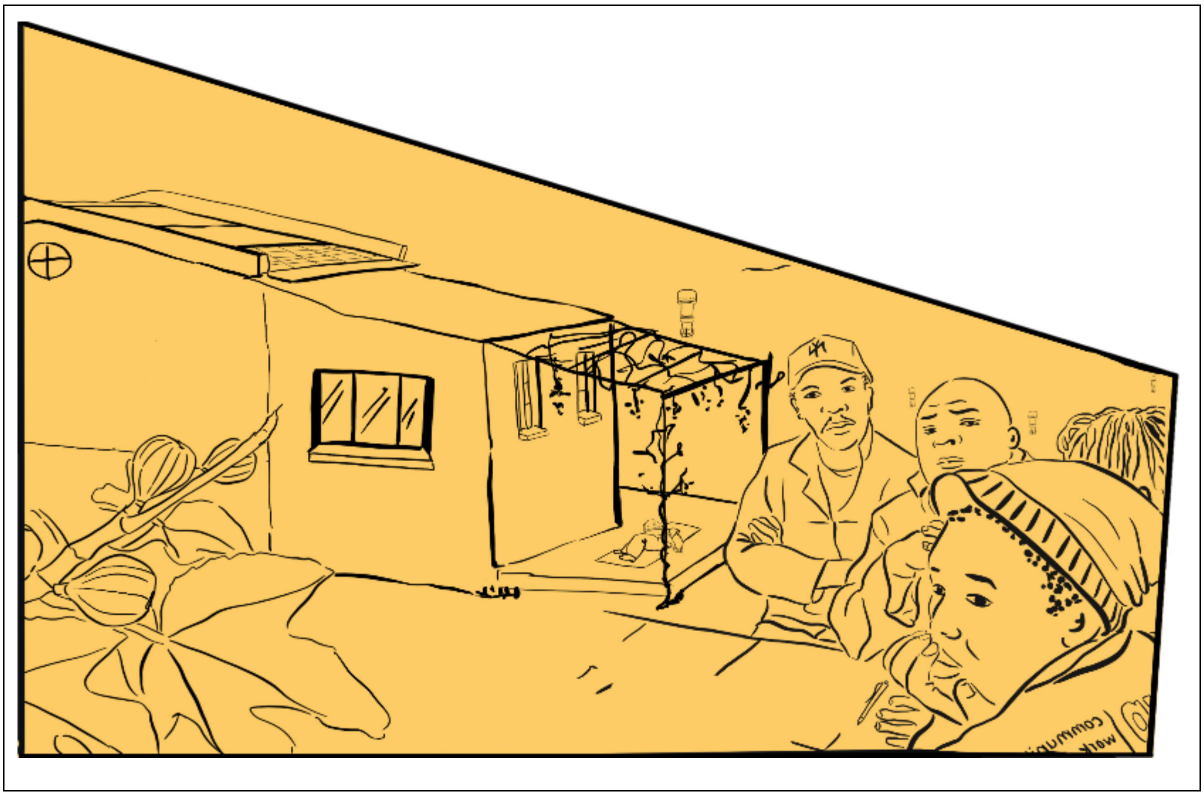
(Source: Researcher's Construction, 2019)7.3 Scenario Two: Frack and Go!

The following sections describes and explains the development of each scenario.

7.3 SCENARIO TWO DESCRIPTION

Climate change, a measurable reality sees the South African NDC setting ambitious targets to support the goals of the UNFCCC and the Paris Agreement of 2015. This scenario sees local regional governments making strong commitments to climate change but there is very weak implementation. Local regional governments by this stage have gained a reasonable level of autonomy and benefit from the regular fiscal transfers from the central government, but there is weak local administration. Significant vulnerabilities in communities exist and which pertain to the impacts of climate change. Low-income informal residents are hardest hit. The following tableau depicts worried people of the Karoo. There has been a slight improvement in housing and basic service, but these have not followed SDG planning parameters. The community are being sensitised to accept liability for the failed operation and this leads to civil unrest in the Karoo, South Africa. Figure 7.3 refers to the depiction of the art of the second scenario which is named as Frack and Go!

Figure 7.3: Art Depicting Images of Scenario 2:



(Source: Sezen, 2018)

Urbanisation in the Karoo starts to manifest along the similar, *ad hoc* lines as in Williston. This scenario is categorised by wide-scale informality. The Karoo population swells as economic opportunity manifests itself. Women remain dis-enfranchised and are likely to work in the informal sector. Policy gaps exist regarding the access to land and accommodation for the growing populations of the Karoo. Government at this stage does not provide energy to the residents of the informal settlements. Civil society engagement remains weak and this prevents the implementation of agreed policies.

Local black investors are encouraged by the government, and attempt to become shale developers, based on the Williston example. This phenomenon frustrates the international oil companies, the environmentalists as well as civil society, who exit the exploration, The IOCs exit the exploration and communities are burdened with the degradation of the environment. In 1977, the population of whites was 4.3 million, constituting 16.4 per cent of the community. By 2016, at least 800,000 white South Africans have emigrated between the period of 1995 and 2015. As the financial crisis affects the global markets, the remnants of the South African currency cannot withstand the high costs in hard currency markets and this sees the 'Homecoming Revolution' bringing 350 000 white South Africans back to South Africa.

7.3.1 Trajectories of Scenario Two

This scenario is presented in the various trajectories to illustrate the impacts of the wild card and uncertain drivers of change.

7.3.1.1 Trajectory 2015 – 2024

Looking back from 2055, into the Frack and Go! Scenario, there is a reflection on the early days of fracking in the Karoo, South Africa, whereby the government in 2012 committed to move decisively and responsibly on the fracking policy-making process. However, by mid-2019, there is no clear direction on the legal framework about UOG extraction. Representations were made to the government from Shell, together with few small international hydraulic fracturing companies, as well as foreign companies which have forged joint ventures with local companies.

Apart from Shell, it is unlikely that the other developers can execute the exploration as per the requirements of the licences which remain the petroleum contracts of choice. In order to salvage the situation, the government moves from the licence agreements and shares the burden through another form of petroleum contract which is the production-sharing agreement. However, to best explain the processes as clearly as possible during the period 2015 – 2024, this research provides a brief background to the fracking in South Africa and the reasons for the 'fits-and-starts' approach (personal interview with SOAGA representative). The South Africa government, relied primarily on early warning signals from the U.S. and had not heeded to the calls of De Wit (2010) and the rest of the local scientific community to invest in local R&D. While it is a widely accepted view that geologies differ, it is equally accepted that fresh drinking water is a critical need as climate change stimulates dry conditions. Earthquake activity is also a significant concern, following reports of increased earthquake activity, in Irving in the U.S. and Lancastershire, in the UK. in 2014-2025.

Zuma's action of corruption categorises this trajectory. The Russian nuclear deal surfaced at the South African investor roadshow in London where Gordhan (2018) and Jonas (2018), the ex-minister of the Eastern Cape region, were presenting to investors. After the release of the budget, a member of the meeting asked about the Russian nuclear programme, to which Gordhan responded that there was no such budget allocated for such a plan. An exchange of calls between the Russian delegate and someone, supposedly in Russia, ensued. Gordhan (2018) and Jonas (2018) were summoned to return to South Africa. The calls were a sharp response to the announcement of the nuclear programme and Zuma was caught out for the non-delivery of a promise on the Russian deal. Gordhan and Jonas were immediately relieved of existing portfolios and the currency went into a downward spiral and took almost two years to rebound. The rating agencies set the final grade to just above junk status.

'Treasure the Karoo', funded by the Ruperts (2018) attempts to challenge the initial start of the fracking discussion. Shell starts to engage with the farmers in the Karoo in order to carry out specific investigations, but the response from the farmers is negative. The farmers would not be able to get the benefit as American landowners did, as in South Africa the state owns the mineral rights. After a series of court hearings regarding the safety of fracking, the government places a two-year moratorium on the exploration in order for a more in-depth investigation into exploration. This leads to Shell, the largest developer, disbanding the global team that is set up to manage the fracking exploration. Public resentment against the company is at a maximum and which sees the company, which possesses the largest market share and the highest share of voice, close many of the company's network of retail forecourts and cease the marketing of its products in that area.

During the years 2012-2014, The AEON Institute, based at the Nelson Mandela University is granted only USD 1 million for research. A pilot exploration for fracking begins and is suspended due to the lack of funds (SOAGA, 2017). The researcher starts the earliest rounds of fieldwork at a farm outside of Jansensville belonging to a white farmer. This was the site of the SOEKOR scientific centre, where international scientists from a global oil company set up camp for approximately twelve months and started to do exploratory drilling. When shale gas was first discovered during that exploration, it was regarded as a fugitive gas. The well hole was sealed, and the exploration abandoned towards the years of 1968. The farmer recalls the days of the exploration, whereby the scientists were cash-flush and spent large sums of money on personal entertainment and lavish living and which contributed income to the small numbers of people who lived in that area. Had the pilot exploration continued, in the early years, it would have led to more concrete decision-making on the extractable reserves of shale that are available.

The IEA (2013) estimated that the extractive value was in the region of 495 TCF. This amount of energy, according to the IEA (2013), would have enabled South African energy security for 93 years. Shabangu (2012) during a parliamentary address, makes this landmark announcement that shale could potentially be an economic game-changer and would be investigated by the government. After the moratorium, the government is still lacking information and commissions a scientific environment assessment (SEA), through the CSIR. The head of this research was a renowned South Africa scientist, Dr Bob Scholes.

The SEA encompasses the work of sixteen interrelated energy disciplines which form part of the framework in the UOG extraction discourse. The team consisted of environmentalists, scientists, ethnographers, water and sanitation specialists as well as representatives from some of the South Africa universities. Many institutes had written about shale, merely referencing the U.S. scientific research which was the only published work available at the time, so the pool of knowledge remained conservative. The results of the SEA were published eighteen months later, in 2016, contained no new scientific or geological findings as no exploration took place(citation?). In the meanwhile, in anticipation, the AEON Institute continued to collect baseline samples. Given the stop-start nature of the 'Frack and Go!' Scenario, there is a weak appetite from all parties and decision-making is very slow.

The end of the Zuma era, sees the end of nuclear, with only domestic nuclear-sourced power from Koeberg Power Station. Radebe (2018), is appointed the Minister of Minerals in 2018 and starts to draft out new energy policy. Radebe (2018) finally agrees that there is merit in separating the shale regulations from the mining legal framework as the activities show no actual convergence (BusinessTech, 2018). The IRP (2030), includes gas, coal, wind, solar and nuclear which is sourced domestically. No clear direction is given on gas, as to whether it is UOG extraction or imported gas from Mozambique and Namibia.

The Ramaphosa administration begins a campaign to solicit USD 100 billion investment into the country. Significant strides are taken to root out corruption and this sees several positive changes in the cabinet, and which stave off the rating agencies and South Africa is back on the road to recovery. Confidence builds with the intent of a Swiss bank wanting to enter the South African lending market. The Chinese government at the 2018 BRICS Summit, hosted by South Africa, sees the highest African investment in Africa of USD 14, 6 billion, the majority of which would be spent on infrastructural programmes.

The government too, is intent on developing local content, both in the form of developing local business for home-grown opportunities as well as South Africa companies investing in other markets on the continent and beyond. To that extent, government funding mechanisms such as the NEF, IDC and BIF schemes relax specific rules. In the renewable energy sector, licence conditions are relaxed and small developers are not required to have a licence for the low production of electricity.

The BEE dealmakers remain firmly entrenched in the coal sector as in the 2030 plan, and coal remains the dominant fuel source. However, the black local investors see that the market conditions begin to work in favour of new endeavours and seek to explore renewables as well as the UOG extraction in the Karoo. With Shell threatening to exit, the BEE dealmakers are encouraged by the government to start looking to invest in the shale exploration. Government invests in capacity-building of youth competencies and the youth start to engage in mobility programmes in the renewable energy sector in other BRICS markets such as India and China.

In the ‘Frack and Go!’ Scenario, Shell exits the market as a shale developer and exits Africa, as part of company plan of 2005. Since the South Africa government, as well as the black local investors, do not have experience in UOG extraction, alliances are formed, and the licence agreements are phased out in favour of production-sharing agreements. With the South African government being a stakeholder in the venture, the burden of providing infrastructure becomes the responsibility of the state. As a stakeholder, the state currently carries the responsibility to manage and distribute the water resources for drinking, sanitation and agriculture and the burden to provide water as a raw material becomes that of the state as well. As the creation of jobs and the facilitating of a positive, enabling environment is the responsibility of the state, the state funds all capacity-building programmes. Programmes relating to pre-shale such as the community work programmes, whereby a stipend is given to maintain the roads, sees workers who are semi-skilled being trained with basic training and they start to occupy jobs created by the state in support of the UOG extraction in the Karoo, South Africa.

Accessing finance from the government funding agencies, the local black developers focus on the drilling operations. Given that South Africans are not familiar with the technique of hydraulic fracturing, experience from the U.S. shale exploration is transferred to South Africa by a significant number of consultants, together with families, based on long term contracts which are signed. This leads to the growing need for accommodation. The white farmers who anticipate a water issue and the growing uncertainty of the agricultural sector, convert the large dwellings into luxury guest homes and rent out properties at exorbitant prices.

The domestic worker sector starts to grow as the expatriate community requires general services. With the low minimum wage for domestic service, expatriates can employ many domestic workers in a single household. New builds are also planned on a large scale to accommodate the growing numbers of youth who move from Gauteng, Port Elizabeth and Cape Town to the Karoo towns of Graaff-Reinet and Jansensville. These new builds are centred around these two towns and given the speed of development, there is very little time for the planning of roads and the infrastructure that is required.

Local trucking OEMs set up small one-person entities to serve the vehicles bought in Gauteng. There are as many as five hundred trucks per day on the streets of these old Karoo towns bearing water to the wellheads and waste back to the disposal sites outside of the towns. The roads too, being part of the infrastructure, become the burden of the government. It is already 2024, and the roads are still not upgraded for the exploration. In 2020, the South African NDC sees that South Africa has not managed to keep the commitment, and there are not too many mechanisms in place to monitor the 2-degree target. However, some carbon sink projects are implemented by international environmental NGOs in the rural areas of Graaff-Reinet and Jansensville. The youth start to be gainfully employed. With the shutdown of the Eskom power plant, local wind farms start to gain traction. The start of a decentralised energy model is ambitiously planned through the autonomy of the local government of Sarah Baartman Municipality.

7.3.1.2 Trajectory 2025 – 2034

Informal settlements and poor urban development characterise this period. Once fracking starts, the fracking areas became unmanageable as the Karoo turns into the wild west with the quiet towns of the Karoo turning into bustling places. There is a very high level of sand storms and dust in the air, given the number of trucks on the many dirt roads which have been created on an *ad hoc* basis. Informal settlements are prevalent in Africa, but the situation in the Karoo is acute. Williston, North Dakota witnessed this level of informality and similar problems and the South African has not learnt from these mistakes.

White farmers have leased vast tracks of property to developers who create gated – complexes, as petty crime increases in the area. The accommodation is more like homes which have been cargo containers and have been modified to become luxury dwellings, as the fracking community have a high disposable income and demand every possible luxury which the towns cannot afford. Therefore, finished goods and services are brought from Gauteng, Cape Town and Port Elizabeth and serviced from those cities. Apart from expatriates with families, South Africans from around the country move to these Karoo towns which are encumbered with high rentals and limited accommodation so that upper-class migrant labour occurs. With a majority of single well-paid men in the towns, female youth who are unemployed turn to the very lucrative trade of prostitution and the HIV statistics are on the rise. The locals are still without jobs as the accommodation on offer is almost self-catering and self-administered. With more significant technology, these homes require less human labour. There is a fair amount of local labour employed as truck drivers and other in essential jobs in public administration.

The increase in population requires higher energy demand and the municipalities are not able to support this demand. Renewable energy used on a local scale is not fully commercialised and does not meet the needs of the emerging middle class of people. There is no means of tracking methane leakage and other fugitive gases and there is large-scale contamination of wastewater. Fracking starts full scale around 2027 to 2030. Few institutions govern the operation and there is only one regional court set up for the resolution of fracking disputes. Government is unable to satisfy obligations of infrastructure and of water being piped from the sea. The developers, having already invested in the high cost of equipment, resort to the unthinkable and start tapping into the surface and ground water.

The years towards 2055 are simply a coal-dominated energy plan. The youth turn to the EFF as the ANC government has failed them and start to vandalise fracking properties and fracking equipment, thereby threatening the developers. The developers have realised investment returns but find that when compared to less demanding coal investments, which provide better returns in the coal sector or simply exit the economy. The youth are compelled to move to the urban areas to seek better opportunities, leaving the elders and young children behind. Poverty levels in the Karoo, South Africa, show a slight increase against the global backdrop which sees an overall decrease in poverty. Women seeking emancipation have left in search of more cosmopolitan lifestyles and smaller disadvantaged groups continue living in despair in the rural areas which remain under-developed. The IRP (2030) at the beginning of 2030 produces disappointing results.

7.3.1.3 Trajectory 2035 – 2045

The fracking towns in the Karoo, namely Jansensville and Graaff-Reinet, employ the policy of Local First, i.e. employment preference to youth of the Karoo town before seeking co-operation with other cities. However, the lack of capacity building results in the local black investors bringing in staff from Gauteng and other regions of South Africa, thereby causing significant resentment. The youth surveyed in the focus group and who are now in their forties, realise that opportunities have passed.

The EFF is in power and civil unrest starts in the towns of the Karoo, thereby impacting upon fracking. The developers start to consider abandoning operations in the Karoo as the exploration starts to fail. The locals start to smell gas in the air, and there is no monitoring of fugitive gases which are emitted into the atmosphere. Local and international NGOs try to intervene, but the local government is not equipped to deal with concerns of the environment. South Africa is tracking the 4-degree Celcius? mark, and climatic conditions are unbearable for the elderly in the Karoo, South Africa. The developers start to leave and there is no legal framework that obligates the developers to pay for the damages and reparation costs for the land and the contamination of some small streams.

7.3.1.4 Trajectory 2046 – 2055

Looking back towards these years, the government has exhausted the borrowed finance. Having entered into the production-sharing agreement, the government is an equal shareholder of the liability and the profits. The land after the exploration belongs to the government and remains within state control. Therefore, it makes sense for the government to assume the responsibility of providing the infrastructure and this entails the management of socio-economic impacts of water which have been affected by UOG extraction. The provision of water for the extraction becomes a government burden. The pipelines to transport water from the sea become a significant expense. The outlay for the capital to install the pipes is exhausted given the incorrect calculations and the number of expatriate companies which are contracted to perform these tasks. With the volatility of the oil price and the alliance between the Americans and the Chinese, the local currency is tortured. The political economy in the energy sector is now stronger as the government's primary focus is developing a few local black investors in shale gas and renewable energy programmes start to fail. With the cracks in the shale sector, government reaches out to China, Brazil and India to procure infrastructure to develop, wind, solar and biomass technologies but the costs are prohibitive. All promises made by the government, that shale would be the economic game-changer result in an economic resource curse. The government must continue to service the debt from the IMF and the other international lending institutions. The EFF refuses to fulfil all obligations and sanctions are being imposed on the country. Poverty is widespread across the entire nation towards the years leading to 2055.

7.3.2 Causal Layered Analysis: Frack and Go!

Table 7.2 provides the CLA for Scenario Two which is named as Frack and Go!

Table 7.2: CLA Scenario Two - Frack and Go!

CLA Layers	Commentary
Litany	The Ramaphosa (2018) spirit, unlike the Mandela (1994) dream, cannot sustain an economy. South Africa needs a single bullet to jumpstart the economy. Empowerment to the people is a good narrative but cannot be achieved in the energy sector. However, government seems intent in pursuing this narrative. It seems right to empower locals but not in critical sectors like oil and gas and which require a legacy of competence and expertise. The lack thereof leads to the lack of health, safety, security and to environmental degradation.
Systemic Causes	Lack of shale competence leads to poor fracking practices, which further alarm the environmentalists and climate management NGOs. The discussion which started with the international oil companies chosen for expertise results in developers using government finances and no experience to manage such a potentially dangerous operation. When shale is gas is found, grid management poses challenges. The decentralised model has not been perfected before the exploration.
Worldview	The government takes a reductionist view, "that shale is a God-given gift and must be exploited for the benefit of the people", and that shale will go ahead, irrespective of what the data yields. Incompetent developers reap financial benefits but the liability of the aftermath, both financial and infra-structural is borne by the state. All the socio-economic impacts of the water are as new contractual agreements are negotiated, water provision for the extraction, is considered as an infrastructure obligation. The human right to water is violated.
Myth/ Metaphor	Government needs to do something, anything to appease the people.

(Source: Researcher's Construction, 2019)

7.4 SCENARIO THREE: NO SHALE, WHAT NOW?

Scenario Three called No Shale, What Now? recognises futures which are dominated by the role of renewable energy, in the context of the global energy as envisioned by the UNFCCC (1992), and under the auspices of the Paris Agreement of 2015. Therefore, this research is incumbent to strongly consider the validity of these pressures and to put forth evidence-based reasons as to why South Africa cannot fully comply with global recommendations.

7.4.1 Scenario Three Description

Economic growth is categorised by increased energy demands which require urgent action to improve efficiency. Designing system which provide low urban pollution is critical. The introduction of capacitors, which enable battery storage is an enormous boost for the RE sector. While the economy transits towards RE usage, cleaner coal technology is used. Given that fossil fuels are still in use in the foresee-able future, new products enter the market and can reduced emissions, which are produced by diesel.

The current energy utility experience challenges in grid management. The introduction of the RE poses technological challenges to the existing grid. Increased urban growth requires management of climate resilience. Focused work is required with informal settlements to manage the needs for energy, water and the safe disposal of waste. Local government capacity is required to deliver local mandates through the accessing of finance by attracting FDI and being able to implement programmes.

This scenario has significant data to develop a business case for renewable energy. However, the current economic conditions do not favour this scenario, as there is the issue of funding. Additional data inform the political and economic issues surrounding the hampering of the development of renewable energy in the wind and solar sectors. Sufficient desktop literature and 20 interviews with industry experts inform the data for this scenario in this research. This set of options examines the various dynamics which prevail in the renewables sector. The focus of this research is on hydraulic fracturing futures for South Africa towards 2055 and puts forward the ‘for’ and ‘against’ arguments for the exploration.

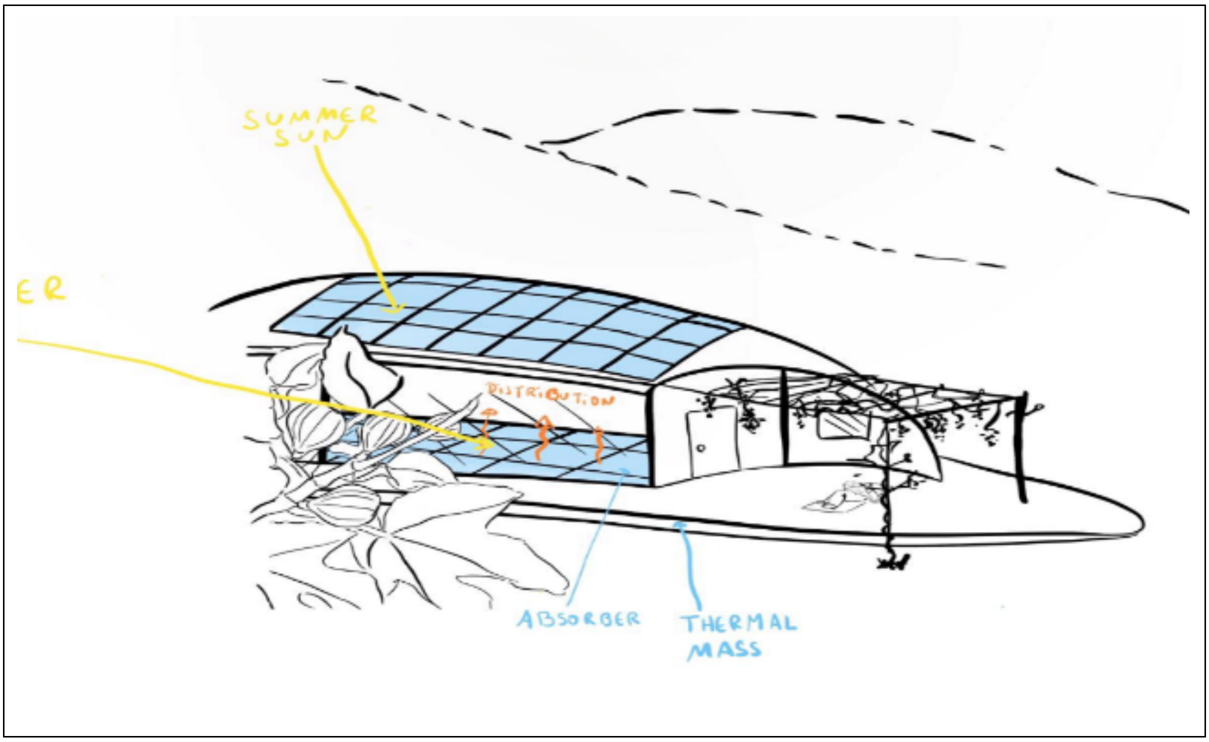
The arguments against the exploration are presented as a summary of the jurisdictions which have chosen not to consider exploration, based mainly on the safety as well as socio-economic reasons. In this non-shale scenario, all sustainable energy forms have been investigated. However, based on the South African data available and the strategic traction of the wind and solar industry, in this market, this scenario considers only the implementation of solar and wind technologies.

The insights are drawn from examples which the research references such as Masdar, are implemented, but the lack of finance does not allow effective implementation. The youth have followed the capacity-building programmes offered by BRICS as well as other UNFCCC agencies and have committed to ambitious targets. Financial constraints resulting in a severe lack of infrastructure frustrates the youth of the Karoo, South Africa and prevents South Africa from attaining rapid growth as predicted.

Given the interaction of the researcher in the global climate management sector and the various forums which been highlighted earlier, the researcher has considered the arguments of the various stakeholders who support the direct path to renewable energy. Appendix Seven summarises the fieldwork of 20 interviews of the various stakeholders in the government, i.e. the SOEs of CEF, IGas, Eskom and PetroSA. In principle, these stakeholders are committed to the current energy plan which sees a more significant use of wind and solar technologies. The country has no other choice but to consider RE as 2025 sees the permanent shut down two of Eskom coal plants, resulting in the loss of 7500 jobs.

What emerged as a critical finding is the lack of government support in the form of subsidies for other forms of energy, except for the coal sector and given to Eskom and SASOL. The discussion examining subsidies has been summarised earlier in the research. The data to rationalises Scenario Three and the implementation strategies for the renewable energy market readiness has been presented through the environment scanning chapters, mainly Chapters Three and Five and which put forth wind and solar futures against a coal-dominated energy future. In Figure 7.4, the art of this scenario depicts the scenes of modern built environments.

Figure 7.4: Art Depicting Images of Scenario 3



(Source: Sezen, 2018)

Interviews with the unions confirmed the concerns of resistance raised by the academics as well as the respondents of the SEOs. Resistance is motivated by the fear of the loss of jobs as wind and solar technologies require fewer people occupying manual jobs. This research summarises in the CLA below, the current understanding of the renewable energy sector in South Africa. This information is used for a set of options that South Africa might exercise if shale exploration does not materialise in the country. The scenario named 'No Shale, what now?' investigates other energy futures for South Africa towards 2055.

7.4.2 Scenario trajectories and wildcard manifestation

The four wild cards continue to manifest differently throughout these various trajectories in this scenario. This research would be incomplete without a back-up scenario, given the critical uncertainties of shale gas. This research considers the four wild cards which affect the South African energy. Scenario Three must consider potential wild cards, which play out and have adverse impacts on the economy.

If South Africa were to pursue Scenario Three as a set of options, the following are critical questions that must be considered.

- If gas were to dominate the global oil and gas sector and South Africa does not explore for shale gas, can South Africa afford to miss out on the opportunity to fast track economic development and becoming an energy seller for Sub-Saharan Africa?
- Relying of the RE FDI only, what if international RE investors find better investment havens outside of South Africa?
- What would be the impact if the political economy continues to prevail in the coal sector and which discourages a flow of investment from coal to RE and barriers are formed by the unions?

Before the research can present the backcasting for Scenario Three, the following should be noted:

- Scenarios One, Two and Four have been evaluated based on the economic benefits to Treasury and based on the business case presented for shale in Chapter Four.
- A business case has not been provided for this scenario which only proposes renewables, as the government does not assume that a renewable energy dominated energy model is a realistic and plausible scenario for the nation.
- The current pricing for energy derived from coal and RE is on par and if the government extends the subsidies to RE, RE prices would be lower and could then become an economic game-changer. Hypothetically, RE futures are definitely possible given the technological advancement in energy storage due to the advances in capacitator capabilities. However, other barriers, such as grid connectivity and a lack of political will and a commitment toward the establishment of a robust RE sector present key challenges.
- The difference in this scenario is that the RE provides for unlimited, sustainable energy security for South Africa. The correct level of investment will provide for a sustainable energy future for the country and lead to sustainable economic development. However, government must act purely as a regulator and allow the private sector and civil society to harness the opportunities of cleaner, greener and cheaper energy which is collaboratively developed on a decentralised energy model.

The research presents this scenario in a different format, given the different set of data that is currently on hand. This research references substantial desktop research as part of the overall literature review on global energy but makes commentary based on the local insights drawn during the 20 interviews as these experts represent the current dialogues in the RE debate in which the country is engaged.

The wildcard of technology advances digitalisation on many levels. Technological innovation facilitates investment in decentralised systems and business model, which could lead to faster economic growth in a regional context. Technology allows for efficient connection to the grid. Relevant technologies would include data digitalisation, the internet, cloud-based storage, mobile device and the reduced cost of satellite communication. The impact of mobile access is critical to successful RE implementation as well as the know-how of implementation staff. Increased decentralised energy supply is readily available as the resource is abundant in all areas, and is enabled, cost-efficiently through, technology.

7.4.2.1 Trajectory 2015 - 2024

Looking back from 2055, wind and solar technologies in South Africa have progressed but have suffered severe investment constraints, which is by far the principal reason for the failure of this scenario. Unlike the shale case, where the extractive reserves are limited to 20 major sweet spots in the world, wind and solar opportunities are available in many welcoming, investment environments. Investors can extract better investment returns from these markets and exercise these options. Given the political economy of the South Africa energy sector, the preference is coal and this frustrates the RE investing community. Even though the government makes efforts to bolster small entrepreneurs by relaxing licences to RE companies, it is not adequate to see large- scale investments in the RE sector by local companies. Therefore, the Chinese, Indian and Brazilians dominant the RE sector in South Africa.

Motsepe (2020), a mining magnate, together with Ramaphosa (2020), Reddy (2020) and others, were founding members of black elite investors otherwise known as the BEE dealmakers (Malherbe, 2018). This appointment solidifies the political interference of the black elite and which has been responsible for the domination of coal in the economy. There have been weak investments in the wind industry by the black local investors, but by-and-large coal evergreen contracts are a more comfortable option and the black local investors are reticent to consider renewable energy or shale gas.

Capacity-building programmes which have been developed to appease the unemployed youth of the years 2020 – 2025, do not provide adequate jobs for the growing number of immigrants as well as the South Africa youth. Therefore, unions still do not support the RE sector as a provider of jobs but prefer to support the coal industry. A large proportion of South African youth remain as blue-collar workers and the impact on the Triple Challenge is low.

The trajectory 2015 – 2024, sees a turning point. The rolling blackouts become a severe embarrassment to the South African government. More than at any other time in the country's history has there been the incidence of such poor energy management as in the years towards 2030. Eskom shuts down power plants in 2025 and sheds 7000 jobs. The years preceding 2025, see government implementing too few projects in support of RE and these too, are ‘a little too late'. However, this catalyst, nonetheless, does spur more significant momentum into the awarding of new RE licences. A further turning point is that due to technology, the capacity of the government grows as it adopts technology to provide the public with greater transparency. The government rolls out more broadband which enables more significant and more efficient connectivity.

A constraint during this trajectory is felt in the area of storage. However, the advent of capacitors provides a solution to the problem globally, but not for South Africa. The root of the problem is the centralised energy model which rests under the custodianship of Eskom. Thus, in order for RE to be effectively integrated into the grid, large scale investment is required for capacitors. Eskom does receive a government bail-out but this does not include the costs and management of the storage facility.

While RE does make an impact in the residential sector, as installation and maintenance costs become more palatable, the large industries still run on coal and the transport industry still runs on fossil fuels. The net effect on emissions is dissatisfactory, as one the major cornerstones for the promotion of the RE sector is the benefit of a greener and cleaner energy future.

7.4.2.2 Trajectory 2025 - 2034

The years 2025 – 2034, see another turning point. An enabling environment for investment improves. However, this is not a result of a fully functioning RE system but of the failed operations of Eskom. The closing of the two power stations in 2025 and the non-commissioning of Medupi and Kusile in 2018, hampers development for economic growth. The growth that is witnessed, weights down on the over-burdened coal energy grid. Having invested in the communication and development of green finance, international environmental NGOs, convince global financial institutions of the profitability of the RE sector. This development leads to decentralised energy models becoming more widespread, as finance enables technological advancement. Operations and control centres become more useful in the integration of information and can act on real-time information.

7.4.2.3 Trajectory 2034 - 2044

A turning point in the years 2030 - 2034 is that battery storage capacity improves and becomes more cost-efficient, specifically in the South Africa market and this also leads to greater decentralisation and the powering of rural households. Software developments allow for improvements in city operations. A skilled workforce starts to develop as on-the-job training becomes more attractive as a learning model. However, the RE job numbers remain very low as the RE requires a highly trained workforce which, using smart technology, requires fewer individuals. The Unions are dissatisfied. Technology is embedded in systems because finance is more readily available in this trajectory. Thus this, overall, becomes a more cost-efficient model as there are reduced costs of retrofitting. As with all technological solutions, planners must account for the level of old obsolete software. Interoperable systems are implemented at a higher cost to enable higher flexibility.

7.4.2.4 Trajectory 2044 – 2055

Looking back from the years 2040 to 2055, South Africa could have realised a more sustainably desired energy future. South Africa is in urgent need of an economic game- changer and failure to achieve this in the mid-part of the first trajectory and the second trajectory sees a slump in economic development and which will lead to civil unrest. The xenophobic attacks witnessed throughout the first trajectory sees repercussion and political isolation on the African continent. Even though RE gains traction, there are small gains in cleaner coal technology, as the pre-occupation and finances are deployed on RE alone. The coal dominated South Africa starts to witness the adverse climatic conditions of a '4 degrees Celsius' level of global warming. Oil shocks impact heavily on the South African economy as the economy relies on the imported fossil fuel raw materials.

7.4.3 Causal Layered Analysis: No Shale, What Now?

Table 7.3 provides the CLA for Scenario Three which is named No Shale, What Now?

Table 7.3: CLA Scenario Three – No Shale, What Now?

CLA Layers	Commentary
Litany	The slowness of government to respond to shale opportunity, the critical uncertainties of the socio-economic impacts of water in a water-stressed environment lead some to consider an energy model, which does not include shake gas in the near future. Therefore, given particular successes in the wind and solar technology, South Africa must consider a cleaner-coal future which transits towards a RE, which the country wishes to meet its UNFCCC obligations. The dynamics of economic growth required cleaner energy, based on a decentralised model, good governance and good urban planning is required.
Systemic Causes	South Africa recognises its climate change obligations and understands how other economies have embraced low-carbon options. Learning has led to demonstrating world best practices in the wind and solar technologies in South Africa. However, Zuma's obsession with the Russian nuclear deal have stalled the transition to renewable energy futures. Given the controversial uncertainties of the greenhouse gases, apart from the potential uncertainties of water issues and earthquakes, South Africa must consider the potential of a no-shale future. South Africa must also consider that climate change obligations also mean a lower-carbon future and a complete reduction of coal using the current techniques. The monopolistic behaviour of the SOE, Eskom, and the interference of the state hamper the transit to renewables. The state must act as a regulator and the private sector should be tasked to provide energy solutions.
Worldview	The INDC confirms the country's will be meet climate change obligations. For this to happen, government must create an enabling environment by gearing all systems to move towards a centralised energy model and build capacity

CLA Layers	Commentary
	within municipalities and civil society in conjunction with the private sector. Government, therefore, must level the playing field and extend all subsidies and support given to the coal sector to the shale sector. Such support will enable local developers to compete with international energy suppliers and provide competitive prices. Local government autonomy and local profit centres would lead to alleviating poverty on a regional basis. This fundamental shift will allow for a more decentralised energy model which will encourage local municipalities to develop transactions with local as well as international companies, when appropriate. Furthermore, global environmental NGOs will be able to support specific municipalities in climate change support programmes.
Myth/ Metaphor	Fast track transition to cleaner, energy futures harnessing all sustainable energy forms.

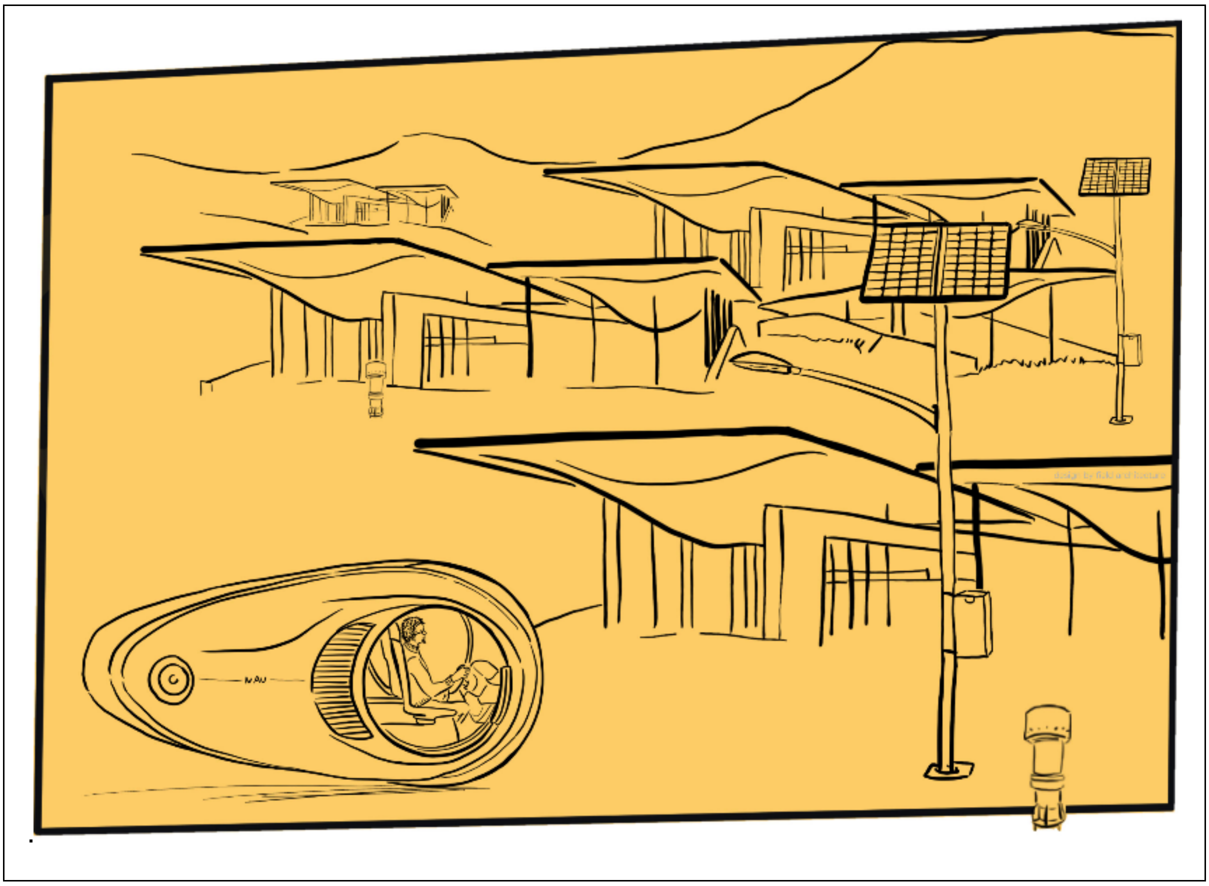
(Source: Researcher's Construction, 2019)

7.5 SCENARIO FOUR: DESCRIPTION OF FRACKING WITH A SMILE ON MY FACE ☺

This section presents Scenario 4 as the integrated scenario for UOG extraction in the Karoo, South Africa and better explains this scenario by displaying the various stages of development and how the megatrends manifest themselves with different impacts over the 40-year forecast period.

This scenario is characterised by technological uptake. Capacity-building programmes based on the concept of development diplomacy are widespread and the sustainability is the cornerstone policy of all economic endeavours. Good governance is witness and this can be widely attributed to a solid regulatory programme. Good infrastructure mitigates the socio-economic impacts of the water usage in the UOG extraction. The human right to water is recognised and implemented and the water resources are safe-guarded. Hydraulic fracturing is supported by innovative techniques which lessens the harmful impact of the exploration. Figure 7.5 refers to the tableau below which depicts the integrated vision of the energy future.

Figure 7.5: Art Depicting Images of Scenario 4



(Source: Sezen, 2018)

The Integrated scenario notes the following issues:

- That central and local regional government must work closely for an enabling environment.
- Decentralisation leads to the diminished role of vertically integrated utilities.
- Good coordination is necessary for good city spatial planning to ensure resilience of the new cities to withstand the ravages of climate change.
- Increase efforts are required from the private sector to support community in the onslaught of climate change by assisting communities to diversify into other business sectors and meet the SDG targets.

Given the innovative types of new petroleum contracts, the future is realised in the next trajectory as earlier adaptation poses lesser climate risks. As noted in the tableau, the government's plan to manage the Triple Challenge has the initial seeds of success. Technological advancement is noted with new comfortable homesteads being powered and insulated by gas and renewables. Electric cars operate at zero emissions.

7.5.1 Core Scenario Dimensions

The following drivers examine the activities of these dynamic scenarios over each trajectory.

- Technological Innovation
- Increased decentralised of the supply – a basket of energy solutions
- Carbon reduction goals are realised.
- Cleaner cooking and heightened safety for women
- Poverty is on the road to eradication due to sustainable, cheaper energy.
- Social programmes start to work and result in a higher satisfaction index.
- The economy prospers, and renewable energy programmes are sustained.

7.5.2 Scenario Four Assumptions

This scenario assumes that the full plan of the IRP 2030 is implemented and fully supported, but UOG extraction is rolled out initially to the fullest capacity of 496 TCF. The business case is based on these projections. Petroleum contracts are modified for the South African case and provide better protection for the environment and people.

7.5.3 Scenario Trajectories and Wildcard Manifestation

Table 7.4 illustrates how the four wild cards manifest over the four scenarios which have a low probability but when manifest have high, adverse impacts. The four wild cards manifest and each trajectory illustrates how the wildcards influence the UOG extractions. Land expropriation and capacity-building are the most impactful on the Triple Challenge. Technological breakthroughs positively impact upon the development of the new energy grid, providing lower costs through long-lasting technological platforms. Technology enables effective seismic and methane monitoring, which leads to lower levels of warming. Early implementation sees the earlier manifestation of lower warming. Civil conflict, being more an internal issue within the country, has the lowest impact of the four main wildcards.

Table 7.4: Scenario 4 – Wildcard Manifestation

	2015 - 2025	2026 - 2055	2036 - 2046	2046 - 2056
Scenario One	Oil shocks	Technological Breakthrough	4 degrees warming	Civil Conflict
Scenario Two	4 degrees warming	Oil shocks	Technological Breakthrough	Civil Conflict
Scenario Three	Oil shocks	4 degrees warming	Civil Conflict	
Scenario Four	Oil shocks	Technological Breakthrough	1,5 degrees warming	

(Source: Researcher's Construction, 2019)

Scenario Four illustrates the earlier treatment of the Triple Challenge and this wild card does not feature in this scenario. Oil shocks in Scenario Four are not an issue as South Africa becomes energy independent through gas and renewables. South Africa, in all scenarios, is adversely impacted by oil shocks. These are further exacerbated through forex volatility.

7.5.4 Scenario Four Trajectories

The manifestation of the critical uncertainties, drivers for change and the wild cards are discussed in the various trajectories. All four wildcards play out in this scenario and manifest acutely throughout this scenario period.

7.5.4.1 Trajectory 2015 – 2024

The IEA reserves of 495 TCF, forecast in 2012 by IEA were correct and the developers fare well in the UOG extraction in the Karoo, South Africa. As in the business case projections set out in Chapter Four, UOG extraction in the Karoo is indeed an economic game-changer for South Africa. South Africa has, over the past four decades, been reinstated as the 'Gateway of Africa' and proves to be the most prosperous country in Africa. In 2018, economic growth, as predicted by the OECD, is set to strengthen in 2018-19. This growth is driven by increased business and consumer confidence with a favourable outlook on trading partners with the benefit of exports. Private consumption, according to the forecasts of 2018, has expanded. At that time, employment trends remain a concern but by 2025 capacity-building programmes, which started in 2020, have already started to see traction in the workplace by 2024

Inflation, on the other hand, projected for 2018, remains in the target range, reflecting an assumed stable, steady exchange rate which lessens the effect of higher international oil prices and the upward pressure from the VAT increase of 1 per cent of 2018. These forecasts of the net benefit of this increased tax are also accurate and go further towards stabilising the economy. The fiscal policy projects moderate expansion, which supports growth. The government budget for 2020-2025 remains tight, but tax reforms create some fiscal room for much-needed investment in higher education and social benefits. By 2025, the fiscal situation starts to show improvement and government debt reduction starts to rapidly advance with network regulation reforms aimed at broadening competition, thus gaining further support and growth.

A more stable political environment sees growth improving in 2022-2025. While a change in the political environment marks a decisive turning point for business and consumer confidence, Investment and stronger trade ties with India and Brazil also start to gain traction between the years 2022 – 2025. This is the result of bi-lateral agreements between the BRICS countries at the BRICS Investment Summit of 2018. At that summit, the international investment community starts to eye South Africa keenly after China's investment of USD 14,7 billion starts to gain traction and show positive results between 2020 to 2025.

The Chinese investment was a crucial turning point in South Africa's economic history, as confidence started to return and was further marked by a Swiss bank announcing its intention to set up an office in South Africa. Rating agencies reflect that South Africa is no longer under such severe pressures as in the time of the Gordhan's dismissal in 2016. This marked a momentous upturn in investment after years of decline. The currency stabilises following an initial period of strengthening after the change of power in the ruling party and Ramaphosa's (2018) bold strides to root out corruption by instating Mboweni (2018) as the Finance Minister.

Rebounding from the severe drought in 2016, the agricultural sector, leading to an upward revision of growth in 2017, continues to show growth towards the period 2019 to 2025. There are initial signs of a definite upturn in the budget for 2018/19 and this reverses past fiscal slippage. Despite the positive outlook, given the increase in immigration statistics, government, until 2025, has still not seen higher employment statistics. Despite wide-scale job creation, unemployment remains high at 27 per cent, weighing on household consumption. Xenophobic attacks and gender-based violence statistics draw global attention to these specific South African problems.

Inequalities in income and a shortage of opportunities continue to be at a high level with young people, especially, vulnerable to unemployment. This reflects an education system of low quality and contributes to skill shortages and low productivity. However, noting these critical issues, decisive action is taken, marking a significant turning point, and this signals the positive trajectory for the financing of renewable energy and UOG extraction in the BRICS countries. The BRICS community works together to set up the BRICS Academic Forum for the effective transfer of skills and knowledge between the partner countries and this establishes the troika of collaboration between government policy-makers, academics and developers, as witnessed in the U.S. success case.

BRICS capacity-building programmes in the energy sector are implemented, given the commonalities within the various jurisdictions. These are as follows:

- A tertiary education environmental law and policy programme supporting sustainability in BRICS countries for the renewable energy sector. Given that India is the leader in solar and wind and Brazil is in second place as a leader of wind technology and a leader in biomass, this programme sees a wide-scale focus on capacity–building across the economic block.
- A specific shale technical training programme to support the shale development in South Africa, China and India.
- A policy brief submitted to the BRICS Development Bank in support of ‘green finance’, is fully implemented in the trajectory of 2025 – 2034. The accessing of green finance enables the South African government to set up contracts in a manner which enables shale developers to access finance from international lending institutions, emulating the U.S.

financial institutions that have funded the oil and gas industry since World War 2.

However, looking back in time from 2055, the UOG extraction in the U.S. shows remarkable success. The UOG extraction has been the critical success factor for the turnaround of the U.S. The U.S. at this time is energy independent and having been the largest customer of OPEC countries, the UOG boom hurts OPEC and leads to the decrease in oil prices.

The Arab states in the Middle-east, for example, Saudi Arabia, become concerned that the Arab spring uprising seen in Cairo would move into the rest of the Arab world as social programmes start to fail across the Arab world. Given the drop in the countries' revenues and the Arab world since 2012, social measures are instituted to curb these issues and start to manifest positive results. ISIS starts unrest in Syria, leading to widespread immigration to all parts of the EU. Immigration is spurred by the sympathetic remarks of the German Chancellor regarding immigrants. Europeans, unhappy with the immigrant issue, see the growth of the far-right political groups, as these immigration programmes start to drain the recovering economies after the financial crisis.

As more countries join the EU and show promise of brighter futures, eastern European countries such as Croatia, Poland and the Baltic states of Estonia, Lithuania and Latvia struggle to keep up with EU regulations and costs, as well as having to bear the costs of the increased burden of immigration. BREXIT (2020), however, becomes a concern for the British as well as the Europeans, as, with a skinny slice of the vote, a significant shift takes place in European politics. Shale is investigated, but reserves are low in most of the productive countries. Poland in 2019, starts new investigations into UOG extraction.

This becomes a turnaround in the sustainability of the planet and the climate change framework can be attributed to the timing in this trajectory. With sustainable development being the cornerstone of EU policy for the economic block, countries of the EU start to implement programmes of environmental protection effectively and under the UNFCCC (1992), The Paris Agreement (2015) is ratified by 181 countries. While hailed as a watershed, the Paris Agreement remains non-binding and allows the U.S. to opt out of the Paris Agreement with no implications for the Trump Administration.

However, despite the over–dramatised issue, there are several critical yet positive manifestations of the problem. In anticipation of a 2016 Trump win, the drafters of the Paris Agreement had the conditions of exit carefully worded, rendering the process taking longer than the first term of office of the Trump Administration. China, after the Trump announcement, pledges more significant commitment.

The Trump victory into the White House in 2016 splits the American public and sees the overturn of Obama Care, as well as the shale exploration regulations which were instituted to monitor cleaner air and to govern the policing of fracking. These actions lead to a lack of further controls on emissions and, not being part of the UNFCCC of 1992 and thus not bound by hard or soft law mechanisms, the world's largest polluter cannot be brought to book.

However, the U.S. during the time of the Obama Administration in 2011-12, instituted many sustainable development programmes. The IEA statistics indicate that coal consumption in the U.S. was the lowest in 39 years (IEA Website, 2019). Carbon emissions in the U.S. power sector declined by 28 per cent since 2005. U.S liquefied natural gas export capacity was expected to increase by more than 100 per cent in 2019. This high probability of success was indicated by the performance of the U.S. in the last weeks of 2018, where the U.S. was the largest exporter of oil and gas products in the world.

The bold Chinese actions not only go against the Trump Administration's exit from the Paris Agreement but also signal a commitment to the development of renewable energy forms and which in turn provide lower RE prices and lower emissions. The IEA forecast for the years 2018 to 2023, indicates an upsurge in gas demand spurred mainly by China (2017). Realising that pollution levels bring harm to the people due to rapid industrialisation, China changes policies in favour of cleaner air and shuts down programmes to build new coal plants. This is another major turning point in the BRICS relation and which starts to impact upon South Africa within this trajectory.

China's amendments of policies in favour of lower emissions and natural gas are followed by other countries in a similar trend towards cleaner energy, as seen in India. In the first trajectory, India emerges as the leader in both wind and solar technologies. BRICS countries start to share insights and encourage sustained performance. Growth trends in the block see Brazil developing RE capabilities and emerging as the leader in wind technology and having 60 per cent of its economy being powered by biomass.

In Africa, economies show growth in GDPs and smooth changes in government result, at the end of dictatorial regimes such as that of Mugabe (2016). Greater transparency and better governance are seen in countries such as the Democratic Republic of Congo (DRC) which tops the rating list of reform. Countries such as Mozambique and Namibia started to explore and extract lucrative pockets of gas which are exported to neighbouring states, allowing for lower emissions. The five years between 2018 – 2023 show a tremendous upsurge in the global gas sector and which is policy-driven as well as price-driven. South Africa, during this period, is in a quandary and is struggling to finalise its energy policy, given the set-back of the Zuma era which categorised the ills of the period 2014 – 2017.

The Zuma era was cynical of the energy policy of South Africa. The first vague announcement on shale was made in parliament by Minister Shabangu (2012), "that government would act decisively and responsibly, given that shale could be an economic game-changer". However, by October 2019, the licences had not been awarded to developers, nor were the amendments to the fracking regulations out for public comment. The two-year shale moratorium was a delaying tactic for Zuma's discussions with the Russians, regarding the nuclear deal which came to a head when Gordhan (2016) announced in London that nuclear was not on the energy agenda for South Africa in the immediate future.

Looking back from 2055, one recognises the seeds of economic stability, which started with growth, beginning to strengthen in 2020-22, driven by increased business and consumer confidence following the change of presidents and the re-shuffling of the cabinet to eliminate corruption and efficiencies in the government. At the Zondo Commission (2018), corrupt politicians are exposed. Nene (2018) admits to being close to the Gupta family and volunteers to resign and the resignation is accepted.

Moyane (2018) is found to be inefficient in the capacity as head of SARS and is fired. A favourable outlook accompanies a positive trading partnership with other countries and exports across the sectors start to thrive as the economic position, due to shale, begins to improve.

Private consumption begins to improve and expand, first at a lower rate in 2018, albeit at a slightly lower rate than in 2017 due to tax increases but it starts an upward climb towards 2023. Employment trends remain a concern between the period 2015 – 2020, but capacity- building programmes start in 2021 – 2024 to realise numbers in a skilled youth workforce.

7.5.4.2 Trajectory: 2025 – 2034

Inflation remains well within the target range, reflecting an assumed stable, steady exchange rate. This lessens the effect of higher international oil prices and thus the upward pressure from the VAT increase. Monetary policy starts to be moderately expansionary, which is appropriate to support growth. One of the reforms from the Ramaphosa Administration (2018) was the appointment of Minister Mboweni, the previous labour minister and governor of the South African reserve bank (SARB) at the end of 2018 and which set the economy's course on a tight but solid road to economic recovery. Once again, in this trajectory, the fiscal situation improves with the prospect of the projected shale income. Government's debt reduction plan is advanced and network regulation reforms are aimed at broadening competition, thereby further supporting growth and development.

Looking back from 2055, in hindsight, it is clear that the Ramaphosa Administration (2018) projected improving growth against a more stable political environment and the change in the political environment marked a decisive turning point for business and consumer confidence. Investment started to pick up after three years of decline and was evidenced mainly in shale and renewable energy as well as in all other sectors. Ramaphosa cleverly dealt with the land expropriation issue, which contributed to the decisive success factors for shale exploration in the Karoo, South Africa. In the amendment of Section 25 of the Constitution, it made sense to institute radical reform, which would see economic benefits as well as address the issue of inequality on a policy level basis.

Ramaphosa uses personal magic. The ‘Mandela Magic' was the ‘Ramaphosa-Meyer' (1992-94) magic which saw South Africa choose the ‘high-road' scenario of the peaceful, negotiated settlement and the transfer of power to a democratic South Africa. The trajectory of 2015 – 2024, witnesses the emergence of younger and more effective politicians who were better situated to understand the modern demands of the world's increasing populations.

Looking back from 2055, from this trajectory, the political situation is categorised by an equal-mixed coalition party. The energy policy, as well as other economic policies, are masterminded and aligned to all political parties' ideologies and this sustains the growth which was established in the second trajectory. This leads to the build-up of confidence and the effective working of the younger politicians within the parties of the EFF and Afri-forum, the party representing the white minority groups. Ramaphosa's design of political inclusion works wonders and unites the various colours of the rainbow.

The currency stabilises following an initial period after the coalition of power in the ruling party. Also, the agricultural sector rebounds from the severe drought in 2016, leading to an upward revision of growth in 2017. The budget for 2018-19 reverses past fiscal slippage. Rating agencies, acknowledging the favourable political developments, refrain from further downgrades after November 2017, thus providing a positive level of confidence. The government budget for 2018-19 and on to 2023 remains tight, but tax reforms create some fiscal room for much-needed investment in higher education and social benefits.

7.5.4.3 Trajectory: 2034 – 2044

As seen in the years of 2005 – 2019, in the U.S., shale successes were replicated in South Africa in the Karoo on a pilot scale. These successes spurred other shale hotspots in the country to be explored. As forecasted, the economy starts to show a positive turnaround and witness the increased GDP. Civil society are appeased, as educational programmes are fast tracked, with access to tertiary education being made available freely to all the population and not limited to low income households. This trajectory is the most important period in the UOG extraction in Karoo, South

Africa. The research uses William's (2019) drivers for change to assess the success of the extraction during this trajectory.

On the climate action level, the fruits in the reform strategies in the years 2015-2024, manifest during this important trajectory. In terms of climate-emergency measures, the clean development mechanisms of the Paris Agreement (2015) fare better that Kyoto Protocol (1997). The planet continues to track a warming level of below 1,5 degrees Celsius. The Two UN Water Conventions become stricter on implementation and protection of global water and the human right to water occupies centre stage. Therefore, the adverse conditions on the early years are better managed with better insulated homes. The wild card of climate risks, which is still prevalent is better managed.

In Africa, the Continental Free Trade Agreement (2020) sees the structured industrialisation of all key business sectors. With sustainable development, being instituted as the cornerstone policy of economic development, which was fashioned on the lines of EU policy, global warming is averted. As gas from African producers are successfully shared within the African states, through the mechanisms of the CFTA (2020) and the AfDB, the resources of Africa are locked-in the continent and allows communities to thrive and prosper. Africa member state recognises the similar challenges, work together to address continental issues. She Trades, an organisation, highlighting the challenges faced by women, start in 2019 to institute programmes which develop female-owned business. Preferential financial models benefit female entrepreneurs, which occupy premium positions which lead to large scale industrialisation of the agricultural and energy sectors (www.shetrades.com).

Economic growth starts to manifest and the wealth parity is narrowed across civil society. Trade is fostered across Africa and with this positive environment, social barriers are broken down. With the shutting down of the Eskom's coal plants, and the loss of 7000 jobs, in 2025, individuals start to engage in CDM, sustainable energy production and other recycling projects. These CDM projects begin to prove the opportunities which could be pursued in sustainable development. By 2034, a natural momentum was achieved, as many schools and university programmes adopted part of the curriculum that was proposed in 2018 which is represented in Appendix Two. This learning programme was achieved by design, a result of the three policy interventions: the economic policy by Mboweni, (2019), The IPP by Mantasche (2019), the UOG Regulations and the Production Sharing Contract by Mantasche (2019) and the water and sanitation programme by Sisulu (2019). With these policies in place, the water, energy, food nexus approach was adopted.

Mantasche's (2019) promulgation of the IPP, sees greater momentum and green financing being channelled into the RE sector. The higher traction of capacitors spurs more innovative battery storage technologies, making renewable energy more accessible in the rural areas. In South Africa UOG was always envisaged to power industry, which in this trajectory sees no interruption of energy on the domestic front. Simultaneously, after the July 2019, SCA ruling on the UOG regulations, greater effort was made by government to finalise the legislation and award contracts.

The management of waste-water in the global UOG extraction sees greater strides in eliminating contamination to surface water. The new regulations ban the use of toxic chemicals as proppants, allowing only the use of sand, water and plant-based gels. There are no known reported incidences of aquifer contamination as the technology of the cement casing has been perfected and there is greater accountability on the part of the developers, given the high punitive measures, which have been instituted by the local regional courts. These courts which have been capacitated to adjudicate disputes have contributed to lessening the downtime of the extraction.

In a responsive and decisive manner, the South Africa government, through the Council for GeoSciences, implemented a large-scale research programme, in 2020 to independently ascertain the extractible reserves, which provided the much-anticipated cost benefit analysis, so that the economy could effectively plan (www.geoscience.org.za). With the formation of better collaboration between government, academia, the private sector and civil society, more investment was ploughed into R&D programmes. Capacity building programmes saw the millennials, as in the focus groups, of Jansensville and Graaff-Reinet set-up companies using high-technology to service the burgeoning UOG extractive sector. With all of these measures in place, South Africa becomes less reliant on the fossil fuels sector and the wild card of oil prices shocks present fewer risks in economic terms.

Urbanisation continues at a steady pace, and rural areas become de-centralised economic hubs. The wild card of technological advancement manifest positively, as capacity development has equipped the millennials, who now occupy jobs in local government and corporations to effectively navigate modern smart systems. With jobs on the doorstep, the millennials requiring new quality values are no longer attracted by the values of the former generations. Rural areas provide peaceful and safe heavens. Xenophobia becomes a lesser worry, as with the advent of more wealth and prosperous environments, solutions are formed through diplomacy. Gender-based violence is no longer prevalent, as the millennials have new values. On the more pragmatic business front, all stakeholders have planned greater inclusion of all segments of the population, with equal treatment of all genders. With the world becoming a smaller place, fostered by the BRICS collaboration, Brazil, China, India and South Africa become a melting pot with shared learnings and pooling of natural resources. The African neighbours are not left behind, as the formation of the BRICS Plus block is now fully integrated. Table 7.5 provides the CLA for the integrated scenario, which is named Fracking with a Smile on my Face☺!.

Table 7.5: CLA Scenario Four: Fracking with a Smile on my Face ☺!

CLA Layers	Commentary
Litany	The global climate emergency mandates govern the decisions taken by the South African government, which is a signatory to most agreements. Africa regroups, realising the opportunities and challenges of the future. New regulations are promulgated setting the course for the rule of law. Rule of law provides an attractive, safe and secure environment for foreign direct investment in the UOG extraction as well as RE sector. Civil society is aligned and participates more in the decision-making of the future. In a quest to optimise natural resources, a new prioritisation emerges, causing a shift in the worldview of rural and urban areas.
Systemic Causes	Climate change, oil shocks, civil unrest and the impacts of a new digital world cause apprehension for government, the private sector and civil society. This apprehension is exacerbated by climate emergency, urbanisation, economic growth and inequality, the effective use of energy sources and the development of strong energy policies, rural-urban migration which leaves people behind, multi-polar worlds, which provides opportunities and increased competition, technological advancement, cohesive water, energy and food systems, social cohesion and the changing values across generations.
Worldview	Citizens around the world and notably Africa with the developing world recognise that fundamental climate action is required. It is widely recognised that the problem was created through large-scale industrialisation. To avoid the errors of the past, the solution lies in cleaner energy solutions. If mankind, can fix this problem, and operate on an equal and fair basis for humans, flora and fauna, surprise-free futures may be envisaged.
Myth/ Metaphor	Prosperous, cohesive societies living in harmony with nature.

(Source: Researcher's Construction, 2019)

7.5.4.4 Trajectory: 2045 – 2055

The 'Fracking with a smile on my face scenario' leading up to 2050 reveals a flourishing economy in the rural towns of Jansenville and Graaff-Reinet. Mr Shane Petersen, (2055), (one of the respondents in the focus group on 2018) is now the CEO (of the company in the visioning exercise) and employs many staff in engineering consulting services which conduct site diagnostics for the placing of fracking rigs. The firm is run jointly by Petersen (2055) and Miss Josephine (2055), (also of the focus group) now grand-mother of four boys, sons of two sons, who work as engineers, having participated in the mobility programmes in Brazil and India.

The family lives in a ‘Masdar – styled’ mansion, as Josephine works from home, in the mornings and studies for a PhD on methane leakage and mitigation. As a courtesy to customers, Miss Josephine invites them for 5 o’ clock tea, maintaining a personal touch, as all systems are automated and robotic. Josephine has realised ‘a dream, a nice house, nothing too big, where she lives close to her family and looks after the grandchildren as a single mum’ (Focus group respondent, 2018). It is 2055, and the Karoo, South Africa is booming. Anxiety over unemployment is over, and conflict has been resolved. Local democratic leaders have established unprecedented calm whereby retired teachers have moved into jobs to mentor and monitor capacity-building programmes.

The fight against diseases gains momentum and it is African scientists who offer salvation to the rest of the world. In the period 2015 – 2020, there are still incidents of ‘mysterious deaths’, but now with better technology, better healthcare programmes are freely available to all South Africans. BRICS governments in this scenario provide political will and decisive leadership to address problems. The BRICS Development Bank and which has funded the lion’s share of the investment is utilised to set up the institutional structure to support ideas and initiatives which are focused on critical issues such as economic policy, democracy, governance, sustainable development and security.

South Africa, since the end of the apartheid government, been able to achieve admission to the international economy and the most modern technologies for more excellent connectivity and big data have been modified and adapted. Government's emphasis has been placed on privatising a variety of state resources for African countries, mainly telecommunications, energy, transport, property development, infrastructure and mining. Political leaders support and combine good governance with democracy, political pluralism, constitutionalism and the rule of law. Crime statistics decline and planned criminal networks are disbanded in the early 2020s.

South Africa has grown into a heavyweight country in the global economy towards 2050, contributing actively to globalisation and is part of international business life. This, in turn, has led to noticeable modernisation and economic growth in areas such as physical infrastructure, the built environment, telecommunications and the service sector. South Africa’s middle class has grown and the country possesses a well-educated, motivated, flexible and globally-oriented workforce.

South Africa grows steadily stronger towards 2055 in areas such as research, innovation and development, with business life characterised by stiff national and international competition and many small and medium-sized businesses appearing. Privately-owned built environment enterprises flourish as never before as towns, modelled on the Masdar model, see higher prevalence in the 2030s as renewables come on stream. The town of Jansensville forms a blueprint for a new modern city of 2055. Towards 2055, the benefits of increased global economic integration and growth benefit most African nations. There is also active integration of the African economy, a relatively, benevolent political context and worldwide progress in tackling the environmental risks.

Strong regional institutions have also emerged in African countries and this institutional strength has helped to strengthen regional economies, enhance international trade and establish global agreements on the mobility of workers. The ageing of South African populations, (in 2055 on 14 per cent in the under 14 year- old category), high economic growth and skills shortages across most sectors are also key drivers of demand for inward migration and increased intra-regional migration.

The continued globalisation of corporations from African countries has also helped increase the competition for both skilled and unskilled labour in the African built environment. In this scenario, the balance of evidence suggests that the next 40 years in Africa offers excellent prospects for realising the African vision of a dynamic, diversified and competitive economic zone, in which extreme poverty is eliminated within peaceful, stable and vibrant societies.

This vision involves the transformation of the fragile and vulnerable Karoo towns, ‘waar daar niks is’ economies into a more robust and developed market, boasting a better, transformed built environment creating opportunities for the poor and leading to peaceful, stable and vibrant societies. The economic growth in South Africa filters into regional governments which generally become strong, fuelled in no small measure by business-enabling policy reforms. Notable is the ‘South Africa Tomorrow’ (2018), an investment road-show to foreign investors. There are cold calls for SAA to be finally shut-down, recognising that such a dead enterprise cannot be managed by the state and that a new national airline should start from scratch leaving the airline business to the private investors yet maintaining the state's right to fly the national colours.

South Africa's reputation is critical, as reputation is built on sound delivery and possesses the credentials, together with Gordhan (2018) and Manuel (2018) who share this new vision. The presidential challenge in March 2018 for the USD 100 billion, seemed overly ambitious, yet by the launch of the Investment summit, USD 32 billion had been committed. The realisation of USD 100 billion against USD 256, 600 trillion. spells out that South Africa is finally open for business. It is, therefore, safe to say that 2018, politically ushered a sharp upturn with the new president and associate colleagues displaying substantial wisdom, knowledge and an understanding of international business, thereby setting the path for an unprecedented political cycle for the nation. This has been a practical turning point in South African constitutional history.

Comprehensive and coordinated local government policy decisions are taken in pursuit of land resource bases. In this context, an integrated set of land reforms and land management initiatives are crafted and implemented, including economic reform, regulatory instruments, land tenure system changes which benefit the UOG extraction of the Karoo, South Africa, sustainable built environment policies, social programmes and technology development for sustainable land use.

The main contours comprise high income and economic growth, improving environmental conditions, more significant equity and reduced conflicts over land, leading to far greater efficiency of land resource use, more reliance on renewable land resources and less environmental pressure. The often-conflicting goals of providing space for human settlement, protecting ecosystems and feeding human populations are reconciled through a combination of measures, and all are centred on policy-driven, sustainable, built-environment land use.

Towards 2050, the towns of the Karoo, South Africa no longer have poverty traps in rural areas, and urban townships with workers isolated on the periphery of cities as these towns have been transformed into decentralised economic centres. There are no longer inner cities controlled by slumlords, and there is no crime. There are no sterile suburbs with homes surrounded by high walls and electric fences. Neither are there households spending 30 per cent or more of the time, energy and money, on daily commuting to work.

There is no decaying infrastructure with power blackouts, undrinkable water, as voiced by the respondents in this research focus group. Potholes and blocked sewers, violent protests, gridlocked roads and unreliable public transport are realities of the past. Instead there is new public housing in beautiful, urban landscapes. New private investment creates exclusive enclaves for the middle-classes. Fearful immigrant communities living in confined spaces no longer exist and prosperity has created harmony.

Instead, all towns in South Africa have been challenged by the Sarah Baartman Municipality. Productive farms are cultivated. Well-governed villages, towns and cities based on tolerance, democracy, fairness and respect for the natural environment are established. Citizen-centred services providing secure water and food supplies are created to serve on a local level. Security barriers in homes are not part of the new, modern architecture, as people reclaim the streets for leisure activities.

A new mix of housing types and tenures develops to meet different needs, Homes are energy efficient, and there are fewer private cars on the roads. Instead, there is decent public transport and public spaces where people from different social groups mix. Well-maintained infrastructure supports dynamic businesses and vibrant economies wherein recycled waste generates sustainable energy forms.

Young people actively engage in local decision-making. Immigrant communities contribute and rural areas are fully integrated into the local economies. New smart technologies are used in buildings for infrastructure and government. All South African towns towards 2055 actively and regularly monitor sustainable, built-environment management in a vast number of areas, including:

- Managing growth of the green economy, including built environment products, jobs and services;
- Monitoring housing affordability;
- Managing the built environment urban land footprint;

- Managing the built environment urban eco-footprint;
- Regularly managing access to parks and open spaces;
- Regularly monitoring of sustainable water quality and water supply;
- Managing access to public transport;
- Actively managing health and family services;
- Actively engaging and facilitating social wellbeing;
- Monitoring energy supply including the amount and types of renewable energy provided as part of the utility electric power grid;
- Regularly monitoring and managing air quality, considering methane leakage;
- Effectively managing substantial waste diversion including recycling and composting rates;
- Managing and monitoring the urban sprawl; and
- Managing access to fresh food and farmers or producer's markets.

With the onset of global climate change, many South African cities also begin to actively measure greenhouse gas emissions as part of carbon reduction programmes as a precursor to more strategically integrated climate action or low-carbon plans. Towards 2055, there is strong growth in working-age populations and the movement of those people to cities helps to fuel a drive towards diversifying economies, away from subsistence agriculture and eventually towards manufacturing and service sectors. Decentralisation assists through the UOG extraction model in the Karoo, South Africa, providing a blueprint for regional local governments to claim autonomy.

7.5.4.5 Change Management Leading Towards the Preferred Future

The America shale success story, the approval by the German, U.K., French and Australian governments of the extraction, as well as the rudimentary business case in Chapter Four establishes that in principle, UOG extraction may be lucrative and profitable. However, that could be said of many examples of extraction, as well as the renewables sector. The question then arises as to what are the unique features and benefits of UOG extraction and what is the relevance of the extraction to the lives of the people living in the Karoo? UOG extraction has critical risks if the operation is not controlled along "operational best practices and enforced through regulation"

(Enercom, 2017). The lasting negative impacts will be the burden of the society, long after the extraction is terminated. Given these externalities, the question is aptly asked, "For whom is UOG extraction, an economic game-changer?" The core themes which emerge in the OUG extraction are linked to environmental degradation, (which are the potential contamination of water, decreased levels of air quality as the result of increased GHGs from the extraction and seismic activity), and the issues related to the Triple Challenge. Table 6.1. refers to the critical uncertainties facing the UOG extraction in the Karoo, South Africa. the table list the megatrends and the drivers for change which emanate as the result of the megatrends. Of the seventeen SDGs only the SDG 13; SDG 8; SDG 9; SDG 7; SDG 3; SDG 4 and SDG10 have be selected by this research to assist the closing of gaps of the current situation and reaching the desired future.

The desired future can be reached by the active collaboration of the international environment organisations, which seek to monitor emission levels and provide supportive mechanisms for the most vulnerable countries, the South African government, referred herein as the central government, the local regional government, which in this case is the Sarah Baartman Municipality, civil society, the youth, the unions and the developers. As African cities develop, the focus is on the developing of de-centralised energy models, using renewable energy to provide affordable and clean energy. The signing of the treaties like the Paris Agreement (2015) allows access to international environmental organisations to work directly and efficiently with the local, regional governments to promote and implement the SDGs.

Table 7.6. refers to the table which crafts the specific actions that international environmental organisations, the state and non-state actors, must undertake, in the upcoming UOG extraction in the Karoo, South Africa, to ensure an efficient and effective UOG extraction. Whilst not explicitly referred, the manifestation of the of wild cards, as referred to in Table 7.4 is taken into account.

The actions specified for each of the actors inform the actions for implementation with will be dealt with in the next chapter.

Table 7.6: Table 7.7: All Stakeholder Participation in the UOG Extraction

	International Environmental Organisations	Central Government	Local Government	Civil Society	Youth	Unions	Developers
Climate Risks **SDG 13: Climate Action**	Temperature increases Drought and de-forestation Air quality Bio-diversity and ecology Water resources Food supply systems WEF Nexus approach	Temperature increases Drought and de-forestation Air quality Bio-diversity and ecology Water resources Food supply systems WEF Nexus approach	Bio-diversity and ecology Water resources Food supply systems WEF Nexus approach	Bio-diversity and ecology Water resources Food supply systems WEF Nexus approach	Temperature increases Bio-diversity and ecology Water resources Food supply systems	Food supply systems WEF Nexus approach	Air quality
Urban Population Growth **SDG 8: Decent Work and Economic Growth**	Population growth Urban planning and policy environment Urban – rural migration Urban transport Air quality Inclusive communities	Population growth Urban planning and policy environment Urban transport	Urban – rural migration Inclusive communities	Population growth Inclusive communities	Population growth Urban – rural migration Inclusive communities	Population growth Urban planning and policy environment Urban – rural migration Urban transport	Urban – rural migration
Economic Growth **SDG 9: Industry, Innovation and Infra-structure**	Economic modernisation Income growth and distribution Access to finance Constitutional and national legislative frameworks Fiscal transparency Local content and capacity development Local first and city to city co-operation Stakeholder collaboration: State and non-state actors (private sector, unions, NGOs and civil society)	Economic modernisation Income growth and distribution Constitutional and national legislative frameworks	Economic modernisation Income growth and distribution Access to finance Constitutional and national legislative frameworks Fiscal transparency Local content and capacity development Local first and city to city co-operation Stakeholder collaboration: State and non-state actors (private sector, unions, NGOs and civil society)	Access to finance Local content and capacity development	Economic modernisation Local content and capacity development Local first and city to city co-operation Stakeholder collaboration: State and non-state actors (private sector, unions, NGOs and civil society)	Local content and capacity development Local first and city to city co-operation	Income growth and distribution Access to finance Constitutional and national legislative frameworks Fiscal transparency Local content and capacity development Local first and city to city co-operation
Increased Energy Demand **SDG 7: Affordable and Clean Energy**	Government political will. Climate policy. Energy policy. Decentralised or centralised energy model Government R&D support Capacity building and development of local SME support Strong regulatory frameworks to support the increased energy demand	Government political will. Climate policy. Energy policy. Economic policy Agreed energy mix or coal-dominated energy supply model Energy mix linked to stakeholders and commercial plan and grid Government R&D support Strong government implementation and monitoring support. Strong regulatory frameworks to support the increased energy demand Strong financial mechanisms to support the increased energy demand	Climate policy. Energy policy. Decentralised or centralised energy model Agreed energy mix or coal-dominated energy supply model Sound infra-structure: pipelines linked to grid, roads and water	Government R&D support	Climate policy. Energy policy. Economic policy Decentralised or centralised energy model Capacity building and development of local SME support	Capacity building and development of local SME support	Capacity building and development of local SME support
Health and Education **SDG 3: Good Health and Well being** **SDG 4: Quality Education** **SDG 10: Reduced Inequality**	Climate policy which manifests in community-driven projects Poverty Alleviation Unemployment Social Inequality and Inclusion Addressing xenophobia and gender-based violence Education and Capacity building Gender equality – "leave no-one behind" Urban planning policy that support energy efficiency and low emissions	Climate policy which manifests in community-driven projects Poverty Alleviation Unemployment Addressing xenophobia and gender-based violence Technological impacts on society Education and Capacity building	Climate policy which manifests in community-driven projects Poverty Alleviation Unemployment Addressing xenophobia and gender-based violence Technological impacts on society Education and Capacity building	Technological impacts on society	Unemployment Social Inequality and Inclusion Addressing xenophobia and gender-based violence Urban planning policy Infrastructure:).	Climate policy which manifests in community-driven projects Unemployment Infrastructure: Urban planning and transportation	Infrastructure: Urban planning and transportation

7.6 CONCLUSION

Chapter Seven focused on the Fifth Pillar of the Six-Pillar approach of Inayatullah (2013), namely creating alternative futures. Four possible scenarios for UOG extraction in the Karoo, South Africa towards 2055 are presented. The scenario analysis in this chapter demonstrated the megatrend manifestation of population growth which results in the need for economic development, the increasing demand for cleaner energy and the externalities which arise from the challenges of climate risks, health and education. These megatrends are global and have varying effects on societies around the globe. However, the society of the Karoo, faces acute issues of the Triple Challenge.

The scenarios No shale, what now? and Fracking with a smile on my smile☺! both have notable merits. The latter has the benefit of the resource being prevalent in high quantity in the Karoo, as well as the exploration having the ability to provide quick revenues which is required to spur economic recovery. Therefore, UOG extraction could be the single-silver bullet for the vitalisation of the rural Karoo economy. The U.S. shale success story has paved the path for investment into this new burgeoning sector. Whilst, technological advancements hasten the pace towards battery storage capabilities, South African legislative and policy frameworks in support of the RE sector could be considered as being in the formative stages. The slow decision-making process in the shale sector has caused severe frustrations and has caused Shell, the leading shale developer in the Karoo to exit the discussion of the extraction. Similar cases may be recalled, in the wind sector, where local developers have been forced out of the sector. Foreign investors, prefer other investment destinations such as India and Brazil, which are more attractive. Of recent, many African markets, also with abundant sunshine, wind as well as more agile regulatory frameworks are being preferred over South Africa.

These over-arching macro issues lie at the doorstep of the central government. The South Africa government, as the custodian of the natural resources, understands the various dynamics, needs to weight-up and choose the energy sources, and develop the appropriate policy mechanisms to prioritise and support these choices. Whilst the change management is elaborated in Chapter Eight for the UOG extraction, the economic benefits occupy the central point of the decision-making process. In the grand scheme of the UOG extraction in the Karoo, reserves exist to power the energy system for 93 years. In line with the Hubert philosophy, this research recommends the shorter period of forty years for the extraction, extracting sufficiently to allowing for an immediate uplifting of society in the short term and the steady transition to sustainable, cheaper and clean energy options for the future. The central government has the responsibility to develop a change management plan for coming into being of the renewable energy sector.

The challenges within environmental preservation and economic development, present opportunities. In presenting scenarios for the future, the research focuses on the youth who were the respondents in the focus groups of Jansensville and Graaff-Reinet. The case study of the Karoo in South Africa provides the blueprint for all South African regional cities, mainly where climate change is most prevalent. The recommendations of this research support the establishment of stable, regional and local governments and the interactions with all stakeholders.

In this chapter, the future of UOG extraction in the Karoo, South Africa, was expanded, with the introduction of four possible scenarios. Thereafter, a brief glimpse was provided on the core issues which require change to move the dial from the current situation to the preferred integrated future. For this to happen, specific action is required for all state and non-state actors. Chapter Eight focuses on the Sixth Pillar of the Six-Pillar approach of Inayatullah (2013b), which is the transforming of current landscapes and creating the preferred future of the UOG extraction in the Karoo, South Africa. During this phase, the future of UOG extraction in the Karoo, South Africa, is narrowed down to the preferred scenario. The narrowing process emphasised the roles of the various stakeholders and the actions. To manage expectations, levels of probability are provided.

CHAPTER EIGHT:

8 TRANSFORMING THE CURRENT LANDSCAPES AND CREATING THE PREFERRED FUTURE OF UOG EXTRACTION IN THE KAROO, SOUTH AFRICA

8.1 INTRODUCTION

For Africa, the Paris Agreement of 2015 signalled a new era, not only for national governments who had submitted voluntary commitments (NDCs) but also for regional and local governments (Petterson, 2017). This research in this chapter provides the scenario analysis which shows the megatrend manifestation of population growth which results in the need for economic development, the increasing demand for cleaner energy and the externalities which arise from the challenges of climate risks, health and education. The challenges of environmental preservation and economic development, similarly, present opportunities. In presenting scenarios for the future, the research focuses on the youth who have been selected by the municipality as respondents in the focus groups of Jansensville and Graaff-Reinet.

The recommendations of this research support the establishment of stable, regional and local governments and the interactions with all stakeholders. The case study of the Karoo in South Africa provides the blueprint for all South African regional cities, mainly where climate change is most prevalent. In Chapter Seven, the future of UOG extraction in the Karoo, South Africa, was expanded upon with the introduction of four possible scenarios. These scenarios provide a better understanding of the future of UOG extraction in the Karoo, South Africa, over the next 40 years, towards 2055. This chapter focuses on the Sixth Pillar of the Six-Pillar approach of Inayatullah (2013b), namely transforming the futures. During this phase, the future of UOG extraction in the Karoo, South Africa, is narrowed down to the preferred scenario.

Envisaging is a transforming method as described by Inayatullah (2013) and is a process where the preferred future is created by way of creative visualisation. To inform this section of the research, the key messages of the focus groups during the use of the Sarkar Game technique, back-casting and visualisation methods were used. The critical question that needs to be considered is: How can all stakeholders across the private, public and non-profit sectors, successfully engage in developing a collective future paradigm for UOG extraction, and which can lead to a smooth implementation with the end-goal of a transition towards cleaner energy futures? In this chapter new strategies, critical enabling factors and practical guidelines in support of an integrated vision for UOG extraction towards 2055, are presented.

The research, in this chapter, focuses on the integration of all strategies and recommendations. The objective is, therefore, to change the perceptions of the anti-fracking public and NGOs and communicate the current needs, wants and desires of the current inhabitants of the Karoo towns as the preferred future allows for a more positive narrative. The current narrative focuses mainly on the negative environmental impacts on water resources, earthquake activity and the emission of fugitive gases. The integrated scenario considers the economic and social game-changing possibilities of the UOG extraction.

This research draws on the UOG discourse in South Africa which has been shaped by the scientists and the academics who have monitored shale progress around the world, and who have not denounced the exploration but have repeatedly called on the government for greater in-depth analysis and local R&D. The stakeholders of the Karoo, who are concerned about economic and social development, look forward to proposals of the integrated scenario. The large commercial farming community, own the rights to the land but not the sub-surface mineral rights and remained concerned about the current debate of land expropriation without compensation. To address that concern, this research drawing on U.S. success regarding property ownership and presents recommendations which may harmonise relations between the community which currently possesses the land, as well as the majority of the population, who have no land equity.

Lastly, there are the interests of international, climate change environmental NGOs, which must first realise that South Africa faces the developing worlds’ economic and social challenges and that together with local decision-makers, local solutions must work together to achieve economic development, while placing planetary concerns at the forefront of any energy discussion.

8.2 THE USE OF THE FUTURE

While planning intends to control and close the future, futures studies are committed to the creation of authentic alternative futures (Inayatullah, 2013). The use of the future, one of Inayatullah's basic concepts of futures thinking, posits a more action-oriented process. The use of futures-based thinking is one of the critical contributions to the originality of this work, making a pure contribution to the existing understanding of the UOG extraction in the Karoo, South Africa. For the first time, a cohesive view of environmental, economic and social factors has been woven together to provide four scenarios, each of which illustrates different courses of actions and the how these would play out on the future energy systems of the country.

8.3 CREATING THE FUTURE

In the process of transforming the present and creating the preferred future of UOG extraction in the Karoo, South Africa, the focal issue of the research is used as a point of departure. The six basic futures questions of Inayatullah (2013), as described in Chapter 2, are then used to assess the focal issues. The aim of this question-driven assessment, which follows Godet's (2001) and Godet, Durance and Gerber (2008) guidelines, stimulates the process of creative visualisation and to arrive at decisions and action plans which are needed to create the preferred integrated vision for UOG extraction towards 2055 (Godet, 2001; Godet *et al,* 2008; Godet and Roubelat, 1996).

In examining the research questions, the focus delved deeper into establishing regional government autonomy. This approach gave rise to the following question: How can the Sarah Baartman municipality strategically partner with the various stakeholders across the private, public and non-profit sectors? This question implies the following related decisions that need to be taken into consideration by various stakeholders in order to create the preferred future for UOG extraction.

- What does this mean for future UOG extraction solutions in the Karoo, South Africa?
- What are the implications for the key stakeholders such as the new local supply-chain providers, regional and local government, private local and international investors, the unions and NGOs?

- What are the issues that challenge the realisation of the preferred future of UOG extraction in the Karoo, South Africa?
- What decisions and action plans are to be taken today to ensure that youth respondents in the focus groups are provided with economic opportunities to exit poverty?
- How will the critical stakeholders involved in UOG extraction in the Karoo, South Africa, move from the current situation to the preferred scenario?
- What events must happen to make the end-point of the preferred scenario for UOG extraction plausible?

As a basis for the development of a realistic and achievable integrated vision for UOG extraction, new strategies are proposed. Before the strategies are proposed, all critical actions for all stakeholders are highlighted. The manner in which these strategies should be implemented is explained in the detail. Based on the success of the U.S., as well as other jurisdictions which have taken decisive and responsible decisions, together with the panel of experts, a level of probability to succeed has been presented. The integrated vision that the research proposes, therefore, depicts a possible, realistic and ideal future that could become the foundation for an integrated energy policy for South Africa. This energy policy collectively would see the nation attaining energy security.

8.4 THE DESIRED FUTURE ENVISAGED

The desired future for UOG extraction in the Karoo, South Africa takes into account all the risk factors which have been extensively studied across all the UOG geologies in the world. The literature review, as well as the extensive laboratory reports of the leading U.S. academic institutions, have comprehensively informed this process. South Africa now needs to verify the level of economic risks.

The desired future assumes that responsible extraction will take place at levels which are deemed necessary to achieved game-changing economic benefits, in line with the analogy of the stone age and stones. The critical question remains (RQ3); for whom is UOG extraction an economic-changer? The desired future puts forth specific recommendations which must be implemented in order for social transformation to take place, following the checklist of the Triple Challenge (Graves, 2012; Heijeden, 2010).

While South Africa does not possess any robust experience in oil and gas exploration, South Africa does boast of world best-practice in the natural resources extractive sector. Therefore, through the careful diagnostic assessments which are recommended for the desired future, South Africa will be able to close the gaps in this area. Earlier in the research, the U.S. case has been referenced for the manner in which legal frameworks were modified from only supporting crude extraction and using vertical drilling, to instituting new provisions in new horizontal drilling in the UOG sector.

The desired future harnesses the African trend of the central governments relinquishing responsibility to regional and local governments. This sees the moving towards a decentralised energy business model (Escudero, 2017). This further permeates other business sectors with the eventual objective to avert rural-urban migration, which is put forth in the preferred scenario. Sarah Baartman municipality will be equipped to execute all the decision-making and operations of a profitable, local exploration.

The desired future, based on the above, can entice and attract the optimal level of investment from fully-competent and experienced developers such as the IOCs which may partner with local, regional companies to develop effective local content while respecting the rules of international law as put forth under the WTO of 1985. Similarly, the unions will assume a more active and participatory role in addressing the capacity-building requirements and in the setting of the correct levels of remuneration for the new shale sector.

The desired future accepts that there is no existing infrastructure in the Karoo to support any level of economic development and that based on the rudimentary business case, the UOG extraction in the Karoo, South Africa has the financial potential to be an economic game-changer. The South Africa government should therefore explore other forms of petroleum contracts such as the production-sharing contract and retain maximum revenue for the nation.

8.4.1 Existing Energy Sector Strategies and Frameworks Reviewed

This section focuses on the fourth stage of the scenario-development process, as illustrated and described in Chapter Two, under 'Use and Assess'.

8.4.1.1 A Shared Vision and Strategy

A key element of Stage 4 (Use and Assess) of scenario-planning process is, therefore, not only to review the existing energy strategies which are predominantly coal-based and to develop new strategies, but also to depict a vision for the energy sector in South Africa, using the Karoo as an example and, more specifically, using shale as pivotal contributor.

The importance of a vision was also included in the initial research question (RQ 3) of 'For whom is UOG extraction in the Karoo, South Africa, an economic game-changer?' The research covers three questions of which the first two questions (The safety question and the economic question) are merely questions relating to the pivotal contributor which leads to, and provides, answers to the possible addressing of the Triple Challenge question around which the ultimate vision is envisaged. The question implies that the vision for the energy sector needs to represent the objectives of all energy and shale stakeholders and should provide all stakeholders with inspiration and hope for the future.

The integrated vision that is proposed for the new shale sector, describes a possible and preferred future that could become the foundation for the energy sector of South Africa. This vision is essential in order for multiple stakeholders across the private, public and non-profit sectors to engage in developing a collective future paradigm for an energy sector which can effectively address the current shortcomings and failures. Besides, the vision also provides guiding principles and recommendations on critical steps that need to be taken to transform the current coal-based energy model to a lower-carbon energy future. This chapter further describes the key elements of the proposed integrated vision towards 2055. This vision also presents some strategic considerations, enabling factors and practical guidelines for all the stakeholders.

8.4.1.2 Aspiration: The Integrated Vision for the UOG Sector in South Africa

In this section, this research attempts to portray the vision of the Karoo, South Africa towards 2055, after the effective implementation of UOG extraction which facilitates the transition into renewable energy futures.

8.4.1.2.1 Foundations for the Proposed Integrated Vision for the UOG Sector Towards 2055

Step 3 of the futures studies process suggests that the ‘Fracking with a smile of my face! ☺’ future is brought back to the present and that a decision is made regarding what steps need to be taken by key stakeholders. It also implies that this future is narrowed to the preferred future which is able to navigate the changes that are required in the energy sector in South Africa.

These changes are chiefly characterised by the promulgation of the new shale regulations, under a separate act. This new legislation would specifically control the use of water in UOG extraction and limit the use of chemicals in the extraction process, the promulgation of the new water and sanitation act, the promulgation of the laws which support and promote the independent power producers as well as amendment of Section 25 of the Constitution (1994) to allow for the ownership of property rights below the surface. The review of the current licence agreements in favour of more advanced petroleum contracts, is necessary for an equitable distribution of profits and the protection of sovereign mineral resources.

8.4.1.2.2 Scenario Development

In this section, the research recaps on the various stages of scenario development.

8.4.1.2.2.1 Sorting of Data for Scenario Development

This research has rigidly followed the steps of the scenario developed as guided by the CLA process which is taught in many universities around the world. Various future studies practitioners have adapted the scenario process development according to specific requirements (Bood and Postma, 1998; Heijden, 2010; Kosow and Gaßner, 2008; Ramos, 2015).

Creating memorable names for scenarios is essential. To enhance this further, this research borrows from the content of an Australian case-study where the practitioner in the development of an energy study used scenario art (personal interview with Inayatullah, 2015; Lederwasch, 2015). The scenario development process in this research is based on the megatrends, the four wild cards and the critical drivers for change, which have been distilled into ten core drivers which narrow the focus and act as key indicators in the scenarios for meaningful comparisons. These key indicators have been further informed by the practical insights of the focus groups. As scenario art presented in this research was not yet conceptualised at the time of the focus groups, similar images were used in the induction section of the focus group. The scenario images helped respondents understand the expected outcomes of the research meeting.

8.4.1.2.2.2 Framing the Scenarios

The scenario development stages included the framing of the scenarios, and in this section, the megatrends were considered to define the scenario field and establish a baseline. The literature review and the fieldwork informed the process. The literature review focused on current trends impacting upon shale and focused on these categories; natural resources and the environment (to answer the safety of the environment questions), governance and society (to answer the social question) and economy and infrastructure and technology (to answer the economic question).

8.4.1.2.2.3 Identifying Scenario Dimensions

The next stage included the identification of the scenario dimensions. This is a critical stage which follows three steps. The first step is to seek validation from the experts in the field. The second step is to categorise the drivers for change and thirdly, conduct the pair tests. These dimensions were first agreed with the relevant experts on the panel for input and validation. The process included the following:

- A round of 20 expert interviews framed the current situation on the South African energy platform.
- Many trips to American institutions which included the API and IEA, which developed the competencies to establish institutions for a new energy sector.

- Specific research projects Sustainability, Water and Air quality at Stanford University, Columbia University, Oregon State University and Cornell University which clarified the extent of the short-coming of America scientific data and allowed for the suggestion of specific data gaps which must be closed.
- The engagement of 49 experts for in-depth discussions, throughout the research period for verification and validation of data relating to fossil fuel subsidy reform, examination of modern petroleum contracts and a critique that has been provided on the shortcoming of the existing UOG regulations.

The API governs the global oil and gas activities and now incorporates the shale sector governance. Interviews with the various heads of departments of the API provided useful insights on how the shale industry should be set up in South Africa. The structured learning programme in support of this research at the University of Eastern Finland informed the legal commentary Step 3 (8.4.2.1) and upon which UOG extraction may be undertaken in South Africa.

The UEF curriculum, which is fully aligned to the UNFCCC of 1982, complements the Glazewski (2019) account of South African environmental legal law. This programme also informs on the capacity development requirements in support of the youth. These insights were incorporated in Section 7.5. The engagements with the International Institution of Sustainable Development, Geneva, Switzerland and the University of Basel on sustainability guided the research on the climate change mandates, the initiatives for mitigation and adaptation, as well as for the investigation of fossil fuel subsidies in South Africa.

The programmes of Delft University and the Masdar Scientific Institution of the UAE, provided the useful insights for the integration of renewable energy forms in South African households before, during and after the UOG extraction in the Karoo towns. These insights specifically informed the ‘No Shale, what now?’ scenario. Finally, the work conducted via the BRICS Academic Forum, Energy Cluster (South Africa), informed the recommendations on capacity building, for not only the UOG sector but also for the entire energy sector for all BRICS nations.

The next step included the categorisation of the drivers for change. This process was informed by the ongoing expert interviews, listed in the above sections, the workshop for capacity development and the youth focus groups. Population growth is a megatrend requiring economic development, which demands increased energy, considering the increase in the carbon footprint leading to climate risks and causing adverse planetary effects. These effects further impact on the health of the people. Linked to population growth is the requirement for appropriate capacity development to ensure the effective creation of employment. Intertwined with the megatrends were the considerations of the critical uncertainties and the wildcards which could manifest over the forty-year period.

The critical uncertainties as defined by this research are economic, social, technological, environmental and natural resources, infrastructure and governance. The four wildcards as presented by this research are energy technology breakthroughs, oil price shocks, civil conflicts and climate risks at 4 degrees C warming. Alarmingly, the four wildcards have already started to manifest in the first trajectory of 2015 – 2020.

Energy technology breakthroughs are being seen in the wind, solar and biomass sectors and are discussed in the 'No shale, now what?' scenario. The decrease in oil prices in 2014 - 2015 has been catalysed by the first America shale successes in 2012. and has led to gas becoming a key player in the oil and gas sector. According to the latest information released by the IEA at the Gas Conference held at Columbia University, 2018, gas in the latest update on the five-year projection 2018 – 2023, emerges as the disruptor in the oil and gas sector, with China providing the highest demand for gas as that market continues heavy industrialisation. The Conference of Parties is the supreme decision-making body of the Convention. At COP 24, Katowice, Poland, 2018, the IPCC stated that the planet is tracking 3 degrees C of warming over pre-industrial times. COP 25, in Madrid, announced that the tipping point is almost being reached.

The next step was the testing of the scenario matrices and the selecting of four scenarios. The testing of the scenarios followed the guide provided by Wilson (1998). The plausibility of the scenarios' capability of materialising and the scenarios being structurally different are the main criteria for evaluating. The scenarios are required to have a high level of decision-making utility as each scenario should contribute to the insights of the future. Finally, scenarios must challenge the conventional wisdom of the future. In this step, sixteen scenario quadrants which best performed against solutions for the three research areas, planet, profit and people were developed. Four of the most plausible are presented in this research.

8.4.1.2.3 Expert Validation of the Scenarios

The process of selecting and validating the four scenarios entails expert validation and scenario analysis. The scenarios were validated explicitly in terms of the plausibility and relevance of the narratives. Confidentiality is vital in this research and therefore mostly, international experts were chosen to validate the scenarios. However, it required input from South Africa service-providers and experts. The following section summarises the consolidated feedback from all the experts.

8.4.1.2.3.1 Consolidated Feedback on 'Frack Off!' Scenario

- Respondents agreed that this business as usual scenario does not match the global climate change mandates, as this scenario sees the continued dominance of a coal sourced energy system. Although cleaner coal technology is referenced, there is no evidence of reduced emissions soon.
- Based on a centralised model, which includes the shut-downs of plants in 2025, rolling blackouts are likely to continue. Renewable energy in the form of wind and solar technologies is only encouraged, but there is no back-up plan to support the decreased provision of coal-powered electricity after the shut-down. Due to weak government capacity and continued political interference, urban growth and policy enforcement are poorly managed.
- There is no clear indication of the source of the gas for this scenario, and there is no clear policy for UOG extraction in the Karoo, South Africa. Local gas production, as a back-up to the decreased coal production in 2025, will not be able to be realised during the period 2019 to 2025.
- Social and economic inequalities are linked to energy inequality and are concentrated in informal settlements. Communities become increasingly disillusioned with the government, and this could lead to civil unrest. The new decade started in Qwaqwa, the second largest black township on a negative

note. With a 23% penetration of piped water and issues of water connection over the past decade, civil unrest erupted. The protestors caused the complete shutdown of services in town after the drowning of an eleven-year-old girl, attempting to get water from the river.

8.4.1.2.3.2 Consolidated Feedback on ‘Frack and Go!’ Scenario

- This scenario sees a decentralised model in which local, regional government has full autonomy, which is intended for regional economic growth. However, all stakeholders have not been adequately trained to administer the extractive processes.
- The respondents were unanimous in the concerns about the lack of local investors attracted to this sector as the coal sector continues to be more attractive. Limited renewable energy in this scenario demonstrates short-term sustainability. International investors with home-based subsidies provide more competitive rates and force local RE investors out of the market.
- Civil unrest and instability could result, owing to the growing divide between the informal and the formal sector which is increased by economic imbalances.
- The overall mis-management of the extraction results in the frustration of the IOCs and the eventual exit from the country. The local investors redeem the remaining spoils. The devastation to the environment becomes the sole responsibilities of the local, regional government and civil society.

8.4.1.2.3.3 Consolidated Feedback on “No Shale, What Now!” Scenario

- Respondents agreed that this scenario does not support the set targets of the IPPC and the UNFCCC, as this scenario sees the continued dominance of a coal-sourced energy system. Clean coal technology has not been introduced as the emphasis has been on the decentralised energy model using wind and solar technologies, post 2025.
- With limited planning and and time to move from a central to decentralised energy model, all actors in the energy market are ill-prepared. The

complexities of dis-placement together with the attempts of implementation of brand new and unfamiliar technologies result in disastrous consequences for the nation.

- International legislations which have been underpinned by fossil fuel reform are also still experiencing teething issues and therefore the South African government are ill-placed to support the renewables sector as the government did with the fossil fuel sector.
- Whilst local content is promoted, the lack of state support sees local power producers disadavantaged in comaparison to the international competitors. These specific issues were acknowledged by the respondents.
- There is no financial catalyst to power the RE sector. Given the haphazard policy making and the data inertia which exists within the governmental circles, foreign investors opt for safer investment destinations.

8.4.1.2.3.4 Consolidated Feedback on "Fracking with a Smile of my Face☺!" Scenario

- After studying the feedback of the youth focus groups, Respondents were unanimous that for the South African's socio-economic situation, UOG extraction could be the only single bullet towards the transition to a lower carbon future. The respondents were particularly impressed by the government's prioritisation of the change management process, which uses revenues generated from UOG extraction to fast track market readiness for the transition to more sustainable energy futures.
- Respondents acknowledged the assumptions of the research on the water issue and that earthquake activity should not be reasons to halt exploration. However, all regulatory measures should be enforced to mitigate the known and unknown risk factors.
- Respondents acknowledged that methane leakage was a critical global concern which should be seen in the context of methane emissions from all business sectors including the global shale sector. However, the respondents made specific recommendations on how strategies should be implemented to ensure greater self-regulation of the shale sector on a global

basis and take measures, such as decreased flaring, as the exploration commences in new jurisdictions.

8.4.1.3 The Integrated Vision for the UOG Sector in the Karoo, Towards 2055

The proposed Integrated Vision for the UOG sector in the Karoo, South Africa towards 2055 is based on the following three considerations:

- The safety consideration of the planet, before, during and after the exploration;
- The diversification and the economic development in all sectors through the game-changing properties of UOG extraction to meeting the Triple Challenge; and
- The use of this economic game-changer to address the Triple Challenge, which is poverty alleviation, significant scale creation of employment and addressing inequality which currently exists in South Africa.

Powered by the UOG extraction in the Karoo, South Africa, the inhabitants of the region continue to thrive. In order to achieve this vision, all state and non-state actors are required to perform specific actions, according to individual competencies in order to deliver operational excellence in the upcoming UOG extraction in the Karoo, South Africa.

8.5 ACTIONS FOR ALL STAKEHOLDERS TO ENABLE SUCCESSFUL UOG EXTRACTION IN THE KAROO, SOUTH AFRICA

This section explains all the actions from all international and domestic stakeholders. Each plays a critical role in responding to the research questions.

8.5.1 Actions for the International Environmental Organisations. The Safety Question

The UNFCCC, under the auspices of the Paris Agreement (2015) has developed many mechanisms to help countries to actively engage in effective climate action. The IPCC, currently leads the world 1.5 degrees' target. Climate change is characterised by the increased levels of GHG emissions as the result of developed nations after World War

2 seeking mass scale industrialisation. This industrialisation produced extensive levels of emissions to be released into the atmosphere. South Africa, together with other developing countries, is vulnerable to this impact, and this is evidenced in water and food security issues, which are currently being faced by the nation. These impact health, human settlements, infrastructure and ecosystem services. South Africa, therefore, realising this issue, has harnessed the global strategies of the Paris Agreement (2015) and within its framework has committed cooperative action and plans to adapt to the unavoidable adverse impacts of climate change. Therefore. the concerned academic community is voicing concerns for greater precaution to be taken, given the potential impacts on the environment at large, but more specifically on the socio-economic impacts of UOG extraction on water.

The UNFCCC (1992) in seeking to provide reparations for the developing markets in the form of non-financial mechanisms. These include a system of trading carbon credits which may be negotiated by the parties. For this to happen, regional and local government autonomy is necessary so that international environmental organisation may guide the discussions that municipalities may have with the UOG developers. Specific models and modes of implementation would be required to drawn up and the specific institutions would be required to be funded and established. The research presents all options which could lead to a low-carbon society and develop sustainable, prosperous communities into the future. With the abundant volumes of available coal, the familiarity of the exploration in most countries, as well as the ample employment opportunities which were created and sustained, coal a is favourable commodity on many levels. Therefore, any attempt to move away from this model, would require a business, scientific and social arguments which convince all stakeholders to accept the benefits of the extraction. Table 8.1 refers to the actions that the international climate changes agencies may implement, directly with the local, regional governments and societies, after the central government has endorsed topline environmental initiatives.

South Africa’s ascension to the UNFCCC’s Paris Agreement of 2015 lays liabilities on the country, but also provides opportunities for rural communities. Therefore, for a mutually beneficial arrangement, the UNFCCC must have direct access to communities to execute global CDM programmes. European Union economic policy is guided by the cornerstone principle of sustainable development. All 27-member states are equally bound, by a policy-level decision, of which at the forefront is environmental protection. Therefore, South Africa, hosted many international conventions, has embedded many of the international environmental principles into the Constitution.

In light of UOG extraction, South Africa, aligned with global environmental frameworks and is required to review and close certain gaps in legislature. South Africa must further institute an Emissions Trading Scheme (ETS), which will allow for the structured institution of Clean Development Mechanisms, (CDM). The CDM is a set of interventions which assist developing countries engage in actions which reduce carbon release and provide sustainable income for communities. Numerous NGOs and development agencies around the world run capacity-building, online programmes, which the regional and local governments, according to specific needs, may easily access.

The pumping of water at very high velocity into the fissures of shale, which is a porous material, is likely to cause earthquakes. Two recent correlations of UOG extraction and earthquakes, in Irving in the U.S. in 2015, and in Lancashire in 2018 have raised public concerns. In both cases, the tremors measured a maximum of 2.8 on the Richter scale, which were deemed superficial and exploration was allowed to continue given the low risk to the low population density in the areas. The population density of the Karoo is even lower and this should make seismic issues manageable.

This research along with the various members of the academic fraternity, emphasise the need for further research into the investigation of GHG emissions on a global scale. More methane is currently emitted by the agriculture sector and by landfills than by UOG extraction. However, extensive global studies into methane leakage is forcing developers to take more precaution. International environmental organisation should provide more assistance in raising more funds for research which provide arguments in favour of protection. It is equally incumbent on the global shale sector to self-regulate and formulate measures to mitigate any possible large-scale emissions. Carbon trading schemes and the creation of carbon sinks are necessary tools for implementation, which may foster the collaborative working relationship between the international environmental organisations and the global shale sector (UEF class lectures 2017 -18; Van Asselt, 2017). A specific exercise in tandem with research on GHG is necessary to establish the acreage of carbon sinks that are required to off-set GHG during the shale exploration process of the Karoo, South Africa. The researcher is currently engaged with the scoping exercise of 6000 disused mine sites, which can be re-habilitated for carbon sinks. This is will be the first pilot study leading to UOG implementation in South Africa, addressing carbon reductions through carbon sinks. Table 8.1 refers to all the actions that international environmental organisations can collaborate in to ensure that minimal harm is caused to the environment before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.1: Actions for International Environmental Organisations.

Issue	**Possible Guidelines to Finding Solutions**	**Success Probability (%) of the Solution**
Promote Sustainable Development: Promote Climate Change Law & UN SDGs Implementation.	PA (2015) and UNFCCC Clean Development Mechanisms to empower all rural areas in the country. Establishment of the Emissions Trading Scheme. Four international environmental law principles should underpin a collaborative working relationship between the global shale sector and the International environmental organisations.	60%
Establish and enforce the Human Right to Water.	In a PSA, establish water as a raw material and shift the burden to developers alone. Establish the prioritisation for water as a human right over shale raw material.	100%
Pressurise the Central Government to review legislature promoting environmental protection.	Identifying loop-holes in the DEL and close gaps through new regulations.	75%
Introduce new measures promoting Sustainable Development.	Biomass; renewables, recycling projects to become mainstream.	75%

(Source: Researcher's Construction, 2019)

Addressing the question of the safety of fracking in the Karoo, this research supports the view of the South African academics and the South African scientific community that a greater research effort is required. The South African government must therefore commit further funding for local research with assistance from international environmental organisations. If this happens, South Africa can in this domain together with the international environmental organisations, achieve the probability of success of up to 60 per cent – 70 per cent.

8.5.2 Actions for Domestic Organisations

In light of the above, the main stakeholders within the domestic shale fraternity would need to assess, resource and implement the extraction. The following sections provide the recommendations for each stakeholder. The core areas of the three research questions are addressed with specific interventions recommended. These interventions are based on an existing support platform. With these in mind, the research has been able to forecast the probability of success in terms of a percentage for each set of actions.

8.5.2.1 Actions for the South African Central Government towards 2055 Addressing the Economic Question, Environmental and Social Question.

Following the discussion for change management at the end of the previous chapter, designated tasks are required to be performed by the various government and non-government stakeholders. The research, drawing the U.S insights, put forth strongly the need for a collaborative approach between the government, academia to support research and development, in collaboration with the OEMs and suppliers. Table 8.2. refers to what the South Africa government must do to support the UOG extraction from regulatory and policy point of view, taking into account the requirements and obligations of the developers and the unions, who bridge the labour gaps between government, developers and the workers.

The apartheid regime, during the years of political isolation in the seventies, sought independence in the energy sector. The regime set up and promoted the state-owned enterprises (SOEs) such as the vertically integrated monopoly utility Eskom, and previously owned liquid-to-fuels producer, SASOL. Both SEOs benefitted from the state subsidies as well as the evergreen supply demand from the government (Baker 2012; Fine & Rustomjee, 1996; Marquard, 2006). From its inception, SASOL received significant support from the state and the benefits were retained by a pricing mechanism which continued to ensure large profits in the CTL business. Eskom has also benefitted from state support and has passed this on in the form of 'under-priced' electricity (Steyn, 2001).

This research, on this specific matter, interviewed 20 experts from SOEs such as IGAS, PetroSA, CEF, Eskom and SASOL, PASA, Unions, The Black Business Forum, and academics focused on the energy field. The verification of data was problematic as government archives could not be accessed. The concern of free IP handed over to SASOL emerged as a concern. The study on subsidies proved critical to this investigation. Subsidies are a legal provision, in WTO Principles (1985), as it is here that stakeholders of the shale and renewable energy sectors attempt to seek similar support from the state in local markets. If this happens, shale gas will be better priced in the market.

This section aims to propose an energy policy that is aligned to all the current political parties, so that the country may embark on an aligned trajectory towards 2055. The research references the city of Malmo, Sweden. Malmo in the 1960s, understanding the energy requirements in Sweden, established a decentralised energy model and devised an energy strategy for the future which was agreed to by all political parties. No matter which political party gains power, cornerstone national policies such as energy remain sacrosanct. Malmo has become the first carbon-neutral in the world (Youtube.com). South Africa has the opportunity to follow a similar trajectory with the IRP 2030, which is currently out for commentary from December 2018.

While South Africa revisits the energy policy and makes strategic choices; political parties are aligned on the land reform discourse which sees the ANC and EFF parties forming an alliance to attempt to seek amendments to Section 25 of the Constitution of 1994 and which could see the expropriation of land without compensation. This reform is relevant to shale in a positive sense. The research references American land ownership which is a critical success factor in the shale exploration in the U.S. South Africa, in process of land reform, should consider land ownership which includes the rights above and below ground belonging to the same land-owner. This will enable landowners to extract the full value of the land. The state, with lesser administrative obligations, receives the taxes on the land ownership.

It is a widely-accepted view that as in most developing economies, governments play an ‘interfering’ role in energy policies and of which the South African government is particularly guilty and this research references the Zuma administration and the loss of momentum on shale exploration owing to the Russian nuclear deal. In light of the constant state interference, this research recommends that the state sets up an independent and neutral institution to manage the UOG operation which should be set up under the ‘One Environment Policy Framework’.

According to Glazewski and Esterhuyse (2016), given the cumbersome workings of the various ministries and the straddling bylaws of nine regional governments, South Africa is well advised to follow the American example for learning in the domain of passing of new legislature for UOG extraction. Therefore, referencing the South Africa case, NERSA exists for the broader energy sector. SANS to a certain degree, provides for the specifications of the oil and gas section and related products by setting the product codes and the barest of safety measures, but this is not provided for all sectors. The oil and gas industry in South Africa take guidance from The American Petroleum Institute (API) (2018), is a body to whom enormous fees are paid by the South African oil and gas sector. OEMs and other petroleum suppliers are subject to the similar types of fees.

It is, therefore, critical that a specific oil and gas administrative body be set up. The South African shale industry requires guidelines. In the American case, The API, assumed the role of guiding the industry on shale as it forms part of the oil and gas sector. In South Africa (interview with API, 2018). PetroSa would be closest to fulfilling such a function but would require severe harmonisation of the various local associates. In collaboration with the Ministry of Minerals, an institution representing a wide range of stakeholders would be able to make the policy recommendations in favour of the new shale regulations and extend these powers into the market for implementation, thus serving a wide range of strategies.

The following recommendation pertains to the setting up of shale legal frameworks and policies. This research first questions the shale licence agreements which were commonplace in 2010 -12 when the shale discourse started. The top-level royalties paid to the state were initially at 22 per cent, then decreased to 18 per cent. In unconfirmed reports, given the uncertainty of the reserves that the figure would be revised to 10 per cent. On the licences alone, this notion of a decrease of 12 per cent is a cause for concern. South Africa must study the current petroleum contracts which are being employed in Malaysia, Thailand, Myanmar and other developing countries in the east. So far, South Africa UOG decisions have been influenced by the oil market leader and a leading developer, Shell Oil Company.

The BBBEE partner of Shell is Thebe Investments, of which the ruling party, the ANC has a significant stake-holding. The rudimentary study of the shale business case for the Karoo, South Africa, looks promising and is very likely on its own merit to be able to solicit the funding from the various international funding institutions. That process alone would mean that the funders would keep a vigilant eye on the appropriation of funds, with audits instituted to allow for cases of misappropriation. Since 2017, the rating agencies have relaxed pressure on South Africa and this has been reiterated in late 2019. With secured funding, South Africa does possess the relevant, specialist, top-level scientific and technical talent to administer the UOG operation in South Africa, along with reputable developers. Local content which refers to goods, services and labour procured within South Africa and from South African black-owned companies could go far in the wide scale creation of jobs. Capacity building is a primary concern and the country should immediately embark on the upskilling of youth through the higher learning programme which is being introduced at South African universities as well as in BRICS countries as part of the BRICS Academic Forum.

Programmes should include the training of the senior management, technicians, policy-makers and administrators who should be deployed to fracking sites, as well as entrepreneurs requiring training on shale health and safety procedures. These procedures should be in line with state labour bodies. In order for this to happen, the South African central government must define its role as a regulator and create an enabling environment for all stakeholders, both local and foreign. Based on the probability index, South Africa can in this domain, if the recommendations are accepted by the relevant stakeholders, achieve a probability of success above 75 per cent. Table 8.2 refers to all the actions required by the South African government before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.2: Action for the South African Central Government.

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution.
Define the Energy Policy for South Africa.	All political parties must to aligned to one energy policy, and it should be enshrined in the new legislature.	80%
Finalise the amendment to land ownership.	Establish landlord rights to below surface of extractive lands..	70%
Establish the role of the state as the energy regulator	NERSA's mandates must be expanded to include UOG extraction.	80%
Finalise specific UOG legislature.	SCA has ordered a separate legislature for UOG extraction from mining..	95%
Establish a clear Gas Policy from Oil and Coal Policy.	Draw the distinction of gas from other fossil fuels. Establish and legislate the pathway towards renewable energy.	85%
Provide financial resources for R&D and the setting up of institutions.	The Treasury and International funders must finalise funds for R&D.	80%
Review the exist shale license.	Compare and contrast the cost and other legal benefits of the PSA and License Agreements	80%
Legislate local content for UOG extraction	UOG BBBEE scorecard will monitor local content and regional economic development.	85%

(Source: Researcher's Construction, 2019)

8.5.2.2 Actions for Local and Regional Government (Addressing the Economical and the Social Question)

The central government has a primary obligation to the regional governments, as this research strongly recommends a decentralised energy model. Table 8.3 refers to the actions for the local and regional government to support the UOG extraction before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.3.: Actions for Local and Regional Government

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Structurally address the process of de-centralisation and local autonomy	Energy de-centralised model are required, for the change in Eskom supply in 2025. Renewable energy generation is linked geographic weather patterns and therefore local considerations are required.	95%
Set-up a local energy policy in alignment with the national energy policy.	An agreed energy mix which supports industrial, domestic and agricultural activities	95%
Foster and maintain direct connection with international environmental organisations.	Avoiding the bureaucracy of central government and fast track UNFCCC initiatives.	95%
Foster and maintain direct connection with foreign direct investors and local developers.	Following the investment protocols of the Department of Trade and Industry provide attractive investment incentives to foreign and local investors.	85%
Agree the tax payments to the Treasury which are specific to the UOG extraction. Taxes paid to the central government	Optimize the full exploitation of the land by encouraging central government to award the rights below the ground to the land owners and benefit from the increase taxes.	95%
Identify, resource and monitor the large scale capacity building programmes which are linked to the creation of jobs through the UOG extraction.	Based on concrete information such as those illustrated in Table 4.3; 4.4; 4;5; 4.6; 4.7 and 4,10, plan effective job and wealth creation programmes towards 2055, addressing issues as set out in Table 7.6.	95%

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Retro-fit current builds and plan future energy – efficient building.	Respond to climate change through adaptation methods. Mitigation methods should in incorporated in the new builds of the future, drawing on the Masdar model, as an example.	85%
Address SDG 3 in the workplace by structure engagement with the Unions for the development of the Shale and Renewables sector	Unions can play a positive role in the integration of the existing and new work-force into new energy sectors.	80%

(Source: Researcher's Construction, 2019)

The growth in urban population is characterised primarily by rural-urban migration, thereby adding pressure on big cities across the developing world (Crush, 1989). This phenomenon also sees the stagnation of rural towns as governments lack resources to grow both areas simultaneously. It is therefore up to the stakeholders of the local regional governments to take measures to curtail and manage these issues. The youth who are particularly prone, must take an active and participative role in this area, chartering the futures.

With the industrialisation of African agriculture requires the extensive use of modern technology which is powered by energy. New industries set-up to stimulate development in rural areas and support the UOG extraction places further burden on the grid. Given the lack of grid-lines and storage capacity, far-flung rural areas lack connectivity. The decentralised model requires a decentralised supply-chain network in new legislature is based on a policy of local content. In order to implement and stimulate local content, regional governments must have the ability to interact with all investors, both local and internationally. In the light of international SDG goals, in which energy is represented under the framework of SDG 8, international NGOs require direct access to regional and local governments. Structures need therefore to be amended, and municipality must administer the following:

- Undertake a diagnostic analysis to understand the opportunities and gaps in the development of UOG extraction.

- Prioritise the key deliverables necessary for the effective functioning of systems between the central government and local stakeholders by ensuring that the current legal and regulatory frameworks are amended to support a decentralised model.
- Lead by example to demonstrating how regional governments can identify special investment projects and use these opportunities to develop as stand-alone cluster cities.
- Develop a decentralised energy model that is based on the principles of sustainability and climate change mandates and that follows a developmental process embracing a coherent approach to project identification, development and delivery.
- Follow a strict diagnostic assessment which is mandated by a new government policy-level decision, through bodies such as UGLA and SALGA and which in turn filters down to the local municipality. This top-line process will ensure that all international and domestic legal trade laws are harmonised.
- Appointed local project managers to administer all the strategic changes which should be recommended by the diagnostic assessment to set up a cluster city model.
- Ensure that the skill sets are developed to provide local content for the international shale developers with well-trained officials to interact with the NGOs who are tasked to implement adaptation and mitigation strategies for effective, climate management.

For this to happen, the Sarah Baartman Municipality must define its role as the facilitator, thereby creating an enabling environment for all stakeholders, both local and foreign investors, as well as for the NGOs which operate under the auspices of the UNFCCC of 1992. Based on the probability index, the municipality can in this domain, if the recommendations are accepted and agreed to by the relevant stakeholders, achieve a probability of success above 85 per cent.

8.5.2.3 Actions for Civil Society. Addressing the Social Question of the Triple Challenge

Commitments to global sustainability are essential (Jordan *et al,* 2010). South Africa, has pressing problems such as the elimination of poverty, reducing unemployment and eradicating social inequality. These issues have been treated in detail by this research under the discourse of the Triple Challenge (Fakir and Davies, 2016; Herbst and Mills, 2003; Hernandez, 2009).

Table 8.4 provides a comprehensive set of recommendations for civil society. This research maintains that the municipality is the primary custodian of all matters in the UOG extraction within its jurisdiction. This research examines the social question and finds that the municipality is the most appropriate conduit for effecting change in the local community. Table 8.4. refers to all the actions for civil society before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.4: Actions for Civil Society

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution.
Address poverty alleviation in a cohesive manner through SGD 3.	The solutions are formed by asking this critical research question: For whom, is shale an economic game-changer? The state must decide. For SA or Karoo? The Columbian and Norwegian model is referenced here.	85%
Address unemployment alleviation in a cohesive manner through SGD 3.	The Lancastershire case illustrates national and local job creation spin-offs. Refer to Table 4.10.	80%
Address inequality in a cohesive manner through SGD 10.	The SDG 10 framework provides and comprehensive set of actions to address a problem that the nation is facing.	75%

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution.
Address the issue of and expropriation without compensation structurally through the review of land below the surface rights.	Motivating the critical U.S. success factor, motivate for land reform in the Karoo. The benefits may be referenced in our areas where this issue is contentious.	75%
Govern communities through good social values, using SDG 3 framework in a cohesive manner.	Focus on family wellbeing and "raise the child by the village" concept could be united civil society through the current times of crisis which is caused by gender based violence.	90%

(Source: Researcher's Construction, 2019)

Creating employment considers sustainable development, improved primary education, a developed health-care system and other social welfare factors, all of which are underpinned by the over-arching requirement for energy in order to develop. The country is heavily dependent on coal, with a fleet of old and inefficient power plants which are at the end of their life-cycle designs and which end in 2025. South Africa, towards 2055, faces rigidity in its economic policy and any policy-driven transition to a low-carbon society (ASSAf, 2016; Glazewski, 2016). The changes in the energy regime will impact on the communities and, therefore, foresight is required in the planning process. An excellent example of this impact is that of the proposed shut-off of the Eskom plants in 2025 when 7000 jobs will be lost (Wakeford, 2016).

The Karoo faces many social problems which are steeped in the past legacy. This research references the 'dop system'. 'Dop' is the Afrikaans slang for cheap wine alcohol which came in the form of such cheap wine poured into a plastic container. The 'dop system' replaced a portion of the cash element in wages. This apartheid mechanism allowed for workers to remain in a state of permanent intoxication so that workers never questioned labour rights.

Foresight assesses the current hypothesis to effect change, which could lead to desired and surprise-free futures. In doing so, the foresight methodology of CLA, in the phase of anticipation, allows the researcher to delve deeper into the systemic causes which shaped the current narrative. What might have been said in jest in the focus group, by the other 39 respondents, was noted as grave concerns to the researcher. The ‘dop' system encouraged an alcohol dependency which has spread from one generation to the other. Since the abolishing of Apartheid, South Africa has witnessed enormous, progressive, strides in the amendments of the labour law. As from January 2019, a minimum wage of R3200.00 became effective as the new minimum wage. Figure: 8.1 below captures the pensive and serious manner in which respondents embraced the elements of this new methodology.

Future studies encourage and identify emerging trends which will affect the future. Future studies do not attempt to change or influence the future but instead encourage the researcher to isolate and identify emerging issues which could impact on a particular outcome in the plan for the future and then plan to address them. In the back-casting exercise, Miss Josephine, a single mother and respondent in the focus group, as depicted in Figure 8.1, recounts the events from 2055, “Fully emancipated and prosperous, after the UOG extraction in the Karoo, South Africa. Happy, but single”.

Figure 8.1: Theme - Visioning

(Source: Sezen, 2018)

The emphasis on being a single parent and not wanting males to be part of the family was a case for concern by the researcher. These worrisome comments could allude to the gender-based violence which is currently gaining visibility in South African society. The nature of such comments, questions the future of men, the perception of men by women, the role of men in the family.

Studies have shown that after the financial crisis, women-managed companies show better performance. As the use of foresight does not aim to change or influence the future, however this research proposes build-environment options which would suit the lifestyle options of the futures. In the case where the civil society of the Karoo chooses the more conservative family approach, the Singaporean model is preferred. In a case, where individuals prefer a single, unattached lifestyle, the Auroville option providing for a more communal lifestyle might be chosen.

Therefore, for all these to happen, civil society of Sarah Baartman Municipality is required to do the following:

- Identify and ensure that there is equal representation of all marginalised groups and which public and government bodies may find it hard to reach and engage.
- Where possible and appropriate, bring in technical and scientific capacity to question the safety of the exploration in a rationalised manner, ensuring that, principles of sustainability are adhered to.
- Work with marginalised communities to ensure inclusivity. In the case of the issue of the 'water's people', which was presented by Chief Margaret (2015), it is essential for civil society to re-group and discuss these issues in line with the economic opportunity of the UOG extraction and seek the peace that is required before the exploration begins.
- Ensure that all parties within civil society are actively engaged in the development of the regional supply networks. This can take the form of rigid business support or small-scale, informal trade, such as kiosks and which, too, are required to be developed within a structure, given the health and safety measures for the new exploration.

Regional supply networks, based on the concept of 'Local First', civil society must be set up to optimise the opportunities with the CDM initiatives of the UNFCCC of 1992. The City of New York has instituted sustainability coordinators in 1100 public schools and appointed custodians of all the trees on the streets of New York. Similar measures can be taken by the civil society of the Karoo. This would lead to greater inclusion of the marginalised groups, such as the elderly in society. Given the allocation of finance, firstly through the licence agreements, the CDM initiatives also are cash generators. Civil society should be cognisant of the value of foreign investors and create a positive and engendering environment for peace and friendly co-existence.

Civil society must be informed of citizens' human rights under the United Nation’s Bill of Human Rights, in particular, the people's right to clean air and water. The objective is to be able to conduct a productive dialogue based on mutual respect and partnership dialogue. The South Africa government and NGOs must assist in the process by firstly assisting civil society in identifying and isolating problem areas. The lack of insulation in the Karoo homesteads, as articulated in the workshop by Mayor De Vos, ‘the Karoo is so dry and so hot, that one simply wants to run away…' is such an intense problem in the Karoo. The dwellers of Jansensville and Graaff-Reinet, with the correct forecasting, can look forward to homes designed on the Masdar model with electric vehicles, and pedestrian streets. Based on the probability index, the civil society of the Sarah Baartman Municipality can in this domain, achieve a probability of success above 80 – 90 per cent.

Columbia University, working in conjunction with Standard & Poor Platts, and IEA France, provides the most updated information on growing trends in the oil and gas sector (IEA, 2017). Gas, once viewed as a wild card now disrupts the global crude industry, impacting unfavourably on the OPEC countries. There has been close engagement with the API to understand the setting up of shale institutions which must support all stakeholders. This research provides and broad framework of recommendations which have been identified. Further goal-oriented action, which will be the outcome of the diagnostic assessment is yet required.

To assist in highlighting the call for further in-depth research into methane and other GHGs emitted during fracking, Ambassador Adam, a board member of IISD and architect of SDG 16, has tabled the most salient arguments of this research from a sustainable development viewpoint (personal interview with Ambassador Adams, 2019). The IISD is one of the leading organisations promoting sustainability and renewable energy on a global scale (Adams, 2019). Ambassador Adams has been instrumental in the furthering of the various gas and economic discourses in

Mozambique given the positive interventions of the Swiss government in that country. Understanding the need for developmental diplomacy in action, capacity development frameworks are being developed, which are referenced in the sections below.

Water remains the primary concern of civil society and is the most likely catalyst for civil conflict. Over the past two years, the researcher has followed the work of Professor Wolf of Oregon State University, in the study of international water conflict. Professor Wolf, a water scientist, pioneered work on water diplomacy and conflict resolution, drawing on the experiences of the separate countries of the Mekong River Basin. This research concludes that the shale discourse on the Karoo, South Africa, regarding the water issue still hanging in the balance, as the developers have yet to disclose the source of water for UOG extraction (Avenant *et al,* 2016; Esterhuyse *et al,* 2016). It is necessary to prepare for challenging discussions between civil society and all stakeholders. These robust discussions will take place when the licences are finally awarded. This research accepts that water is a raw material and is the liability of the developer. While potential concerns on water issues have been highlighted, in particular, the human rights of the inhabitants of the Karoo, South Africa, this matter is a subject of further research, before engagement with developers and civil society may begin.

8.5.2.4 Action for the Youth of the Sarah Baartman Municipality. Addressing the Economic and Social Question

Robust fieldwork in this sector of this research has been conducted, which surveyed the attitudes and behaviours of the youth in this region. Government and developers have made representation in this community announcing premature statements which have sparked the adverse reaction of the public. The researcher complied with the research ethics of the Nelson Mandela University and the research design was vetted by Mayor De Vos and the Executive Committee of the Sarah Baartman Municipality. As such, it was agreed at the start of the research that there would be no public engagement, outside these focus groups. A comprehensive list of businesses was also provided by the municipality.

From the onset, the research following the pitfalls of the research conducted by the developers, that the focus of this research would be on the developers and policy makers to establish the strategic standpoint. However, through the classification process of the research fieldwork, capacity-building became a pivotal aspect of UOG extraction to be addressed. It was then agreed ‘that someone was missing in the room'. Inayatullah (2015) in workshops held in South Africa in 2015, explained how vital discussions take place without consultation with the key stakeholders, referring to these stakeholders as ‘someone is missing in the room'. This critical insight was discussed with Mayor De Vos, citing the observation of Inayatullah (2015), highlighting that youth had not been consulted. The municipality then arranged two groups of 80 youth respondents in the towns of Graaff-Reinet and Jansensville.

Eighty youth in the focus groups were introduced to the Sarkar game, visioning and backcasting techniques. The youth respondents identified and coined the concept of ‘Local First', which informed (or influenced) the techniques which were employed by this research. Table 8.5 refers to all the actions for the youth before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.5: Actions for The Youth of the Sarah Baartman Municipality

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Addressing SDG 13 and raise awareness of climate action amongst the youth.	Conduct an employment census of the region and put forth the job opportunities in CDM and other climate action opportunities.	95%
Address the narratives pertaining to rural urban migration.	Structurally manage old paradigms that entice youth to the urban areas, but exposing opportunities through climate action and the UOG extractive activities in the region. Once these are running, encourage the transition into employment created by the renewable energy sector.	90%
Embrace economic modernisation	Engage with developers to explore economic opportunities through establishing partnership. Guidelines from SDG 17 may be consulted.	90%

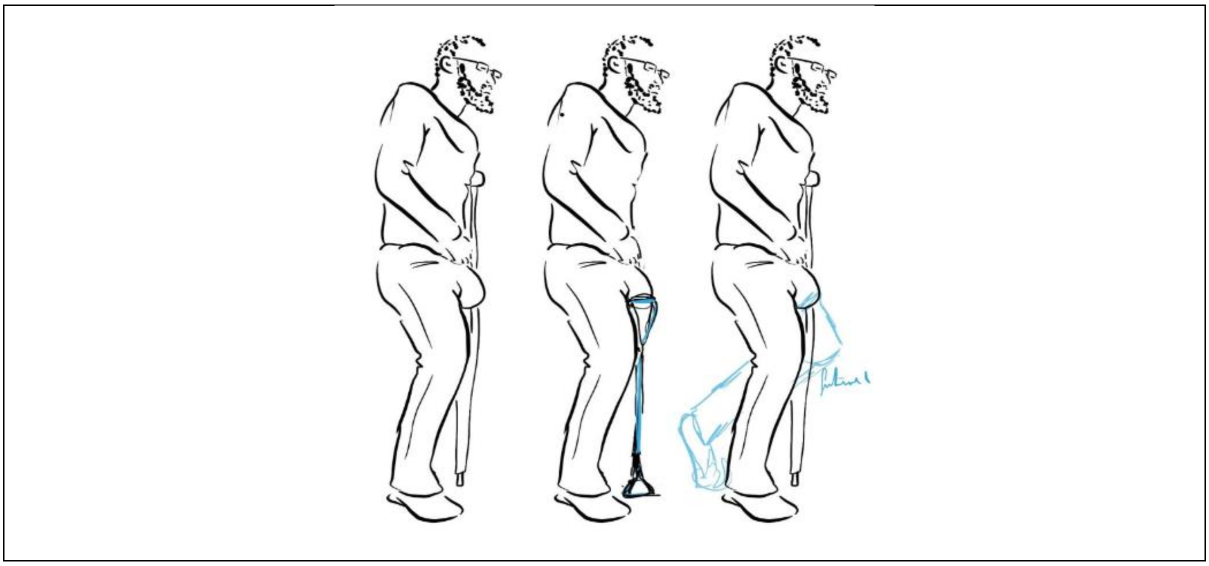
Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Embark on wide-scale capacity building programmes.	Insights from the Capacity Building workshop Refer to Appendix 2, would be a useful starting point to establish a strategic standpoint from which to build the necessary skill sets required for the UOG extraction.	75%
Develop a new supply network to support UOG extraction.	Using current government financial mechanisms, the youth should start engaging in upskilling as entrepreneurs and develop a local supply network for the upcoming extraction.	95%
Develop a network of environmental monitoring agents	Monitoring of shale operations can be conducted by trained youth.	75%
Foster inclusivity, by challenging issues of gender-based violence and xenophobia.	Following the advice of Inayatullah (2019) and Williams (2019) appeal to the modern mindset of the youth and address critical social issues. Many expatriates are expected to participate in the extractive process, bring in new skills.	95%

(Source: Researcher's Construction, 2019)

Thus, this research fieldwork was concluded by rounding up all stakeholders. The youth, in the space of three hours, were able to envisage hopeful futures and gave requirements for further development. With 25 per cent of the respondents having reached the third year of tertiary education, certain myths surrounding the youth in rural areas were de-constructed. The proposed BRICS curriculum (Refer to Appendix 2) for higher education, was discussed, and youth expressed appetite but aired concerns of the financial constraints.

In developing the probability for success index, the researcher believes that the data is trustworthy and that 25 per cent of the respondents, despite the odds against this community, were capable of pursuing university courses up to third-year level. The respondents displayed leadership qualities which enabled the researcher to use the ‘peer to peer' techniques employed at the University of Eastern Finland Law School, to administer the Coursera programme in Jansensville. Inadequate health care facilities of that area claimed the life of a respondent. Figure 8.2. refers to a 28-year-old, physically-challenged male respondent, third-year law student, who was nominated to administer a peer-to-peer learning experience, passed away two weeks after the focus group research.

Figure 8.2: Theme - Vision of Hope



(Source: Sezen, 2018)

At the government experimental farm, gura production can be piloted with a specific focus on the recruiting of female farmers. Specific projects under the UNFCCC may also be implemented to create a new mindset around a lower carbon society. For this to happen, the youth of the area must take an active role and participate in all aspects of the UOG extraction as demonstrated voluntarily in the Sarkar game. The youth must be supported by both local and foreign investors as well as the NGOs which operate under the auspices of the UNFCCC. Based on the probability index, the youth can achieve a probability of success above 90 – 95 per cent. This answers the question as to whether the UOG extraction can be a game-changer, primarily to the youth of the Sarah Baartman municipality. Finally, given the critical requirements for wide-scale job creation and capacity-building, special programmes have been recommended within the BRICS-South African education frameworks.

8.5.2.5 Actions for the Trade Unions. Addressing the Social Question of Unemployment

Firstly, the unions are entrenched in the notion that new energy forms such as shale and renewable energy will reduce the number of jobs in the coal mining sector. Government, as well as industry, needs to educate the unions and the workers about the rate of technological transformation which all sectors are facing. Capacity development would enable workers to command better salaries. In the case of shale, this research has provided data to substantiate those additional workers that would be required for the UOG extraction in the Karoo, South Africa. Table 8.6 refers to the actions for the trade unions before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.6: Actions for the Trade Unions

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Embrace and promote climate action.	Be part of the process to explore employment opportunities in the climate action agenda.	80%
Address population growth by creating entrepreneurs of the future	Encourage the growing populations to become entrepreneurs rather than workers and assist in the developing of an integrated supply network to the UOG extraction.	75%
Develop local content and address rural urban migration	Adhere to the concerns of the youth in the focus group and develop a sense of regional belonging which will address a national problem.	95%
Address impacts of increased energy demand	Encourage the work-force to be energy efficient and promote the transition towards renewable energy.	80%
Promote the mantra of Local First!	Promote the concept coined in the focus groups to ensure jobs for locals first.	85%

(Source: Researcher's Construction, 2019)

Table 4.4 illustrated an increased number of jobs in the U.S. and the UK. Shale, being part of the oil and gas sector in South Africa, will develop new jobs in the Karoo, if the policy of Local First is formed and implemented. UOG extraction will play a supportive role to industries in the rest of South Africa, employing the logistic companies, logistic staff, business-to-business (B2B) marketing and sales staff. These increased job numbers should be developed with the unions being part of the diagnostic assessments, so that unions have all the data required to make meaningful decisions in favour of the new sector.

In addressing the social questions, as set forth by this research, the issue of unemployment sits squarely with the civil society and unions. In the round of interviews with the heads of Black business and the farmers' organisations in the town of Graaff-Reinet, it was clear that civil society will lead the discourse on job creation and capacity-building. For this to happen, unions and civil society must play an active role in pressurising the municipality and the developers to devise implement the Local First policy. Based on the probability index, the unions and civil society can exist in this domain, if the recommendations are accepted and agreed to by the relevant stakeholders, and a probability of success above 85 per cent can be achieved.

8.5.2.6 Actions for Developers and Local Investors. Addressing the Economical question.

In the new dispensation of regional government autonomy, the Sarah Baartman Municipality will assume responsibility to interact with the developers and investors. Table: 8.7 below refers to the actions for developers and local investors before, during and after the UOG extraction in the Karoo, South Africa.

Table 8.7: Actions for Developers and Local Investors

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Insist on stringently worded legal agreements which favour primarily the environment and the community. Secure joint ventures will local companies to comply to labour and empowerment mandates.	Developers should be protected under WTO Principles, yet be subject to international and domestic environmental principles. Special clauses in the regulations must govern the impacts on water, air, humans, flora and fauna to avoid the potential impacts in the Frack and Go! Scenario. There should be full disclosure on the use of all chemicals with heavy penalties for non-compliance.	85%
Insist on WTO Principles being applied to all contracts and ensure a safe investment in the country, Ensure the correct TRR and reflect in contracts.	Using the MFN clause and the Legitimate Expectation clause, developers should ensure that the extraction is viable from the onset. The latter must be achieved before any final contract is signed with the government.	85%

Issue	Possible Guidelines to Finding Solutions	Success Probability (%) of the Solution
Insist on transparency of the contracts and payments.	Contracts with government or local should be subject to public scrutiny before entering into force. JVs with locals should be encouraged to promote participation for skills acquisition.	85%
Investigate the use of modern petroleum contracts	A mix of options emanating from licences, production-sharing agreements and outsourced contractor's agreements should be appraised for each part of the extraction process.	80%
Stemming the migration to urban areas and developing local content.	State should implement a new BBBEE scorecard with incentives for the UOG extraction which obligates developers to contribute positively to sustainable employment. Joint ventures with local companies will ensure that obligations are met even if the international developer is unwilling to carry this burden.	80%
Establish and agreed off-take price based on a minimum of five year tranches.	An agreed off-take price is necessary for planning purposes given the volatility of the oil and gas sector.	80%

(Source: Researcher's Construction, 2019)

Foreign energy investors would pressurise the South African government to match support given by other global markets. In order for South Africa to be considered as an energy investment destination against other African markets, the government must ensure that the contracts are lucrative to the investors without sovereign compromises which could result in a resource curse to the economy. Other African markets are now appearing as attractive investment destinations, posting higher consistent GDP growth figures, better governance and lower corruption levels.

Based on these factors alone, South Africa must develop distinct legal frameworks and regain the confidence of the investors for the UOG extraction in the Karoo, South Africa. The rudimentary business case provides the scope of the shale prize and the options which are available to the South African government to access finance. As in the case of the U.S., UK, Canadian and individual EU governments, the South African government must invest significantly in shale R&D to gain useful insights to negotiate with the developers. The current level of uncertainty provides developers with unwarranted, negotiating ‘clout'.

8.6 CONCLUSION

Chapter Eight concludes the transforming of the landscapes into the future. The introduction of this chapter set the context of the topic in the perspective of global warming, which is supported by the Paris Agreement (2015) and the Sustainable Development Goals. The research problem is characterized by the environmental, the economical and the social issues. The social issue is further teased out into poverty, unemployment and social inequality.

With energy being the fundamental catalyst to spur economic development, low carbon solutions are required. The African continent is the last to industrialise and adhering to the SDGs is key to a sustainable development. The establishment of stable, regional and local governments with access to global environmental organisations is critical for the monitoring of global warming and lower emissions levels. International agencies which support the SDGs can provide useful support in making African cities resilient to the ravages of climate emergencies. Strategies have been put forth for the UOG extraction in the Karoo, to enable the successful implementation of the exploration. This relies on the cohesive working together of all stakeholders, responding within designated mandates. To that extent the research pays careful attention to proposing sets of actions that each stakeholder can undertake, thereby making an attentive contribution to the lives of the people of the Karoo.

The research in this chapter has provided a comprehensive framework of implementation strategies which satisfy the concerns of the environmentalists. This research provides policymakers with the list of mandatory activities which are required to apply the command and control approach. The extensive fieldwork examining the U.S. case and the ongoing interaction with the U.S. leading scientific and oil and gas institutions have been able to sufficiently inform the South African oil and gas industry on how self-regulation must take place, in order to attain readiness for effective UOG implementation. The research informs South African civil society on citizen rights in respect to the use of water, by calling on the provisions set forth under the United Nations framework and international public law. The next chapter is the final chapter that reflects on the research, summarizing the methods employed, the key contributions, the limitations of the research and presents the final conclusions.

CHAPTER 9:

9 REFLECTIONS AND CONCLUSIONS

9.1 INTRODUCTION

Mouton (1996), maintains that research concludes with an interpretation of the research findings against the background of the original research problem and further asserts that the final interpretation of the data should be presented in an objective manner and should not be selective. Mouton also argues that a valid conclusion is one in which the empirical data or the evidence provides both sufficient and relevant grounds for the conclusion (1996).

Research questions Q1, Q2 and Q3 are reviewed in this chapter, where the insights of the research are used to evaluate the possible hydraulic fracturing options for South Africa towards 2055. The first part of the chapter provides an overview of the research. In the second part, the research findings are interpreted against the background of the original research problem and the research objectives. The final part of the chapter presents specific recommendations for further research, as well as some specific concluding remarks. The limitations of the research are also clearly defined.

9.2 REFLECTIONS AND OVERVIEW OF THE RESEARCH

In this final chapter, this section reviews the previous chapters and makes the conclusions.

9.2.1 Research Questions

This research embarked on an extensive and controversial subject matter, that has economic benefits but possibly serious environmental consequences. UOG extraction has been an emotive topic sparking wide-scale protest action around the world, and which has led to moratoria in many jurisdictions around the globe resulting in partial and complete bans in many countries (Glazewski and Esterhuyse, 2016).

The expert interviews conducted at the beginning of this research, as well as the initial review of the South African shale exploration-specific literature, indicate that the key findings have been around developer frustrations, the lack of evidence-based science which would enable policy-making and the apathy and slowness of the government to react to critical energy issues (De Wit, 2012; Fakir, 2015).

This research embarked on an extensive review of the legal frameworks under international law, climate change law and international commercial law under the World Trade Organization (WTO), (1995), examining protection of international investors and how South African domestic law has adopted these international, commercial frameworks. Linked to this discourse has been the review of the current license offering to developers by the South African government against the development of new petroleum contracts.

Strategic potential changes in the current property laws in South Africa have been presented by this research. Such changes are realistic, at a time when the Section 25 of the Constitution is being considered for review. The recommended amendment addresses not only the problem of land redistribution, but also provide economic viability and optimum use of the properties where natural resources are situated.

This research tests the readiness of the South African economy to undertake the opportunistic UOG extraction, by providing a holistic examination of the UOG extraction problem in line with the expectations of the NDP 2030. The research deals with three main concerns of the UOG extraction of the Karoo, South Africa, i.e. (1) the safety of the exploration, (2) the economic viability and (3) the opportunistic role of the exploration to address the Triple Challenge of poverty, unemployment and inclusion.

This research, in consideration of the environment firstly asked the question if fracking was safe in the Karoo, South Africa, and it attempted to understand all the risk factors and the extent to which these may be mitigated. The answer to the second concern illustrated to what extent UOG extraction could be a game-changer in the South African economy. In doing so, this research suggested a numbers-based approach to ascertain in monetary value the eventual net gain to the current GDP. This research further presented the time-frame that the economy could plan far in order to attain the additional income to fast-track the energy plans set out in the Integrated Scenario. Therefore, linked to this question were the contractual mechanisms that the government would sign with developers. Table 9.1 tabulates the research questions.

Table 9.1: Main Research Questions and Objectives.

POSSIBLE HYDRAULIC FRACTURING FUTURES FOR SOUTH AFRICA TOWARDS 2055					
Planet		**Profit**		**People**	
Question	**Objective**	**Question**	**Objective**	**Question**	**Objective**
Is fracking safe in the Karoo, South Africa?	Understand the risk factors and how these may be mitigated.	What is the extent to which UOG extraction will be a veritable game-changer for the South African?	Demonstrate in numeric terms the extractive value of the new sector, against current GDP and other main economic sectors.	To whom will the exploration be an economic game-changer and what are the timeframes in which these will be realised.	Demonstrate in numeric terms the contribution to the current annual GDP of South Africa towards 2055.
Is water usage in UOG extraction in the Karoo, ethically defensible?	Understand to what extent is the human right to water, violated by the socio-economic impacts.	To what extent is the appropriatenes s of the current petroleum contract, and what are the other possible options?	Evaluate licence agreements against other modern-day petroleum contracts?	What are the rights of the people in respect to the environmental concerns which have been initiated in the UOG discourse?	Understand the legal rights of the people of the Karoo, South Africa, in respect of the environmental aspects of the exploration viewed against the principles of sustainable development.
Emerging megatrends which impact upon the UOG discussion in the Karoo, South Africa					
Climate Risks Water Methane Leakage Seismic Activity		Increase in Urban Population Need for Economic Development Increased Demand for Energy which results in climate risks.		Education and Health Social Uprising Capacity Development	

(Researcher's Construction, 2015)

This research questioned the validity of the current licence agreements. While priority is given to the environment (planet), people are also important in this discourse, and this research elaborated the questions of many South African authors, as well as civil society for whom the exploration was seen to be an economic game-changer and also how this would be manifested (Esterhuyse *et al*., 2016).

9.3 CONCLUSIONS FROM THE RESEARCH METHODOLOGY

In this section, this research reviews the primary research methodological efforts.

9.3.1 Causal Layered Analysis in Support of Scenarios

The Six Pillars approach in Causal Layered Analysis (CLA) was the primary method of extracting quantitative data which informed the research. CLA, is a theory of knowledge and a methodology for creating more effective policies and strategies. CLA works at several levels, delving more in-depth than the litany, the headline, or the level of reality determined by data to reach a systemic-level understanding of the causes for the litany. In the examination of the narrative, many engagements in the form of interviews and laboratory analyses are employed. Below that level, CLA goes further, searching for a worldview or the stakeholder views on issues. Finally, it explores the deepest metaphorical levels of reality (Inayutullah, 2014).

The scenarios for the Karoo, presented by this research are based on profound metaphors. South African experiences of social aspects come from the interaction with the youth respondents in the focus groups of Jansensville and Graff Reniet. The CLA-recommended techniques of the Sarkar Game, back-casting and visioning which were used, revealed the evidence of seeds of gender-based violence, property-ownership issues and the dissatisfactory treatment of foreigners. Each subsequently lower level revealed a more profound cause and broadened the understanding of causal issues and led to profound scenarios.

More deep-rooted myths were explored and new litanies based on the views of different stakeholders were examined to see how solutions were constructed. CLA can be used to deepen our understanding of strategy (Inayutullah, 2014). This research has been very attentive to the sentiments of the respondents, in order to understand the systemic causes of problems which plague the lives of the inhabitants of the Karoo, South Africa. One female respondent in the visioning process made specific comments on the vision of the preferred scenario. The respondent envisioned a life of a single mother, leading the researcher to consider the systemic reasons for such deep-seated emotion and the future role of the males in the Karoo households. Based on anticipated changes in lifestyles, various type of accommodation structures have been suggested for all the inhabitants of the Karoo.

9.3.2 Academic Forums, Workshops and Summits

After the bulk of the fieldwork was concluded, a supplementary workshop was conducted in Cape Town, in July 2018, with the Mayor of the Dr Beyer's Naudé Municipality, together with the principal of the local technical college and a university professor of pedagogics. The professor addressed the capacity-building issues for the upcoming UOG extraction in the Karoo, South Africa.

Two extended trips to America were conducted in collaboration with Professor Jackson of Stanford University to verify the desktop research, the feedback from the South African experts on this literature and the new technologies in the shale sector. There has been long-standing communication with the authors of the Vengosh *et al.* Report (2014), of which Professor Jackson's input and advice is most noted and referenced.

Given the criticism of the report by Green (2016), the researcher travelled to Stanford University and examined the laboratory reports and interrogated the sampling and monitoring of the air in fracking areas in order to understand the improved technology for the monitoring of methane leakage and that of other fugitive gases. The actions pointed towards further research to be conducted on methane emissions and should include global collaborative action.

At the Quarter 4, 2018, IEA presentation in New York, on the IEA Gas Five Year Forecast (IEA, 2018), one of the panellists stated that U.S. UOG successes would not be replicated in the rest of the world. This forum allowed for interrogation of this critical and controversial discussion point. The researcher pointed out that markets such as China, are investing extensively in R&D to ensure that shale successes can be replicated with lower risks than those experienced in the U.S. The panel was not able to answer direct questions posed by the audience regarding the excessive flaring and methane leakage, and this further reinforces the need for more research which could lead to stricter monitoring of the methane emissions.

The fieldwork continued with shale corporations and bodies such as the American Petroleum Institution (API) which has initiated a separate Shale Department to formalise the various institutions, business structures and policies, OEM engagement and channels of marketing and sales as the shale sector continues to develop. South Africa National Standards, the previous South African Bureau of Standards (SABS), which was established in 1929 is the closest equivalent to the American Petroleum Institute which only focuses on the oil and gas sector.

The legal counsel of AfriForum, the right-wing Afrikaans farmer pressure group dealing currently with the land reform issues and the nationalisation of state's natural assets, was also regularly consulted on matters for verification. PwC in the U.S. have commented extensively in that jurisdiction, and to that extent, for consistency, PwC, Cape Town office was consulted on the development of the business case numbers. The findings from all these interactions were evaluated, and wherever there was significant merit, due consideration was paid and content incorporated into the final recommendations which this research puts forth.

This research posits the need for the balance in sustainability as defined by the Brundtland Report (1987). The fieldwork examined the various approaches in America (notwithstanding the Trump Administration's exit of the Paris Agreement of 2015 and in which the initiatives promoting sustainability during the Obama Administration have resulted in local government bylaws being promulgated, promoting sustainability with punitive measures for the America public.

Most laudable is the awareness programme between the period of 2010 – 2011 and which was implemented in all 1200 schools across the five boroughs of New York City, appointing a sustainability coordinator in every school. In association with the IISD, a scoping exercise is being scoped to understand how sustainability can be extended to all learning institutions as well as how CDM programmes may be implemented and monitored against the specific objections relating to the possible high levels of methane emissions in the exploration of shale in the broader global context.

The discipline of Development Diplomacy (DD), which promotes sustainability is an essential contribution to this research. The researcher made recommendations that DD should be incorporated into corporate score-cards, in order to gain traction in the global marketplace. A scoping exercise is currently underway with Ambassador Adam in collaboration with Seaton Hall University's School of Diplomacy and international affairs.

All of the above interventions, which have been initiated during the period of the research, ensured that this research continues to inform the critical decision-makers in the discourse of the UOG extraction of the Karoo, South Africa. In the final phase, the individual scenario aspects were structured along three dimensions, namely:

- Planet: the safety impacts of fracking on water, earthquakes and methane and other fugitive gases emissions;
- Profits, the game-changing economic potential of UOG extraction towards energy security and the overall impact that UOG will have on the growth of manufacturing; and
- People, which will, in turn, stimulate economic development with the accompanying impact that this exploration will have on the development of people's lives, firstly in the Karoo towns, and then the overall impact on the South African public life, as witnessed in the U.S.

Subsequently, the research presented the following four future scenarios, which provide a better view of possible hydraulic fracturing futures for South Africa, over the next 40 years:

- The 'Fracking with a smile on my face!☺' scenario, in which the three main elements are successfully addressed by the research and provide the optimal solutions to energy security for the next 90 years. This scenario details the financial mechanisms which will enable the transition to large-scale renewable energy and the overcoming of the issues of poverty, unemployment and social inequality.
- The 'No shale, what now?' scenario, considers the concerns of the various environmental groups and the civil society at large. Critical questions are put forth around the use of renewable energy only. This gave rise to a scenario which illustrates the financial, political and economic challenges, which plague the current trajectory toward energy security in South Africa. While this scenario clearly illustrates the

responsible, unbiased approach of this research in considering all possible, plausible options for energy security for South Africa, the scenario illustrates the critical need for an economic, 'silver bullet' to galvanise the energy plan into action. This silver bullet, at the current time, can only be provided by UOG extraction.

- The 'Frack and Go!' scenario, in which UOG extraction, due to the interference of the state in the UOG extraction, enters into contracts with local developers. The interference of the State, in turn, frustrates the international oil companies, who exit with the expertise which is required to provide for safe exploration and which will render the exploration economically successful and which would impact upon the broader society. In this scenario, only the developers benefit, and when the systems fail, they exit the market. The damage to the environment becomes the burden of the society of the Jansensville and Graaff-Reinet.
- The 'Frack Off' scenario, in which the current IRP 2030 is rolled out with a high carbon footprint. Gas, following the global trend, becomes a disruptive force to the oil sector. Other markets have planned more successfully for this 'wild-card' which plays out between 2020 and 2025. In South Africa, divided along the lines of safety concerns, distrust in the government sees no concrete plans to face the critical problems of poverty, unemployment and social inequality.

9.4 INTERPRETATION AND CONCLUSIONS OF THE RESEARCH QUESTIONS

The development of possible future scenarios for possible hydraulic fracturing futures for South Africa towards 2055 forms the basis of the leading research question, which was formulated in Chapter 1 and relates to: 'Possible hydraulic fracturing futures for South Africa towards 2055' by takes a candid view on the concerns of the global and South African public on UOG extraction in the Karoo, South Africa, and assessing the positive economic and social impacts which the exploration may yield.

Firstly, the South Africa government must aim to attain energy security, using the cleanest and cheapest form of energy at its disposable. Currently, South Africa has an abundance of coal for electricity, but there are severe infrastructural issues at

Eskom, which led to more rolling blackouts in late 2018. In line with South Africa' s strict 2020 carbon reduction obligations to the UNFCCC of 1992, a coal-dominant energy system presents massive challenges. Therefore, South Africa must thoroughly investigate the recommendations suggested by this research, paying particular attention to the environmental risks, with the main focus on the emission of greenhouse gases. Once the South African government has recognised shale as the new energy source, it must then seek to align the implementation objectives of solar and wind technologies, further investigate nuclear production, and continue coal production using clean-coal technology.

Once this is achieved, the South African government must invest further in research and development to close the scientific gaps of two main factors. The first factor is the correct establishment of the extent of extractable reserves. The second factor is the calculation of the potential green-houses gases, mainly methane, that are likely to be emitted. The level of extractive gas determines the economic viability of the exploration conclusively and further, helps the government to determine the range of legal, contractual provisions with which it may engage the developers as well as the level to which government could attract capital from global financial institutions.

Knowing the potential of methane emission will assist global environmental NGOs in the possible net contribution of methane to the global environment. This information is critical to understand, firstly, the overall net emission of methane caused by global shale extraction. Following the last Conference of Parties (COP 24) in Poland, institutions such as the IISD and the IPCC were forced to re-consider current strategies in an attempt to become more hard-hitting and results-oriented. Mechanisms such as the clean development mechanisms (CDM) and (carbon) emissions trading schemes (ETS) have emerged as useful tools. Further research can then be commissioned to understand to what level CDMs and ETS need to be rolled out and in which jurisdictions, these would be implemented in order to offset the GHG related to fracking.

Finally, it is also vital for shale developers to understand the correct level of culpability relative to agriculture and other sectors. Shale developers can self-regulate and behave more responsibly as in the broader oil and gas sector. With the discourse finally reaching a balance between environmental safety and economic viability, cleaner and cheaper energy is produced, which allows for the economic development through large-scale industrialisation, in Africa. Governments in Africa will be better placed to manage population growth and decentralisation will address the problem of rural-urban migration.

Chapter Three was structured deliberately in four parts. Part One investigated the reasons for countries which banned the explorations and which were Germany, France, Holland, Bulgaria and Ukraine (Georgiev, 2016). These EU member states, having embarked on EU RE policies are very advanced in the implementation of renewable energy. The shale reserves of these countries are relatively low, but they have other well-developed economic sectors with advanced energy programmes, e.g. France (with137 TCF) which has a nuclear capacity which is being phased out, given the successes of RE. Also, French shale reserves are situated beneath established and profitable wine farms which already are an established source of French revenue. Germany has between 25 – 81 TCF and is already one of the leaders in RE in the EU. Germany is the most influential EU economy and foresees the closure of all nuclear plants by 2022. For Holland, also a leading market in RE with 26 TCF, shale is not a compelling priority (Hess, Ausich, Brett, 2010). Bulgaria benefitting from other EU policies, does not need to access its low reserves of 195 TCF, and Ukraine also has unconfirmed shale reserves, as total tight oil and shale, of 247 TCF.

Table 9.2 illustrates the poverty and unemployment levels of South Africa relative to other countries. Viewed against these abovementioned indicators, the countries, which have elected not to exploit shale resources have been studied. Concerns were noted and environmental risks were highlighted. However, countries which have approved UOG extraction, have been examined, in greater depth to gather useful insights.

Table 9.2: Poverty Levels: South Africa and Selected Other Countries

Country	Poverty Levels	Unemployment Levels
Germany	15.7%	9.3%
France	14.2%	3.9%
Holland	14%	3.9%
Bulgaria	20%	5.2%
Ukraine	54.5%	9.46%
South Africa	53.4%	26%

(Source: Researcher's Construction, 2019)

Part Two of the environmental chapter examined the South African context of water issues and earthquake activity. Water in fracking is considered in this research as a raw material. If surface water and aquifers are contaminated by the exploration, civil society will draw on existing water legal provisions as outlined in both domestic as well as in international legal provisions. Concerns of methane leakage have been discussed and it has been concluded that UOG extraction is one of the sources of the creation of this problem and within that context, the safety question has been answered.

A rudimentary business case has been provided in Chapter Four, allowing for adequate discussion of the UOG extraction in the Karoo, South Africa. It has been concluded that if the appropriate regulatory frameworks were in instituted and implemented in controlling all stakeholders, UOG extraction could potentially be an economic game-changer for South Africa.

Chapter Five provided the issues which face the regional and local government as well as the societies of the Karoo. After concluding that the UOG extraction is potentially an economic game-changer, the research then set out to establish for whom exactly is UOG extraction a game-changer. The megatrends and the drivers for change framed the arguments which arrived at the conclusion that UOG extraction, along with the utilization of other extractive natural resources, could be an economic game-changers for rural communities and could address the challenges which currently plague rural communities.

Chapter Six provided a summary of the megatrends and the critical uncertainties impacting upon the economic development of the Sarah Baartman Municipality and prepared the data for the four scenarios which painted the picture of addressing the wicked economic and social problems that face the inhabitants of the Karoo.

Chapter Seven presented four future scenarios for possible hydraulic fracturing futures for South Africa towards 2055. These scenarios incorporate different economic, environmental and socio-economic futures, emanating from the research. Based on the three discourses, the environmental, the economic and the social, each scenario was elaborated within relevant trajectories. Finally, this research has attempted to address the Triple Challenge question and has set out very detailed recommendations in Chapter Eight, for the Sarah Baartman Municipality, the youth of the Karoo, as well as the unions. Following the advice of De Wit (2015), developers too, are reminded of obligations. This research concludes that the issue of methane leakage is not restricted to the South African context. South Africa should assist in the development of a global pool of insights, and should, in the interest of the youth of the Karoo, South Africa, as well as the greater South African civil society, give heed to the recommendations of this research and actively pursue the UOG extraction of the Karoo, in South Africa, without further delay.

9.5 KEY CONTRIBUTIONS OF THE RESEARCH

Firstly, the research has made an essential contribution to framing the UOG extraction in the South African context under the Planet, Profit and People Framework, paying particular attention to the mandates of the UNFCCC of 1992 and the various conventions, to which South Africa has voluntarily elected to participate., This research examined in detail the current needs of the inhabitants of Jansensville and Graaff-Reinet, as well as the shortcomings and challenges faced by a local, regional government in order to meet the needs of its constituents. This was the first time such issues had been examined,

In doing so, this research understands that the UOG extraction, requires the interaction of global co-operation, both in terms of climate change management as well as the inclusion of the international investor, who are predominantly the international oil companies. South Africa, if embarking on contracts which require intense capital investment, would be required to behave in a financially responsible manner in order to access funding from the global financial organisations. In order to satisfy these obligations, compliance with public international law is critical and this research has highlighted and put forth how South Africa must comply with UNFCCC and WTO mandates to ensure that the UOG extraction is managed decisively and responsibly (Shabangu, 2012). Furthermore, given the megatrends and the responses of the developing countries towards building the resilience of cities in such developing countries, this research, after analysing the need for regional local government autonomy, presents specific actions required for the amendments in legislative and policy frameworks. These frameworks will enable the central government to build capacity and promote and sustain local government autonomy. Such strategies may lead to decentralised energy and other sectoral models. Addressing these issues will consider how legal and policy frameworks would be explicitly required for UOG extraction, thereby closing the gaps, and attaining readiness for the exploration.

Secondly, the research proved that shale-gas exploration in South Africa will be an economic game-changer for South Africa, by detailing how the exploration would be instrumental in bringing about a reduction of poverty levels, creating wealth and finally addressing inequality through the reforms in land distribution and inclusion of all communities. This research goes further and challenges the government to be bolder and use the opportunity of the review of the Constitution of 1994, a phenomenon, which in itself is a source of discomfort to the majority of South Africans, to affect further progressive amendments which will result in a higher and more effective utilisation of natural mineral and land resources. This research calls for the amendment of property rights to include the land-owners' rights to the resources below the ground.

Thirdly, the research, following on the above point, has provided a rudimentary business case which quantifies that UOG extraction in South Africa would be an economic game-changer. However, while this research accepts that the IEA projections on the extractable reserves have been correct in other fracking jurisdictions, together with the academics, scientists and critics, it recommends that the South African government must develop a national pool of scientific instruments and more local research is required to inform the upcoming exploration.

Fourthly, addressing the Triple Challenge with the Executive Committee of the Dr Beyer's Naudé Municipality, has identified the need for large-scale capacity-building.

The focus group research has unravelled potential systemic sources of underlying social problems which need to be further investigated, understood and catered for, in order to attain surprise-free futures.

Finally, the Integrated Vision that the research presents, a possible and realistic future for cleaner energy solutions for South Africa, it also serves as a source of inspiration and hope, especially for local, regional governments which are better positioned to manage the hopes and aspirations of modern societies. The 'Fracking with a smile on my face!☺' scenario is driven by multiple actors and demonstrates how a collective and purposeful effort can create hope for all South Africans.

9.6 LIMITATIONS OF THE RESEARCH AND RECOMMENDATIONS FOR FUTURE RESEARCH

The research acknowledges the high level of complexity related to all jurisdictions' quests for energy security and equitable rights to natural resources which lie at the heart of the economic, social and political challenges in South Africa and which are set against the backdrop of the critical concerns of climate change. The research community of South Africa, in examining the America scientific findings, has concluded that there are serious shortcomings.

Therefore, the South African government must respond to the calls of the South African scientific and academic communities for significant funding for further research and development, before UOG extraction may be given permission to continue. Further to this government action, a thorough examination of the new petroleum contracts is required before government issues the current licence agreements. Once these contracts are reviewed, agreed and aligned to the public and the environmentalists' expectations, the government must assume the role of a regulator and allow the private sector to perform its respective duties.

Finally, the most critical limitation of shale research, which applies not only to South Africa, but to the entire global UOG extractive sector, is the uncertainty of methane leakage. The researcher has tabled recommendations to global environmental NGOs in collaboration with leading scientific institutions, for wide-scale funding into this critical area of concern. UOG extraction is tipped to be a global disruptor in the global energy sector. This research summarises that there are mitigating factors which can offset the uncertain futures of higher emissions.

9.7 CONCLUSION

The four scenarios for UOG extraction in the Karoo, South Africa were developed to illustrate how conditions for the energy sector and UOG extraction in the Karoo, South Africa may unfold and change the energy landscape in South Africa towards 2055. These scenarios can be used as a starting point for UOG key stakeholders, to create a standpoint from which to identify future challenges and to maximise the emerging business opportunities offered by the energy sector in South Africa. The research presented energy as a multi-dimensional and complex sector that fulfils different roles and functions and is a cornerstone of all economic development. This level of complexity is exacerbated by the negative perceptions regarding the perceived riskiness of UOG extraction in the Karoo, South Africa. The scenarios, therefore, aim to stimulate new thoughts on a broader developmental approach to UOG extraction in the Karoo, South Africa, and to identify gaps in the knowledge about a broad range of research issues relating to the level of complexity with regard to the decision-making environment in UOG extraction in the Karoo, South Africa.

Limitations of this research have been listed, and the South African government is urged to take note of the concerns raised by local scientists and academics. The four scenarios towards 2055, therefore, offer a starting point to develop new and more inclusive UOG extraction strategies that have the ability to speed up income convergence and economic diversification, especially with regard to rural economies in South Africa that are heavily dependent on the energy sector and its related industries for the creation of employment. In line with the Hubert quotation, humankind must explore only according to the current need, pay careful attention to the needs of the planet and achieve the benefits for humankind, flora and fauna.

The integrated vision for UOG extraction in the Karoo, South Africa, envisages a future, in which all stakeholders, including women, the physically challenged, and all previously disadvantaged individuals are socially and financially integrated into value systems, serving as a source of inspiration and hope for future generations and leaves no-one behind.

REFERENCES

Abiodun, A.J. and Oyeniyi, O., 2011. Ethical dilemmas in management: An African perspective. Journal of Business Systems, Governance and Ethics, 6(2): 36-44. doi:10.15209/jbsgev612.203.

Academy of Science of South Africa, 2016. South Africa's technical readiness to support the shale gas industry. [Online] Available at: http://www.assaf.org.za. (Accessed: January 2017)

Acheampong, E., 2004. Impact assessment of mining activities by Ashanti Goldfields-Bibiani Limited on the environment and socio-economic development of Bibiani. Unpublished Undergraduate Dissertation, Faculty of Social Sciences, Kwame Nkrumah University of Science and Technology.

Ackoff, R.L. 2011. Thinking about the future. Ackoff Centre. [Online] Available at: http://ackoffcenter.com/ackoff. Accessed: 15 April 2011. (Accessed: June, 2012).

ACOLA 2016. New U.S Shale Reserves. [Online] Available at: http://acola.com. (Accessed: May 2017).

Addy, S.N., 1998. Ghana: revival of the mineral sector. Resources Policy, 24(4): 229-239. [Online] Available at: https://ideas.repec.org/a/eee/jrpoli/v24y1998i4p229-239.html. (Accessed: June, 2018)

Adendorff, C.M. 2014. Possible futures for South Africa towards 2055. Published thesis submitted for the degree of DBA. Port Elizabeth: Nelson Mandela Metropolitan University. [Online] Available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwjB2KvriLznAhWbiVwKHfqnDHsQFjABegQIBBAB&url=http%3A%2F%2Fbusinessschool.mandela.ac.za%2F&usg=AOvVaw1Lo9oReVQD9G1psT8DtWA3. (Accessed: May, 2019)

Adendorff, C.M., 2011. Possible futures for Sierra Leone towards 2051. South Africa: Published thesis for PhD. University of Stellenbosch. [Online] Available at:

https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.researchgate.net%2Fpublication%2F270724730_Leveraging_ethnic_entrepreneurship_culture_and_family_dynamics_to_enhance_good_governance_and_sustainability_in_the_immigrant_family_business&psig=AOvVaw1_REU5A0Um5MaVi_qYvxS9&ust=1581049371109000&source=images&cd=vfe&ved=2ahUKEwjKma-CirznAhUK1uAKHTtFCrEQr4kDegQIARBE. (Accessed: May, 2019)

Administration, E. I. 2013. International Energy Outlook 2013 With Projections to 2040. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf (Accessed: May, 2016)

Administration, E. I. (2014). Annual Energy Outlook 2012: With Projections to 2035. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf (Accessed: June, 2015)

Administration, E. I. (2015). Annual Energy Outlook 2012: With Projections to 2035. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf (Accessed: August, 2017)

Administration, E. I., & Office, G. P. (2016). International Energy Outlook: 2016 With Projections to 2040. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf (Accessed: May 2017).

Administration, E. I., & Office, G. P. (2017). International Energy Outlook: 2016 With Projections to 2040. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf.(Accessed: February 2018)

Administration, E. I., & Office, G. P. (2018). International Energy Outlook: 2016 With Projections to 2040. Washington, DC: Government Printing Office. [Online] Available at: https://www.eia.gov/outlooks/ieo/pdf/0484(2013).pdf(Accessed: April, 2019)

AEON Energy Centre, Nelson Mandela University. (2016). [Online] Available at: http://www. aeon.co.za (Accessed: October, 2017)

Affleck. WS. 1999. Stark reality of finite oil reserves. The Times, Section: Features, Letter to the Editor London, England. [Online] Available at: NewsBank Access World News. 12 September 1999:19.

African Development Bank. (2019). African New Resources. [Online] Available at: http://africandevelopmentbank.com (Accessed: August 2019).

Agarwal, B., Humphries. J. and Robeyns. I, 2005 A Gender Perspective. University of Denver. Patterns of Potential Human Progress Vol 1. Business University of Cape Coast, Cape Coast, Ghana.

Agence France-Presse. 2017. Shale [Online] Available at: Retrieved from http://www.afp.fr. (Accessed: March, 2018).

Albright, K.S., 2004. Environmental scanning: radar for success: environmental scanning-the internal communication of external information about issues that may influence an organization's decision-making process--can identify emerging issues, situations, and potential pitfalls that may affect an organization's future. Information Management Journal, 38(3): 38-45.

Aleklett, K. 2012. Peak of the Oil Age. Peeking at Peak Oil, 121-148. doi:10.1007/978-1-4614-3424-5_11

Amara, R. 1986. The Uses of Social Science and Humanities Knowledge[Online] Available: http://www.zu.de/deutsch/lehrstuehle/kulturwissenschaften/Bibliographypracticalknowledge.pdf. (Accessed: June, 1986).

Amara, R., 1991. Views on futures research methodology. Futures, 23(6): 645-649. [Online] Available at:https://books.google.co.za/books?id=bPzUGBGtsLQC&pg=PA254&lpg=PA254&dq=Amara, +R., +1991. +Views+on+futures+research+methodology. +futures,+23(6):+645649.&source=bl&ots=qdUcxc9Mf5&sig=ACfU3U33_cCOwYIMD7Iu3l58FGibR6_voA&hl=en&sa=X&ved=2ahUKEwiL372hjLznAhWQYMAKHZqRB4gQ6AEwAXoECAoQAQ#v=onepage&q=Amara%2C%20R.%2C%20

1991.%20Views%20on%20futures%20research%20methodology.%20futures%2C%2023(6)%3A%20645-649.&f=false. (Accessed: July, 2019)

Anonynous. 2000. World Petroleum Congress Roundup. Propane Canada, Volume 92, (6):12, Column 3, Publisher: Northern Star Communications Ltd. (Calgary, Canada).

Aronson, R. 1998. Introduction. Sartre Studies International, 4(2). doi:10.3167/135715598783623755.

Asseez, L. O. 1969. Color Standardization in Shale Analysis. Geological Society of America Bulletin, 80(4), 721. doi:10.1130/0016-7606(1969)80[721:csisa]2.0.co;2.

Atangana, A., & Van Tonder, G. 2014. Stochastic Risk and Uncertainty Analysis for Shale Gas Extraction in the Karoo Basin of South Africa. Abstract and Applied Analysis, 2014: 1-10. doi:10.1155/2014/342893.

Avenant, M., Watson, M., Esterhuyse and Seaman, M. 2016. Book Chapter 11: 225-244. Potential Impact of Unconventional Gas Mining on Surface Water Systems of the Karoo. In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd.

Bagla, P. 2008. INDIA: Beyond Islands of Excellence. Science, 317(5834): 74-75. doi:10.1126/science.317.5834.74a.

Baker, V. 2011. Revolve. In Encyclopedia of Women in Today's World. doi:10.4135/9781412995962.n700. 27 – 39.

Bartko, K., & Al-Naimi, K. 2009. Overcoming Hydraulic Fracturing Difficulties in the Sarah and Qasim Formations. First EAGLE Workshop on Tight Gas Reservoirs. doi:10.3997/2214-4609.20147139.

Baumgartner RJ, Korhonen J. 2010. Strategic thinking for sustainable development. Sustainable Development 18:71–75 [Online]Available: https://scholar.google.co.za/scholar?q=Baumgartner+RJ,+Korhonen+J.+2010.+

Strategic+thinking+for+sustainable+development.+Sustainable+Development+ 18:+71–75.&hl=en&as_sdt=0&as_vis=1&oi=scholart. (Accessed: March 2013).

Baumgärtner, S., Becker, C., Frank, K., Müller, B., Quaas, M.F., 2008. Relating the philosophy and practice of ecological economics. The role of concepts, models and case studies in inter- and transdisciplinary sustainability research. [Online]Available: https://doi.org/10.1016/j.ecolecon.2008.07.018 (Accessed: June, 2018).

Becker, C., 2006. The human actor in ecological economics: philosophical approach and research perspectives. Ecological Economics 60: 17–23. [Online]Available: https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.sciencedirect.com%2Fscience%2Farticle%2Fpii%2FS0921-8009%2806%2900032-2;h=repec:eee:ecolec:v:60:y:2006:i:1:p:17-23 (Accessed: March 2015).

Becker, C., 2011. Sustainability ethics and sustainability research. Springer Science & Business Media. [Online]Available: https://www.springer.com/gp/book/9789400722842 (Accessed: April, 2016).

Becker, C., Faber, M., Hertel, K., Manstetten, R., 2005. Malthus vs. Wordsworth: Perspectives on humankind, nature and economy. A contribution to the history and the foundations of ecological economics. Ecological Economics 53: 299–310. [Online]Available at :https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.sciencedirect.com%2Fscience%2Farticle%2Fpii%2FS0921-8009%2805%2900103-5;h=repec:eee:ecolec:v:53:y:2005:i:3:p:299-310 (Accessed: June, 2017).

Belinskij, A. 2015. Water-Energy-Food Nexus within the Framework of International Water Law. Water, 7(10): 5396-5415. doi:10.3390/w7105396.

Belinskij, A., & Kotzé, L. 2016. Obligations Arising from the Right to Water in Finland and South Africa. Aquatic Procedia, 6, 30-38. doi: 10.1016/j.aqpro.2016.06.005.

Bell, W. 1957. Public Opinion Quarterly, 21(4): 562 - 569. doi:10.1086/266755

Bell, W. 1997. Foundations of futures studies: Human science for a new era. Values, objectivity, and the good society. Long Range Planning, 30(4): 638-638. doi:10.1016/s0024-6301(97)84590-6.

Bell, W., 1997. Foundations of Futures Studies, Vol.I-II. New Brunswick, NJ, and London: Transaction Publishers. [Online] Available at: http://www.yale.edu/sociology/faculty/pages/bell/InterviewLevelhead753-4.pdf (Accessed: April 2012).

Bell, W. 2017. Foundations of Futures Studies. doi:10.4324/9780203791677. Routledge, New York.

Bell, W. 2017. The Land of Oz. Memories of the Future: 225-235 doi:10.4324/9780203785805-17.

Bell, W. 2017. Winning Wings of Gold. Memories of the Future: 41-54. doi:10.4324/9780203785805-5.

Bennett, E.M., Carpenter, S.R., Peterson, G.D., Cumming, G.S., Zurek, M. and Pingali, P., 2003. Why global scenarios need ecology. Frontiers in Ecology and the Environment, 1(6): 322-329.

Berman, H.J., 2006. Public trust and good governance: an essay. Inquiry-Excellus Health Plan. [Online] Available at: http://www.inquiryjournalonline.org/doi/pdf/10.5034/inquiryjrnl_43.1.6 (Accessed: April 2012).

Bernstein, S., and Hansen, C.J. 2006 Poverty and youth reproductive health [Online]Available at: http://www.healthpolicyinitiative.com/Publications/Documents/975_1_Poverty_ YRH_ FINAL_acc.pdf (Accessed: April 2012).

Bezold, C., 1991. Creating Wiser Futures, Knowledge Base of Futures Studies Millennium Edition CD ROM. Australia: Foresight International.

Bezold, C., Juech, C., & Michelson, E. S. 1991. Conclusion: “Foresight for smart globalization” synthesis statement and recommendations. Foresight, 11(4): 82-85. doi:10.1108/14636680910982458.

Bloomberg Business News. Fracking, The Debate 2019. [Online]Available: www.bloomberg.com. Accessed: June 2019.

Bohi, D. R. 1988. Book Review. Natural Resource Modeling, 2(3): 533-536. doi:10.1111/j.1939-7445.1988. tb00071. x.

Bohi, D.R., 1990. Energy price shocks and macroeconomic performance. Resources for the Future, Inc., Washington, DC (United States); Johns Hopkins Univ. Press, Baltimore, MD (United States).

Bohi, D.R., 1998. Changing productivity in US petroleum exploration and development (No. 1318-2016-103486).[Online] Available at: www.econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fageconsearch.umn.edu%2Frecord%2F10902%2Ffiles%2Fdp980038.pdf;h=repec:ags:rffdps:10902. (Accessed: January, 2018).

Bohi, D. R., & Toman, M. A. 1996. Basic Economic Concepts. The Economics of Energy Security, 9-29. doi:10.1007/978-94-009-1808-5_2. Routledge, London.

Bood, R., & Postma, T. 1997. Strategic learning with scenarios. European Management Journal, 15(6), 633-647. doi:10.1016/s0263-2373(97)00047-9.

Bohi, D. R. 2015. Analyzing Non-renewable Resource Supply. doi:10.4324/9781315668543. Routledge, London.

Bohi, D. R. 2017. Energy Price Shocks and Macroeconomic Performance. doi: 10.4324/9781315670218.Routledge, London.

Bood, R., & Postma, T. 1997. Strategic learning with scenarios. European Management Journal, 15(6), 633-647. doi:10.1016/s0263-2373(97)00047-9. Orebro, Sweden.

Bood, R.P. and Postma, T.J.B.M., 1998. Scenario analysis as a strategic management tool. Netherlands: University of Groningen. [Online] Available at: www.ub.rug.nl/eldoc/som/b/98B05/98b05.pdf. (Accessed: February 2017). Orebro, Sweden,

Brahmbhatt, M., Bishop, R., Zhao, X., Lemma, A., Granoff, I., Godfrey, N. and Te Velde, D.W., 2016. Africa's New Climate Economy: Economic Transformation and Social and Environmental Change. [Online] Available at: https://www.odi.org/publications/10593-africa-s-new-climate-economy-economic-transformation-and-social-and-environmental-change. (Accessed: June, 2018).

Brandreth, G. Article: Farewell to riches of the earth. Interviewer: Gyles Brandreth, Interviewee: Ahmed Zaki Yamani, The Telegraph, The Telegraph Media Group Limited, London, England. June 2000. [Online] Available at: www.telegraph.co.uk (Accessed: January, 2018)

Bremmer I., 2009. Global emerging market risk. World Policy Institute. [Online] Available at: www.worldpolicy.org/ian-bremmer (Accessed: February 2012).

Bremmer, T., and Keat, C. 2009. The power of political knowledge. Oxford University [Online] Available at: www.global.oup.com/academic/product/the-fat-tail 9780195328554;jsessionid=B6262EB344CBDD4F596374FC733689 (Accessed February 2012).

Briggs, A. 1981. World economic development, 1979 out beyond Herman Kahn. Futures, 13(6), 526-528. doi:10.1016/0016-3287(81)90112-9

Brooks, M. 2013. Frack on or frack off: can shale gas really save the planet? New Scientist, 219(2929): 36-41. doi:10.1016/s0262-4079(13)61997-1

Bryson, J.M., 2004. What to do when stakeholders matter: stakeholder identification and analysis techniques. Public Management Review, 6(1): 21-53.

Bukari, N.K., 2011. Conflict and development in the Bawku Traditional Area. Unpublished Thesis Submitted to the Institute for Development Studies, UCC.

Bundesanstalt fur Geowissenschaften und Rohstoffe. (2012). Shale [Online]Available at: http://wwwbgr.bund.de. (Accessed: June, 2018).

Burton, J., Lott, T., & Rennkamp, B. 2019. Sustaining Carbon Lock-In. The Politics of Fossil Fuel Subsidies and their Reform: 229-245. doi:10.1017/9781108241946.015. Business Day,12 June, 2019:4 [Online] Available at: http://businessday.co.za. (Accessed: August, 2019).

BusinessTech. Shale and Fracking. [Online] Available at: http://businesstech.co.za. (Accessed: September 2019).

Chemical and Engineering News Magazine. (CENM) 2014. Shale in Asia. [Online] Available at: http://wwwcen.acs.org. (Accessed: June 2016).

C40 Cites and Arup. 2015 Powering Climate Action: Cities as Global Change-makers. [Online] Available at: http://www.cam3.c40.org/images/C40ClimateActionInMegacities3.pdf.(Accessed February 2018).

C40 Cities, 2014. Climate Action in Megacities. C40 Cities, 2015. Cities 100. [Online] Available at: https://www.c40.org/tags/cities100 (Accessed February 2018).

California Institute for the Future. Unconventional Gas Reserves in Canada [Online] Available at: http://www.iftf.org/futureworkforce/ (Accessed February 2012).

Cape Report. 2016. Shale Gas in the Karoo [Online] Available at: Retrieved from http://capereport.gov.za. (Accessed: June 2018).

Cape Report. 2017. Shale Gas in the Karoo [Online] Available at: Retrieved from http://capereport.gov.za. (Accessed: June, 2018).

Carpenter, S. R., Bennett, E. M., & Peterson, G. D. (2006). Editorial: Special Feature on Scenarios for Ecosystem Services. Ecology and Society, 11(2) doi:10.5751/es-01609-110232.

Carr, T.R., Wilson, T.H., Kavousi, P., Amini, S., Sharma, S., Hewitt, J., Costello, I., Carney, B.J., Jordan, E., Yates, M. and MacPhail, K. 2017. Insights from the

Marcellus Shale Energy and Environment Laboratory (MSEEL). Technology Conference: Unconventional Resources. Austin, Texas, 24-26 July 2017. Society of Exploration Geophysicists, American Association of Petroleum Geologists, Society of Petroleum Engineers.

Cediey, E., Fine, B and Rustomjee, Z. 2000. The Political Economy of South Africa: from minerals—energy complex to industrialisation. London: 161-162.

Chan, S., van Asselt, H., Hale, T., Abbott, K.W., Beisheim, M., Hoffmann, M., Guy, B., Höhne, N., Hsu, A., Pattberg, P. and Pauw, P. 2015. Reinvigorating international climate policy: a comprehensive framework for effective non-state action. Global Policy 6(4): 466-473.

Chere, N., Linol, B., de Wit, M. and Schulz, H.M., 2017. Lateral and temporal variations of black shales across the southern Karoo Basin-Implications for shale gas exploration. South African Journal of Geology 120(4): 541-564.

Chhabra, B. 2014. Doctrine of Legitimate Expectation. SSRN Electronic doi:10.2139/ssrn.2478696.

Chhabra, E. 2014. Corporate Social Responsibility: Should It Be A Law? [Online] Available at: https://www.forbes.com/sites/eshachhabra/2014/04/18/corporate-socialresponsibility-should-it-be-a-law/#d282d9137363 (accessed 5 June 2017).

Choo, C.W., 2003. The art of scanning the environment. Reframing Environmental Scanning:7. [Online] Available https://asistdl.onlinelibrary.wiley.com/doi/abs/10.1002/bult.117. (Accessed: June, 2014)

Chopra, S., Sharma, R.K. and Marfurt, K.J. 2013. Current workflows for shale gas reservoir characterization in Unconventional Resources Technology Conference. August 2013. Society of Exploration Geophysicists, American Association of Petroleum Geologists, Society of Petroleum Engineers.

Christen, M., 2010. A Theory of the Good for a Conception of Sustainability. In The Sixteenth Annual International Sustainable Development Research Conference. Conference Proceedings, Hong Kong.

Cilliers, J., 2008. Africa in the new world: how global and domestic developments will impact by 2025. Institute for Security Studies Monographs, 151.

Cilliers, J., & Hedden, S. 2014. Africa's Current and Future Stability. SSRN Electronic Journal. doi:10.2139/ssrn.2690122.

Hedden, S., Cilliers, J., Hughes, B. and Moyer, J., 2011. African Futures 2050. The next forty years. Institute for Security Studies Monographs, 2011(175): 102.

Climate consensus. 2013. Nature Climate Change, 3(4): 303-313. [Online] Available at: https://www.nature.com/articles/nclimate1875 (Accessed: June 2012).

Coates, J.F. 2010. The future of foresight. A US perspective. Technological Forecasting and Social Change, 77(9): 1428-1437. https://books.google.co.za/books?id=Dt0vDwAAQBAJ&pg=PA252&lpg=PA252&dq=Coates,+J.F.+2010.+The+future+of+foresight.+A+US+perspective.+Technological+Forecasting+and+Social+Change,+77(9):+1428-1437.&source=bl&ots=zZuzjsjFmr&sig=ACfU3U326YPEexz4uDkJZiPP94oZeeZ4hw&hl=en&sa=X&ved=2ahUKEwiuxpW-w7znAhUIV8AKHaThAaoQ6AEwAHoECAkQAQ#v=onepage&q=Coates%2C%20J.F.%202010.%20The%20future%20of%20foresight.%20A%20US%20perspective.%20Technological%20Forecasting%20and%20Social%20Change%2C%2077(9)%3A%201428-1437.&f=false

Coetzee, H., & Kotzé, L. J. Shale gas development and water in South Africa: regulatory aspects. Water Resource Management and the Law: 22(2) 369-388. doi:10.4337/9781785369834.00025.

Control Risks. 2018. Scenarios of the Future. [Online] Available: http://www.control-risk.co.za. (Accessed: June 2018).

Conway, M., 2009. Environmental scanning: What it is, how to do it. Thinking Futures. [Online]Available: https://s3.amazonaws.com/academia.edu.documents/46986171/Strategic_Thinking_what_it_is_and_how_to20160703-21999-19zq9pu.pdf?response-content-disposition=inline%3B%20filename%3DStrategic_Thinking_what_it_is_and_how_to.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20200205%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20200205T162432Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=27df78062f4af794a2fd4c2a02e124a4d5b4d47a1f08fb5c8f0bd2512aaa737f. (Accessed: June 2015).

Cornish, E., 2004. Futuring: The exploration of the future. World Future Society. The Futurist Magazine: 23-29.

Coser, L. 1956. The Functions of Social Conflicts. The American Catholic Sociological Review, 17(4), 368. doi:10.2307/3708766.

Coser, R. L.1956. A Home Away from Home. Social Problems, 4(1): 3-17. doi:10.1525/sp.1956.4.1.03a00010.

Council for Scientific and Industrial Research. 2016. Strategic Environmental Assessment: Shale Gas in the Karoo. [Online] Available http://csir.co.za. (Accessed: July, 2016).

Crane, B., & Kahn, H.1965. On Escalation. Metaphors and Scenarios. International Journal, 20(4): 541. doi:10.2307/40199684.

Credible Carbon. 2012. Shale Gas [Online] Available: http://www.crediblecarbon.com/index.htm. (Accessed May 2015).

Creswell, J.W. and Creswell, J.D. 2017. Research design: Qualitative, Quantitative, and Mixed Methods Approaches. California, Sage publications.

Crush, J., 1989. Migrancy and militance: The case of the National Union of Mineworkers of South Africa. African Affairs, 88(35): 5-23.

Darbonne, N., 2000. Participants in CNN oil-price poll vote for battery-powered cars Oil & Gas Investor. [Online] Available at: https://www.hartenergy.com/exclusives/participants-cnn-oil-price-poll-vote-battery-powered-cars-5396 (Accessed: April 2015).

Darrah, T. H., Vengosh, A., & Schwartz, F. W. 2018. Time to settle the debate, but how? doi:10.1130/abs/2018am-324013.

Darrah, T.H., Vengosh, A., Jackson, R.B., Warner, N.R. and Poreda, R.J., 2014. Noble gases identify the mechanisms of fugitive gas contamination in drinking-water wells overlying the Marcellus and Barnett Shales. Proceedings of the National Academy of Sciences, 111(39):14076-14081.

Dator, J. 2007. What futures studies is, and is not. University of Hawaii Research Center for Futures Studies. [Online] Available at: http://www.futures.hawaii.edu. (Accessed April 2015).

De Almeida, P. R. 2009. The Brics' role in the global economy. In: Cebri-Icone- British Embassy in Brasília: Trade and International Negotiations for Journalists (Rio de Janeiro, 146-154. [Online] Available at: http://www.pralmeida.org/05DocsPRA/1920BricsRoleEnglish.pdf (Accessed July 2012).

De Geus, A. 1988. An Evaluation Method for Solar Energy Systems Monitored in the TPD System Test Facility. Advances in Solar Energy Technology 23 (12) 783-788. doi:10.1016/b978-0-08-034315-0.50151-8.

De Jouvenel, H. 2010. Manières de voir. Futuribles, (362): 3-4. doi:10.1051/futur/3623.

De Wit, M. J. 1999. Event stratigraphy of Gondwana keynote papers. Journal of African Earth Sciences, 28(1): 1 -12. doi:10.1016/s0899-5362(99)00016-0.

De Wit, M. J. 1999. Geologie en Mijnbouw (Geology and Mining), 76(4): 369-373. doi:10.1023/a:1003290014097.

De Wit, M. J. 2011. The great shale debate in the Karoo. South African Journal of Science, 107:7-8. doi:10.4102/sajs. v107i7/8.791.

De Wit, M.J., 1997. Early Archean processes: evidence from the South African Kaapvaal craton and its greenstone belts. Geologie en Mijnbouw, 76(4): 369-373.

De Wit, M.J., Du Toit, A. 1999. Special issue: Stratigraphy of Gondwana.

Proceedings of the 10th International Gondwana Conference, Cape Town, South Africa.

Department of Minerals and Energy. Shale Gas in South Africa [Online] Available: http://www.dmr.gov.za. (Accessed: June 2019).

Ding, Y., Li, Y., Liu, C. and Sun, Z., 2015. Solar Electrical Energy Storage. In Solar Energy Storage (pp. 7-25). Academic Press.

Dosi, G., Gambardella, A., Grazzi, M. and Orsenigo, L. 2007. Technological revolutions and the evolution of industrial structures. [Online] Available: http://oro.open.ac.uk/10092/. (Accessed: May 2017).

Down, A., Armes, M., & Jackson, R. B. (2013). Shale Gas Extraction in North Carolina: Research Recommendations and Public Health Implications. Environmental Health Perspectives, 121(10): 23 -29. doi:10.1289/ehp.1307402.

Du Toit, L., 2016. Book Chapter 2: 14-24. Experiences from Other Jurisdictions In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd.

Economist Intelligence Unit. 2011. Global food security index 2014. Special Report: Food loss and its intersection with food security. [Online] Available at: http://www.foodsecurityindex.eiu.com/. (Accessed May 2016).

Economist Intelligence Unit. 2012. Global food security index 2014. Special Report: Food loss and its intersection with food security. [Online] Available at: http://www.foodsecurityindex.eiu.com/. (Accessed June 2017).

Economist Intelligence Unit. 2013. Global food security index 2014. Special Report: Food loss and its intersection with food security. [Online] Available at: http://www.foodsecurityindex.eiu.com/. (Accessed April 2016).

Economist Intelligence Unit. 2015. Global food security index 2015. An annual measure of the state of global food security. [Online] Available at: http://www.foodsecurityindex.eiu.com/. (Accessed March 2017).

Economist Intelligence Unit. 2016. Global food security index 2016. An annual measure of the state of global food security. [Online] Available at: http://www.foodsecurityindex.eiu.com/. (Accessed May 2015).

Economist Intelligence Unit Country Reports, 2016. Choice Reviews Online, 53(07), 53-2904-53-2904. [Online] Available at: https://www.eiu.com/public/topical_report.aspx?campaignid=IndustriesIn2016 (Accessed May 2016).

Elkington, J., & Fennell, S. (n.d.). 2013 Partners for sustainability. Terms for Endearment: Business, NGOs and Sustainable Development: 149-162. doi:10.9774/gleaf.978-1-907643-14-9_13

Ener Com Inc. (2016). Shale gas [Online] available at:

https://www.google.com/search?q=Ener+Com+Inc.+(2016).Shale+gas+%5BOnline%5D+Available%3A+http%3A%2F%2Fenercominc.com.+(Accessed%3A+June+2017)&tbm=isch&ved=2ahUKEwjW0LWY277nAhUP_4UKHcqNDfAQ2-cCegQIABAA&oq=Ener+Com+Inc.+(2016).Shale+gas+%5BOnline%5D+Available%3A+http%3A%2F%2Fenercominc.com.+(Accessed%3A+June+2017)&gsl=img.12...0 . 0..38928...0. 0..0.0.0.......0......gws-wiz img.wbcSAGsSPFs&ei=KPY8XtacBo_lwTKm7aADw&bih=595&biw=1437&client=safari(Accessed: June 2017).

Environmental Impact Assessment. (2015). Environmental Considerations for Shale in the Karoo [Online] Available: http://eia.gov. (Accessed: June 2017).

Ernst & Young. 2010. Business redefined. A look at the global trends that are changing the world of business. [Online] Available at: http://www.ey.com. (Accessed May 2014).

Eskom. 2015. Transmission Development Plan: 2015-2024. [Online] Available at:http://www.eskom.co.za/Whatweredoing/TransmissionDevelopmentPlan/Documents/ TransmissionDevPlan2015-2024.pdf. (Accessed October 2017).

Eskom. 2017. Company Information: Our Operating Environment. [Online] Available: http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Inform ation_1.aspx. (Accessed October 2018).

Esterhuyse, S., Avenant, M., Redelinghuys, N., Kijko, A., Glazewski, J., Plit, L., Kemp, M., Smit, A. and Vos, A.T., 2018. Monitoring of unconventional oil and gas extraction and its policy implications: A case study from South Africa. Energy Policy, 118, 12 (2): 109-120. doi:10.1016/j. enpol.2018.03.001

Esterhuyse, S., De Lange, F and Glazewski, J. 2016. Potential Impact of Unconventional Oil and Gas Extraction on the Karoo Aquifers. In Glazewski, J., and Esterhuyse, S.(ED) Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd. p.206 -222

Moll, P. 2012. Europe and the United States. [Online] Available: http://master-foresight-innovation.fr/wpcontent/uploads/2012/06/PMollThirstforCertainty.pdf (Accessed: February 2012).

Exxonmobil. (2017). Greener Options – Shale. Retrieved from exxonmobil.com. [Online] Available: https://corporate.exxonmobil.com/. (Accessed November 2017).

Fahey, L. and Randall, R.M. 1998. Learning from the future: competitive foresight scenarios. Vol.332. [Online] Available: https://books.google.co.za/books?hl=en&lr=&id=KD7VzPqI3S4C&oi=fnd&pg=PA3&dq=Fahey,+L.+and+Randall,+R.M.+1998.+Learning+from+the+future:+competitive+foresight+scenarios+(Vol.+332).+New+York:+Wiley.&ots=WGwxMwj

WFK&sig=lNuafWplKQZZWQ_pjd5UydPvAgM#v=onepage&q&f=false. (Accessed: June, 2016)

Fakir, S. 2014. Shale Gas Hydraulic fracturing in South Africa: Will the costs be socialised and the benefits privatised? [Online] Available: http://www.polity.org.za/article/shale-gas-fracking-in-south-africa-will-the-costs-be-socialised-and-the-benefits-privatised-2014-06-17 (Accessed November 2018).

Fakir, S. 2015. South Africa's Energy Crisis. Renewables for the Rich? [Online] Available at: http://sacsis.org.za/site/article/2241 (Accessed November 2018).

Fakir, S. and Davies. E. 2016. The Economics of Shale Gas Fracking in the Karoo: what can the American Experience teach us. In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd. p. 164-175.

Fan, S., Brzeska, J., Keyzer, M. and Halsema, A., 2013. From subsistence to profit: Transforming smallholder farms Food Policy Reports 26 Intl Food Policy Res Inst.

Farlam Commission Report. (2016). .[Online] Available: http://www.sahrc.org.za. (Accessed: January, 2018)

Fine, B., & Rustomjee, Z. (2018). The Political Economy of South Africa. doi:10.4324/9780429496004 Routledge, New York.

Fleming, R. 2017. Shale Gas, the Environment and Energy Security: A New Framework for Energy Regulation. [Online]Available at https://www.researchgate.net/publication/327634476_Book_Review_Shale_Gas_the_Environment_and_Energy_SecurityA_New_Framework_for_Energy_Regulation_R_Fleming. (Accessed: March, 2019).

Floyd, J., 2008. Towards an integral renewal of systems methodology for futures studies. Futures.40(2):138-149 .[Online] Available https://www.sciencedirect.com/science/article/abs/pii/S0016328707001693. (Accessed: January, 2018)

Forbes Magazine, 5 April, 2015. The Shale Report. [Online] Available: www.forbes.com. (Accessed: January, 2019)

Freeman, R.E., 2010. Strategic Management: A Stakeholder Approach. Cambridge University Press. [Online] Available at: https://books.google.co.za/books?hl=en&lr=&id=NpmA_qEiOpkC&oi=fnd&pg=PR5&dq=Freeman,+R.E.,+2010.+Strategic+Management:+A+Stakeholder+Approach.+Cambridge+University+Press.&ots=60jgG2N8RP&sig=ZKbbmDw7Ar7B0tKdBCzSwiPtce0#v=onepage&q=Freeman%2C%20R.E.%2C%202010.%20Strategic%20Management%3A%20A%20Stakeholder%20Approach.%20Cambridge%20University%20Press.&f=false

French, W. L., Bell, C., & Zawacki, R. A. (2006). Organization development and transformation: Managing Effective Change. New Delhi: Tata McGraw-Hill Education Private Ltd.

Friedman, T.L. 2000. New York Times, (September 2000) Foreign Affairs: The Secret Oil Talks by Thomas L. Friedman, Quote Page A27, Column 5, New York..

FTS International. (2015). Shale in China. [Online] Available: http://www.fts.com. (Accessed: June, 2018)

Gallopin, G.C., Hammond, A., Raskin, P. and Swart, R., 1997. Branch points: Global scenarios and human choice. SEI. Global Scenario Group, Stockholm Environment Institute.

Galtung, J., & Fischer, D. 2013. Johan Galtung, the Father of Peace Studies. Johan Galtung, 3-23. doi:10.1007/978-3-642-32481-9_1

Galtung, J., and Inayatullah, S. 1997. Macro history and Macrohistorians. Westport, Ct: Praeger [Online] Available: http://www.metafuture.org/Books/MacrohistoryandMacrohistorians.htm (Accessed September 2012).

Georgiev, A. (2016). Shale and Eastern Europe-Bulgaria, Romania, and Ukraine. The Global Impact of Unconventional Shale Gas Development, 75-96. doi:10.1007/978-3-319-31680-2_4

Gervais, B.K., Voirin, C.R., Beatty, C., Bulltail, G., Cowherd, S., Defrance, S., Dorame, B., Gutteriez, R., Lackey, J., Lupe, C. and Negrette, A.B., 2017. Native American student perspectives of challenges in natural resource higher education. Journal of Forestry, 115(5): 491-497.

Ghamari-Tabrizi, S. (2000). Kahn, Herman (1922-1983), civilian military strategist and futurologist. American National Biography doi:10.1093/anb/9780198606697 article.1302091.

Gharajedaghi, J., 2011. Systems thinking: Managing chaos and complexity: A platform for designing business architecture. [Online] Available: https://books.google.co.za/books?hl=en&lr=&id=b0g9AUVo2uUC&oi=fnd&pg=PP1&dq=Gharajedaghi,+J.,+2011.+Systems+thinking:+Managing+chaos+and+complexity:+A+platform+for+designing+business+architecture.&ots=CDYbVv9Hcv&sig=e3N8U5T56ZC59VGwCZ8NZEI4DjE#v=onepage&q=Gharajedaghi%2C%20J.%2C%202011.%20Systems%20thinking%3A%20Managing%20chaos%20and%20complexity%3A%20A%20platform%20for%20designing%20business%20architecture.&f=false. (Accessed: January, 2018).

Glazewski, J. 1994. (a) Natural Resource Management: Towards an effective legal regime.: Land and Agriculture Policy Centre. Johannesburg, South Africa [Online] Available: https://web.worldbank.org/archive/website00668/web/pdf/natural.pdf. (Accessed: June, 2019).

Glazewski, J. 1994. (b) The environment and the new interim constitution. South African Journal of Environmental Law and Policy, 1(1): 3-16.

Glazewski, J. 2016. Sustainable development and proposed shale gas extraction in South Africa: Prospects and Challenges. Shale Gas and the Future of Energy: 209-229. doi:10.4337/9781783476152.00022.

Glazewski, J. and Collier, D., 2012. South Africa's climate change. Climate Change Liability, Transnational law and practice: 319-347. [Online] Available: http://www.publiclaw.uct.ac.za/pbl/staff/jglazewski. (Accessed: June, 2019)

Glazewski, J., and Esterhuyse, S. 2016. Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives. Juta and Company (PTY) Ltd.

Glazewski, J., Esterhuyse, S. 2016. Introduction. In Glazewski, J., and Esterhuyse, S (ED). Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. p. 1-14. Claremont, South Africa. Juta and Company (PTY) Ltd.

Glazewski, J., Steenkamp, L. 2016. Revenue and Tax Policy Considerations. In Glazewski, J., and Esterhuyse, S. (ED) Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. p. 176-205. Claremont, South Africa. Juta and Company (PTY) Ltd.

Glazewski, J., & Collier, D. 2015 Exploring the Impact of Climate Change on Children in South Africa: 319-348. Pretoria: UNICEF South Africa. doi:10.1017/cbo9781139084383.017.

Gleeson, T., Wada, Y., Bierkens, M.F. and van Beek, L.P., 2012. Water balance of global aquifers revealed by groundwater footprint. Nature, 488(7410):197. [Online] Available: https://www.google.com/search?client=safari&rls=en&q=Gleeson,+T.,+Wada,+Y.,+Bierkens,+M.F.+and+van+Beek,+L.P.,+2012.+Water+balance+of+global+aquifers+revealed+by+groundwater+footprint&ie=UTF-8&oe=UTF-8

Glenn, J.C. and Gordon, T.J. eds., 1997. State of the Future. Washington DC: American Council for the United Nations [Online] Available at: University.https://www.researchgate.net/publication/223043061_The_Millennium_Project_Issues_and_Opportunities_for_the_Future

Global Risks (n.d.). An Introduction 1. Global Risks. doi:10.3726/978-3-653-00719-0/3

Gnatzy, T., Warth, J., von der Gracht, H. and Darkow, I.L., 2011. Validating an innovative Real-time Delphi approach. A methodological comparison between

Real-time and conventional Delphi studies. Technological Forecasting and Social Change, 78(9):1681-1694.

Gödeke, S. and Hossain, M. 2012. Simulation of Shale Gas Field Development: An Example from Western Australia. In SPE Middle East Unconventional Gas Conference and Exhibition. Society of Petroleum Engineers.

Godet, M. and Roubelat, F. 1996. Creating the future: the use and misuse of scenarios. Long Range Planning, 29(2): 164-171.

Godet, M., 2001. Creating futures. Economica. [Online] Available at: https://issuu.com/asap1/docs/creating_futures_scenario_planning__strategic_mana. (Accessed: June, 2018).

Godet, M., Durance, P. and Gerber, A. 2008. Strategic Foresight, La Prospective, use and misuse of scenario building. [Online] Available at: https://www.scribd.com/document/360636592/Godet-Durance-Gerber-2008-Strategic-Foresight-La-Prospective-Use-and-Misuse-of-Scenario-Building-pdf. (Accessed: June, 2016).

Goldman Sachs. 2018. Unconventional Gas [Online] Available at: http://www.goldmansachs.com. (Accessed: March, 2019).

Goldthau, A. and LaBelle, M., 2016. The power of policy regimes: explaining shale gas policy divergence in Bulgaria and Poland. Review of Policy Research, 33(6): 603-

Green, L.2016: What does it mean to require “Evidence-based Research” in Decision Making on Hydraulic Fracturing? In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd.p366 - 379

Graves, T. 2012. SCAN and Causal Layered Analysis. [Online] Available at: http://weblog.tetradian.com/2012/10/24/scan-and-causal-layered-analysis/ (Accessed: September 2012).

Gregory, J., Stocker, T., Lemke, P. and Bindoff, N., 2007. Climate Change 2007. The physical science basis. [Online] Available: https://scholar.google.com/citations?user=zKErnggAAAAJ&hl=en. (Accessed: June: 2018).

Grimble, R. and Wellard, K., 1997. Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities. Agricultural Systems, 55(2):173-193.

Guo, H., Wang, Y., & Wang, Z. 2016. Shale Development and China. The Global Impact of Unconventional Shale Gas Development: 131-147. doi:10.1007/978-3-319-31680-2_6.

Guo, L., Jiang, Z. and Liang, C., 2016. Mineralogy and shale gas potential of Lower Silurian organic-rich shale at the south eastern margin of Sichuan Basin, South China. Oil Shale 33(1): 1-18.

Guo, X., Li, Y., Li, J., Feng, M., & Duan, H. 2015. Discovery of Fuling Shale Gas Field and its prospects. Frontiers in Energy. doi:10.1007/s11708-018-0581-z

GWP. 2009. Global Water Partnership and International Network of Basin Organizations. A Handbook for Integrated Water Resources Management in Basins. [Online]Available: https://www.inbo-news.org/IMG/pdf/GWP-INBOHandbookForIWRMinBasins.pdf.

Hall, J., Giovannini, E., Morrone, A. and Ranuzzi, G., 2010. A framework to measure the progress of societies. [Online] Available: https://doi.org/10.1787/18152031. (Accessed: June, 2019).

Hall, R., 2004. A political economy of land reform in South Africa. Review of African Political Economy, 31(100): 213-227.

Hao, F., Zou, H. and Lu, Y., 2013. Mechanisms of shale gas storage: Implications for shale gas exploration in China Mechanisms of Shale Gas Storage. AAPG bulletin, 97(8): 1325-1346. doi:10.1306/02141312091

Harding, T. The Tragedy of the Commons. (1968). Science, 162(3859), 1243-1248. doi:10.1126/science.162.3859.1243

Harleman, M. and Weber, J.G., 2017. Natural resource ownership, financial gains, and governance: The case of unconventional gas development in the UK and the US. Energy policy, 111: 281-296. [Online] Available at: https://ideas.repec.org/a/eee/enepol/v111y2017icp281-296.html. (Accessed: June 2018).

Harman, G. (1976). Reply to Lisagor. Philosophical Studies, 29(6) 477-477. doi:10.1007/bf00646330.

Harman, W.W., 1976. An Incomplete Guide to the Future. The Portable Stanford. [Online] Available: https://www.abebooks.com/incomplete-guide-future-Portable-Stanford-series/30283677022/bd. (Accessed: November, 2018)

Harvey, G. 2013. Shale Gas: Green groups condemn methane flaring plans for wells. The Guardian. [Online] Available: https://www.theguardian.com/environment/2013/may/09/shale-gas-fracking-gas-flare

Hashem Pesaran, M., & Pesaran, B. (1989). Data-Fit. Applied Economics, 21(4) 567-568. doi:10.1080/758519720

Healy, M., & Healy, T. (2009). Introduction. Renaissance Transformations, 1-11. doi:10.3366/edinburgh/9780748638734.003.0001

Heijden, K., 2010. Scenarios: The Art of Strategic Conversation. London. John Wiley & Sons, Limited.

Hellier. UN Special Rapporteur: Human Rights to Water., L. (2017, June 20). Hellier 2018 Human rights to water [Video file]. [Online] Available at: https://www.youtube.com/results?search_query=Hellier+2018+Human+rights+to+water. (Accessed: June, 2018).

Herbst, J. and Mills, G., 2003.The African Development and Security Record. Adelphi Series, 43(361):11-27.

Hernández, P. 2009. Measuring Progress in a Globalized World. Measuring the progress of societies. Mexico: Scientific and Technological Consultative Forum.

Hertwich, E.G. and Peters, G.P., 2009. Carbon footprint of nations: A global, trade-linked analysis. Environmental Science & Technology, 43(16): 6414-6420.

Hess, H., Ausich, W.I., Brett, C.E. and Simms, M.J., 2002. Fossil Crinoids. Cambridge, New York, Melbourne. Cambridge University Press.

Hess, H., Hess, H., Ausich, W. I., Brett, C. E., & Simms, M. J. (n.d.). Lower Jurassic Posidonia Shale of Southern Germany. Fossil Crinoids: 183-196. doi:10.1017/cbo9780511626159.025

Hilson, G., 2002. Land use competition between small-and large-scale miners: a case study of Ghana. Land Use Policy, 19(2): 149-156.

Hjorth, P. and Bagheri, A., 2006. Navigating towards sustainable development: A system dynamics approach. Futures 38(1):74-92. https://www.semanticscholar.org/paper/Navigating-towards-sustainable-development%3A-A-Hjorth-Bagheri/b071ef9380416c0fcba32ceb10e8f3292fa8ab87

Holton, M. M., Gokulakrishnan, P., Klassen, M. S., Roby, R. J., & Jackson, G. S. (2009). Autoignition Delay Time Measurements of Methane, Ethane, and Propane Pure Fuels and Methane-Based Fuel Blends. IN Volume 2: Combustion, Fuels and Emissions. doi:10.1115/gt2009-59309

Honkonen, T. (2009). The Common but Differentiated Responsibility Principle in Multilateral Environmental Agreements: Regulatory and Policy Aspects. Alphen aan Den Rijn, Zuid Holland. Kluwer Law International B.V.

Honkonen, T., 2013. Challenges of mining policy and regulation in Central Asia: The case of the Kyrgyz Republic. Journal of Energy & Natural Resources Law, 31(1): 5-32.

Honkonen, T., 2017. Water security and climate change: The need for adaptive governance. Potchefstroom Electronic Law Journal. Potchefstroomse Elektroniese Regsblad, 20(1).

Hoontrakul, P. 2017. Asia's Economic Transformation in a Disruptive and Uncertain World. Economic Transformation and Business Opportunities in Asia: 1-32. doi:10.1007/978-3-319-58928-2_1.

Hoontrakul, P. 2018. Economic Transformation and Business Opportunities in Asia. doi:10.1007/978-3-319-58928-2

Horton, A., 1999. A simple guide to successful foresight. Foresight, 1(1): 5-9.

doi.org/10.1108/14636689910802052

Howarth, R. W. 2014. A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Energy Science & Engineering, 2(2): 47-60. doi:10.1002/ese3.35

Hu, S., Xiao, C., Jiang, X., & Liang, X. 2018. Potential Impact of In-Situ Oil Shale Exploitation on Aquifer System. Water, 10(5), 649. doi:10.3390/w10050649

Hubert, R. 1999. Fuel cells meet big business. The Economist, Section Business. Economist Group, London, England [Online] Available: https://www.economist.com/business/1999/07/22/fuel-cells-meet-big-business (Accessed: June, 2017).

IEA's Gas 2018 Medium Term Market Report and Global Gas Security Review, 2018. Columbia University Events Calendar [Online] Available at: https://events.columbia.edu/cal/event/showEventMore.rdo;jsessionid=8419349F29EC80D.

IFS, International. [Online] Available: www.ifs.com. Accessed 12 December 2017.

Ilbury, C and Sunter, C. 2009. The South African Scenarios. In Developing [Online] Available: http://www.ajol.info/index.php/wsa/article/viewFile/87919/77568 (Accessed: September, 2012).

Inayatullah, S. 1986. The adaptive corporation. Futures, 18(1): 102-105. doi:10.1016/0016-3287(86)90068-6

Inayatullah, S. 1997. Future generations thinking1. Futures, 29(8): 701-706. doi:10.1016/s0016-3287(97)00049-9

Inayatullah, S. 2000. Deconstructing the year 2000. Futures, 32(6), I. doi:10.1016/s0016-3287(00)00032-x

Inayatullah, S., & Milojevic, I. 2000. Metafuture.org: Futures studies. Maroochydore, DC Qld: Sohail Inayatullah and Ivana Milojevic.

Inayatullah, S. 2001. The Views of Futurists, Vol 4 of the Knowledge Base of Futures Studies, CD-ROM. Foresight International, Brisbane.

Inayatullah, S. 2004. Causal layered analysis: Theory, historical context, and case studies. In The causal layered analysis reader: Theory and case studies of an integrative and transformative methodology:1-52. Tamkang University Press.

Inayatullah, S. 2004. The causal layered analysis (CLA) reader: Theory and case studies of an integrative and transformative methodology. Taipei: Tamkang University Press.

Inayatullah, S. 2004. The causal layered analysis (CLA) reader: Theory and case studies of an integrative and transformative methodology. Taipei: Tamkang University Press.

Inayatuallah, S. 2007. Questioning the future: Methods and tools for organizational and societal transformation. Taipei, Taiwan: Tamkang University.

Inayatullah, S. 2008. Six pillars: Futures thinking for transforming. Foresight, 10(1): 4-21.

Inayatullah, S., 2009. Causal layered analysis: An integrative and transformative theory and method. Futures Research Methodology, Version, 3.

Inayatullah, S. Causal Layered Analysis. At TEDx Noosa, S. (2013, May 12). YouTube [Video file]. [Online] Available: https://www.youtube.com/watch?v=ImWDmFPfifI&t=307s. (Accessed: June 2018).

Inayatullah: Introduction to Futures Thinking. Excerpts from Speeches and Interviews, S. (2012, January 30). YouTube [Video file]. [Online] Available: https://www.youtube.com/watch?v=L5MJ_APlLc4

Inayatullah: At TEDx Noosa, S. 2013. YouTube [Video file]. 12 June 2013. [Online] Available at: https://www.youtube.com/watch?v=ImWDmFPfifI&t=307s. (Accessed: June 2018).

Inayatullah, S. 2015. What works: Case Studies in the Practice of Foresight. Taipei: Tamkang University Press.

Inayatullah, S. and Milojevic, I., 2015. CLA 2.0: Transformative Research in Theory and Practice. Taipei: Tamkang University Press.

Inayatullah, S. Future in the Making. FTA 2018, S. 5 August 2018. YouTube [Video file]. [Online] Available at: https://youtu.be/Qc_rNQNg8is. (Accessed: June 2018)

Inayatullah, S. Future with Sohail Inayatullah. DBTV, Live., S., & Parisey Tariq. 2019. (22 May 2018,). YouTube [Video file]. [Online] Available: https://www.youtube.com/watch?v=voUb9-XvWIw. (Accessed: June 2019).

Industrial Development Corporation (IDC). 2013. South African Economy: An overview of key trends since 1994. Department of Research and Information. December. [Online] Available at: www.idc.co.za/.../IDC%20R&I%20publication%20-(Accessed August 2014).

Industrial Development Corporation (IDC). 2015. Economic Overview – Recent developments in the global and South African economies. Department of Research and Information, 10 February. [Online] Available at: http://www.idc.co.za/images/download-files/economic-overviews/economic. (Accessed August 2014).

Ingle, M. and Atkinson, D., 2015. Can the circle be squared? An enquiry into shale gas mining in South Africa's Karoo. Development Southern Africa, 32(5): 539-554.

Intergovernmental Panel on Climate Change. 2015. Good practice guidance and uncertainty management in National Greenhouse Gas Inventories. Montreal [Online] Available at: http://www.ipcc- nggip.iges.or.jp/public/gp/english/ (Accessed October 2017).

International Atomic Energy Agency. (2016). Fukushima Nuclear Accident [Online] Available at: https://www.iaea.org/newscenter/focus/fukushima (Accessed: June, 2017).

International Energy Agency (IEA). 2011. World Energy Outlook. November. IEA Publications. Paris: Soregraph.

International Energy Agency. 2012. [Online] Available at http://iea.org. (Accessed: June, 2016).

International Institute for Sustainable Development (IISD). 2002. Learning from the Future: Alternative Scenarios for the North American Mining and Minerals Industry. [Online] Available at: http://www.iisd.org/pdf/2002/mmsd_scenarios.pdf. (Accessed August 2014).

International Monetary Fund (IMF). 2015. Global growth revised down, despite cheaper oil, faster US growth. World Economic Outlook Update. IMF Survey Magazine, 20 January. [Online] Available at: www.imf.org/external/pubs/ft/survey/so/2015/NEW012015A.htm (Accessed May 20160).

International Monetary Fund. 2018. World Economic Outlook: Challenges to Steady Growth. Chinese Demand for GAS. [Online] Available at: http://www.imf.org. (Accessed: June 2018). https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=2ahUKEwi95bLJ5b7nAhXkrnEKHeapDiQQFjAEegQIBhAB&url=https%3A%2F%2Fwww.imf.org%2F~%2Fmedia%2FFiles%2FPublications%2FWEO%2F2018%2FOctober%2FEnglish%2Fmain-report%2Fc1.ashx&usg=AOvVaw3weIxPo-hSJHcN4_toxSYf

International Renewable Energy Agency (IRENA). (n.d.). Renewable Energy options for the Industry Sector: Global and Regional Potential until 2030. [Online] Available at:https://irena.org/-/media/Files/IRENA/Agency/Articles/2016/Nov/IRENA_RE_Potential_for_Industry_BP_2015.pdf?la=en&hash=1214D8FDBD507297FC61073DACE78F8F31927663. (Accessed May, 2016).

International Water Management Institute (IWMI). 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. [Online] Available at: http://www.iwmi.cgiar.org/assessment/files_new/synthesis/Summary_SynthesisBook. pdf Accessed: 14 October 2014. Introduction – a research agenda for shale gas in the European Union. (n.d.). Regulating Shale Gas, 1-18. doi:10.4337/9781786433190.00010 (Accessed October 2014).

Introduction – A research agenda for shale gas in the European Union. (n.d.). Regulating Shale Gas, 1-18. doi:10.4337/9781786433190.00010

Investec Wealth Bank. 2016. [Online] Available: http://investec.com. (Accessed: June 2017.

Issifu, A. K. 2014. Ethnic conflicts occur when a particular set of factors and conditions converge: The Dagbon Conflict in Northern Ghana. [Online] Available at: https://www.scribd.com/doc/250683117/ethnic-conflict-occur-when-a-particular-ethnic-conflicts-occurs-when-a-particular-set-of-factors-and-conditions-converge-the-dagbon-conflict-in-northern-ghana (Accessed October 2014).

Jackson, 2000. Rematerializing social and cultural geography. Department of Geography, University of Sheffield, Sheffield S10 2TN, UK [Online] Available at: http://www.geo.ntnu.edu.tw/faculty/moise/words/information/social/social%20geogra phy%20theory/rematerializing%20social%20and%20cultural%20geography.pdf (Accessed: November 2012).

Jackson, R. B., Osborn, S. G., Vengosh, A., & Warner, N. R. 2011. Reply to Davies: Hydraulic fracturing remains a possible mechanism for observed methane contamination of drinking water. Proceedings of the National Academy of Sciences, 108(43), E872-E872. doi:10.1073/pnas.1113768108.

Jackson, R.B., Vengosh, A., Darrah, T.H., Warner, N.R., Down, A., Poreda, R.J., Osborn, S.G., Zhao, K. and Karr, J.D., 2013. Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction. Proceedings of the National Academy of Sciences, 110(28):11250-11255.

Jarvie, D. M. 2015. Geochemical Assessment of Unconventional Shale Gas Resource Systems. Fundamentals of Gas Shale Reservoirs: 47-69. doi: 10.1002/9781119039228.ch3

Jenner, S. and Lamadrid, A.J. 2013. Shale Gas vs. Coal: Policy Implications from environmental impact comparisons of shale gas, conventional gas, and coal on air, water, and land in the United States. Energy Policy, 53: 442-453.

Jordan, A., D. Huitema, H. van Asselt, T. Rayner and F. Berkhout (Eds.) 2010.Climate Change Policy in the European Union: Confronting the Dilemmas of Mitigation and Adaptation? Cambridge, UK: Cambridge University Press: 284.

Kahn, H., & Wheeler, J. W. 1980. The great modernization. Futures, 12(1): 67-71. doi:10.1016/s0016-3287(80)80009-7.

Kaplan, D. 2005. Rethinking Government Support for Business Sector R&D in South Africa. A Case for Tax Incentives. South African Journal of Economics, 69(1): 72-92. doi:10.1111/j.1813-6982.2001. tb00003. x.

Kapros, Z. 2016. The Reference PV Power Plant-Based Method. Proceedings of the ISES Solar World Congress 2015. doi:10.18086/swc.2015.05.25.

Keeler, J. T. 2016. The Politics of Shale Gas and Anti-Fracking Movements in France and the UK. The Global Impact of Unconventional Shale Gas Development: 43-74. doi:10.1007/978-3-319-31680-2_3.

Kendie, S. B. 1992. Survey of water use behaviour in rural North Ghana. Natural Resources Forum, 16(2):126-131. doi:10.1111/j.1477-8947. 1992.tb00558. x.

Kendie, S.B., 2010. Conflict management and peace building for poverty reduction. Proceedings of the 2010 Harmattan School, GILLBT Press, Tamale.

Khan, M. J. 2011. The BRICS and South Africa as the gateway to Africa. The Journal of the Southern African Institute of Mining and Metallurgy, 111(7): 493-496.

Kidder, R.M., 1992. Ethics: A matter of survival. The Futurist, 26(2):10. [Online] Available at: https://usm.maine.edu/sites/default/files/core/How%20Good%20People%20Make%20Tough%20Choices-Kidder%20chapter1.pdf

Kiggudu, M. 1989. Managing organizations in developing countries: An operational and strategic approach Moses Kiggundu Kumarian Press, West Hartford, Connecticut, :187-187. doi:10.1002/pad.4230110209.

Kinnaman, T. C. 2011. The economic impact of shale gas extraction: A review of existing studies. Ecological Economics, 70(7): 1243-1249. doi: 10.1016/j.ecolecon.2011.02.005.

Kijko, A., Kahle, B., Smit, A., Esterhuyse, S and Glazewski, J. 2016. Book Chapter 13: 264-278. Hydraulic Fracturing, Wastewater Pumping and Seismicity. In

Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd.

Kleynhans, C. J., Moolman, J., Reyers, B., Cowling, R. M. 2007. Rivers in peril inside and outside protected areas: a systematic approach to conservation assessment of river ecosystems. Diversity and Distributions, 13(3): 341-352. [Online] Available at: doi:10.1111/j.1472-4642.2007.00308. x.

Koester, V. 2016. Shale Gas in Germany: Game Changer or Risky Technology. ChemViews. doi:10.1002/chemv.201600011.

Kohler, P.M., Conliffe, A., Jungcurt, S., Gutierrez, M. and Yamineva, Y., 2012. Informing Policy. The Roads from Rio: Lessons Learned from Twenty Years of Multilateral Environmental Negotiations. [Online] Available at: http://publications.iass-potsdam.de/pubman/item/escidoc:1669889

Kosow, H. and Gaßner, R., 2008. Methods of future and scenario analysis: overview, assessment, and selection criteria. Vol. 39:133. Deutschland. [Online] Available at: https://www.google.com/search?client=safari&rls=en&q=Kosow,+H.+and+Gaßner,+R.,+2008.+Methods+of+future+and+scenario+analysis:+overview,+assessment,+and+selection+criteria.+Vol.+39:133.+Deutschland.&ie=UTF-8&oe=UTF-8

Krawczyk, E., 2008. Futures methods and techniques. [Online] Available at: http://www.thefuturesacademy.ie/methods. (Accessed November 2015).

Kreibich, R., Oertel, B. and Wolk, M., 2011. [Online] Available: Futures studies and future-oriented technology analysis principles, methodology and research questions. (Accessed June, 2015).

Kretsinger Grabert, V., Kaback, D. S., Briskin, J., Brantley, S. L., Darrah, T. H., Jackson, R. B., … Poreda, R. J. (2014). News & Views. Groundwater, 53(1), 19-28. doi:10.1111/gwat.12307.

Krupnick, A., & Wang, Z. 2014. Introduction to Special Issue: Current Energy Issues in China. Energy Policy, 75, 107-108. doi: 10.1016/j.enpol.2014.09.012.

Krupnick, A., Wang, Z. and Wang, Y., 2014. Environmental risks of shale gas development in China. Energy Policy: 117-125.

Kulovesi, K., Romppanen, S. and Yamineva, Y., 2016. Introduction to Climate Law’s Special Issue on Renewable-Energy Law. Climate Law, 6(3-4): 227-231.

Kuokkanen, T. and Yamineva, Y., 2013. Regulating geo-engineering in International environmental law. CCLR: 161.

Kuokkanen, T., Couzens, E., Honkonen, T. and Lewis, M. eds., 2016. International Environmental Law-making and Diplomacy: Insights and Overviews. Routledge.

Laing, E. 2013. Legitimate Expectation. Judicial Review, 18(2):153-166. doi:10.5235/10854681.18.2.153.

Lall, S. V., Henderson, J. V., & Venables, A. J. 2017. Africa's Cities: Opening Doors to the World. doi:10.1596/978-1-4648-1044-2.

Lasswell, H. D. 1958. Men in Space. Annals of the New York Academy of Sciences, 72(4): 180-194. doi:10.1111/j.1749-6632. 1958.tb32304.x

Lawson-Remer, T. 2012. Property Rights, Growth, and Conflict. SSRN Electronic Journal. doi:10.2139/ssrn.2000036 (February 6, 2012).

Lawson, K., Daalder, H., Hahn, W. G., Hrebenar, R. J., Remmer, K. L., Seymour, J. D., & Ware, A. 1990. Political Parties: Inside and out. Comparative Politics, 23(1), 105. doi:10.2307/422307

Lee, S. 2012. Shale Oil from Oil Shale. Handbook of Alternative Fuel Technologies, 223-296. doi: 10.1201/9781420014518.ch8

Legislative History of the Federal Oil and Gas Royalty Management Act of 1982 P.L. 97-451. 1983.

Lewis, A, McMichael, L., and Glazewski, J. 2016. Book Chapter 12: 222-244. Water Quality, Fracking Fluids and Legal Disclosure. In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd.

Lindgren, M., & Bandhold, H. 2009. Scenario Planning - Revised and Updated Edition. doi:10.1057/9780230233584

Linol, B., De Wit, M. J., & Schulz, H. 2017. Unconventional Shale Gas Development in South Africa: Possible Technically Recoverable Volumes in the Southern Karoo Basin. doi:10.1130/abs/2017am-299937

Liu, J., Liang, W., Kang, Z., Lian, H. and Geng, Y., 2018. Study on the Quantitative Models of Oil Shale Porosity in the Pyrolysis process based pyrolysis kinetics. Oil Shale, 35(2).

Loures, F.R. and Rieu-Clarke, A. eds., 2013. The UN watercourses convention in force: strengthening international law for transboundary water management. Routledge.

Lutz, D. S., Ames, F., Ames, S., & Allen, W. B. (1985). Works of Fisher Ames. CrossRef Listing of Deleted DOIs, 15(2): 117. doi:10.2307/3329971

Lv, D., Li, Z., Liu, H., Li, Y., Feng, T., Wang, D., Wang, P. and Li, S., 2015. The characteristics of coal and oil shale in the coastal sea areas of Huangxian Coalfield, Eastern China. Oil Shale, 32(3): 204-218.

McElroy, J.C., 2010. HR environment and regional attraction: An empirical study of industrial clusters in China. Australian Journal of Management, 35(3): 245-263. https://doi.org/10.1177%2F0312896210384679

Magsig, B.O., 2011. Overcoming state-centrism in international water law: Regional common concern as the normative foundation of water security. Goettingen J. Int'l L., 3: 317.

Mail and Guardian. 2018. [Online] Available: http://www.m&g.co.za. 12 May 2018. (Accessed: June, 2019).

Mangaliso, M. P. 2001. Building Competitive Advantage from Ubuntu: Management Lessons from South Africa. SSRN Electronic Journal. doi:10.2139/ssrn.1762783

Mangaliso, M. P. (n.d.). Ubuntu as essential inspiration for more humanistic organizational management. Routledge Handbook of Organizational Change in Africa: 80-101. doi:10.4324/9781315630113-6.

Manzi, M., Scheiber-Enslin, S., Webb, S. 2016. Seismic imaging of dolerite sills in the Karoo Basin, with implications for shale gas potential. In Origin and Evolution of the Cape Mountains and Karoo Basin: 17-26. Springer, Cham.

Masini, E. B. 1989. The future of futures studies. Futures, 21(2):152-160. doi:10.1016/0016-3287(89)90003-7.

Mason, L.M., Lederwasch, A.J., Daly, J.G., Prior, T.D., Buckley, A., Hoath, A. and Giurco, D., 2011. Vision 2040: Mining, minerals and innovation-A vision for Australia's mineral future.

Masondo, S. 2011. SA farm exodus shock. Timeslive. [Online] Available at: http://www.timeslive.co.za/local/article1001783.ece/SA-farm-exodus-shock (Accessed: February 2012).

Matola, M. 2012. BRICS gives a boost to brand South Africa. [Online] Available at: http://www.reconnectafrica.com/June-2011/africa/brics-gives-a-boost-to-brand-south- africa.html. (Accessed: February 2012).

Maugeri, L. 2006. The Age of Oil: The Mythology, History, and Future of the World's Most Controversial Resource. Portsmouth: Greenwood Publishing Group, Incorporated.

Maugeri, L. 2010. Beyond the age of oil: The myths, realities, and future of fossil fuels and their alternatives. Santa Barbara, CA: Praeger. [Online] Available at https://www.belfercenter.org/publication/shale-oil-boom-us-phenomenon. (Accessed: June, 2014).

Maugeri, L., & Belfer Center for Science and International Affairs. 2012. Oil: The next revolution, the unprecedented upsurge of oil production capacity and what it means for the world. Cambridge, MA: Harvard Kennedy School, Belfer Center for Science and International Affairs.

Maugeri, L. 2012 Shale Oil Belfer Center for Science and International Affairs, Harvard Kennedy School of Government, Harvard University, June 2012. [Online Available at:https://www.belfercenter.org/publication/oil-next-revolution (Accessed: May, 2017).

Maugeri, L., 2012. Oil: the next revolution. Belfer Center for Science and International Affairs Discussion Paper. [Online] Available https://www.belfercenter.org/publication/oil-next-revolution. (Accessed: June, 2016).

Maugeri, L., and Belfer Center for Science and International Affairs., 2013. The shale oil boom: A U.S. phenomenon. [Online] Available at: https://www.belfercenter.org/. (Accessed March 2015).

McCaffrey, S.C. 2019. The law of international watercourses. Oxford University Press. [Online] Available: https://global.oup.com/academic/product/the-law-of-international-watercourses-9780198736929?cc=za&lang=en&. (Accessed: July, 2018).

McIntyre, O., 2012. The human right to water as a creature of global administrative law. Water international, 37(6): 654-669. [Online] Available: https://doi.org/10.1080/02508060.2012.710948

McIntyre, O., 2016. Environmental Protection of International Watercourses under International Law. Routledge.

Michelle Energy Resources Limited. 2015. [Online] Available at: http://michellenergy.com. (Accessed: May, 20150

Milojević, I., & Inayatullah, S. 2015. Narrative foresight. Futures, 73: 151-162. doi: 10.1016/j.futures.2015.08.007

Mitra, A., & Nagar, J. P. 2015. Cities and Towns in India: Judging the Quality of Urbanisation. SSRN Electronic Journal. doi:10.2139/ssrn.2924192

Mitra, A. and Nagar, J.P., 2018. City size, deprivation and other indicators of development: Evidence from India. World Development, 106: 273-283. doi:10.2139/ssrn.2924192

Moll, P., 1996. The thirst for certainty: futures studies in Europe and the United States. The knowledge base of Futures Studies, 1: 15-29. [Online] Available: http://master-foresight-innovation.fr/wp-content/uploads/2012/06/PMollThirstforCertainty.pdf. (Accessed: June, 2017)

Moncel, R. and van Asselt, H., 2012. All hands-on deck! Mobilizing climate change action beyond the UNFCCC. Review of European Community & International Environmental Law, 21(3): 163-176.

Moonaw, E. 2011. Our Hunger for Energy. Renewable Energy and Climate Change: 1-23. doi: 10.1002/9781119994381.ch1

Morales Velasco, C., McVay, D., & Lee, J. 2014. Assessment of the Mexican Eagle Ford Shale Oil and Gas Resources. SPE Unconventional Resources Conference. doi:10.2118/168983-ms

Morgera, E. and Razzaque, J. eds., 2017. Biodiversity and Nature Protection Law (Vol. 3). Edward Elgar Publishing.

Morkel, B., & De Witt, M. (n.d.). South Africa. The Shale Dilemma: 342-378. doi:10.2307/j.ctv75d8x4.13

Moualiem, C. 2013. Shale Gas Exploration in Brazil. 20, September, 2013. Curitaba In English [Curitaba]. [Online] Available at: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0370-44672014000400004.9(Accessed: May , 2017)

Murthi, S. 2019. Access to Safe Water and Sanitation. A human and Civil Rights Perspective. Duke University, S. (n.d.). YouTube [Video file]. [Online] Available: https://youtu.be/Hd4qQbmtK1c. (Accessed: December, 2019)

Naidoo, B. 2008. Challenge is to turn resources to account for broad national benefit, says Godsell. Mining Weekly. 7 March. [Online] Available at : http://www.miningweekly.com/article/challenge-is-to-turn-resources-to-account-for- broad-national-benefit-says-godsell-2008-03-07-1. (Accessed June 2015).

Nanocarbons for Advanced Energy Storage., 2015. [Online] Available at: http://staff.ustc.edu.cn/~zhuyanwu/paper/2015/10.pdf (Accessed June 2015).

National Planning Commission, 2012. National Development Plan 2030: Our future– Make it work: Executive summary. [Online] Available: www.gov.za. (Accessed: June, 2017)

Natural gas market outlook. (2013). World Energy Outlook 2013: 99-138. doi:10.1787/weo-2013-6-en. [Online] Available at: http://www.natural gas world.com. (Accessed: May 2013).

Nazarenko, M. Y., Kondrasheva, N. K., & Saltykova, S. N. 2016. Prospects for oil shale mining and multipurpose use in Russia. Gornyi Zhurnal: 36-38. doi:10.17580/gzh.2016.02.07

Nel, A.E., Mädler, L., Velegol, D., Xia, T., Hoek, E.M., Somasundaran, P., Klaessig, F., Castranova, V. and Thompson, M., 2009. Understanding bio physicochemical interactions at the Nano–bio interface. Nature materials, 8(7): 543. [Online] Available at: https://pennstate.pure.elsevier.com/en/publications/understanding-biophysicochemical-interactions-at-the-nano-bio-int. (Accessed: June, 2016).

Nel, E. & Hill, T. 2008. Marginalisation and demographic change in the semi-arid Karoo, South Africa. Journal of Arid Environments, 72(12): 2264-2274.

Nell, J.H., 1999. Utilising scenario planning in formulating the strategic marketing plan in the commercial vehicle market sector in South Africa (Unpublished Doctoral dissertation, University of Johannesburg).

Newell, P., & Johnstone, P. (n.d.). The Political Economy of Incumbency. The Politics of Fossil Fuel Subsidies and their Reform, 66-80. doi:10.1017/9781108241946.006.

Newman, J. and Choo, B.S. eds., 2003. Advanced concrete technology set. Elsevier. [Online] Available at: https://books.google.co.za/books?hl=en&lr=&id=wTqMFyczxngC&oi=fnd&pg=PP1&dq=Newman,+J.+and+Choo,+B.S.+eds.,+2003.+Advanced+concrete+technology+set.+Elsevier&ots=8iIxq5AD8j&sig=t1ODt854G5SvNN5qGQIZ7PxqSio#v=onepage&q=Newman%2C%20J.%20and%20Choo%2C%20B.S.%20eds.%2C%202003.%20Advanced%20concrete%20technology%20set.%20Elsevier&f=false. (Accessed: June, 2017).

News 24, Africa. [Online] Available at: http:/www.news24.com. (Accessed: May, 2018).

Nikiforov, O. N. 2016. Shale Gas Production in Germany: Ecology and Political Aspects. The Handbook of Environmental Chemistry, 57-65. doi:10.1007/698_2016_61.

Norgaard, R. Ecological Economics and Sustainable Development. Science.67 (3), 384–393. [Online] Available: https://www.sciencedirect.com/jou rnal/ecological-economics/vol/67/issue/3 (Accessed May 2016).

Oberholster, J.H., 2014. The development of a financing model for agricultural production in South Africa. Nelson Mandela University,

Objectives and shale gas. (n.d.). Shale Gas, the Environment and Energy Security, 179-200. doi:10.4337/9781786433176.00012

Oborn, I., Magnusson, U., Bengtsson, J., Vrede, K., Fahlbeck, E., Jensen, E.S., Westin, C., Jansson, T., Hedenus, F., Lindholm Schulz, H. and Stenström, M., 2011. Five scenarios for 2050: conditions for agriculture and land use. Swedish University Agriculture Science, Uppsala.

OECD, 2011. Towards Green Growth: A summary for policy makers. [Online] Available at: www.OECD.org. (Accessed: July, 2012).

OECD. Greenhouse Gas Emissions: Climate Change. 2013. doi:10.1787/9789264186217-13-en.

OECD, 2017 Environment Statistics. Fossil fuel support: South Africa (Edition 2017). [Online] Available: http://www.oecd.org/environment/support-to-fossil-fuels-remains-high-and-the-time-is-ripe-for-change.htm (Accessed July 2012).

Oil and Gas Financial Journal. 2013. [Online] Available: http://www.ogfj.com. (Accessed: June, 2017).

Oleas, A., Osuji, C. E., Chenevert, M. E., & Sharma, M. M. 2008. Entrance Pressure of Oil Based Mud into Shale: Effect of Shale Water Activity and Mud Properties. SPE Annual Technical Conference and Exhibition. doi:10.2118/116364-ms.

Olsson, P. A. 2002. Journal of Applied Psychoanalytic Studies, 4(4), 465-468. doi:10.1023/a:1020348416903.

Onyango, R., 2018. Information resources and technology transfer management in developing countries. Routledge.

Organisation Development International. 2015. [Online] Available at: http://www.odi.co.za. (Excessed: June, 2017).

Ortmann, G.F. and King, R.P., 2007. Agricultural cooperatives II: can they facilitate access of small-scale farmers in South Africa to input and product markets? Agrekon, 46(2): 219-244.

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge, England: Cambridge University Press.

Ouma-Onyango, R. 2018. Research Methodology Considerations. Information Resources and Technology Transfer Management in Developing Countries: 71-79. doi:10.4324/9781351131230-7

Oyeniyi, A., 2011. Conflict and violence in Africa: Causes, sources and types. Transcent Media Service.

Palz, W. 2013. PV photovoltaics Policies photovoltaic (PV) policies and Markets photovoltaic (PV) market. Solar Energy: 212-225. doi:10.1007/978-1-4614-5806-7_458.

Panther, W. 1984. An introduction to development planning in the third world. Diana Conyers and Peter Hill. Wiley, Chichester, 1984: 271 Public Administration and Development, 4(4), 389-389. doi:10.1002/pad.4230040416.

Penn State Extension. 2016. [Online] Available at: http://www.extension.psu.edu. (Accessed: June, 2018)

Pesaran, B. and Pesaran, M.H., 2010. Conditional volatility and correlations of weekly returns and the VaR analysis of 2008 stock market crash. Economic Modelling, 27(6),:1398-1416.

Pesaran, M., & Pesaran, B., 1989. Data-Fit. Applied Economics, 21(4), 567-568.

Pieter Vermeulen. 2008. The Future of Possibility. Postmodern Culture, 18(2). doi:10.1353/pmc.0.0013.

Pieter Vermeulen. 2012. The Future of Possibility. Postmodern Culture, 18(2). doi:10.1353/pmc.0.0013.

Pizmony-Levy, O. 2011. Bridging the Global and Local in Understanding Curricula Scripts: The Case of Environmental Education. Comparative Education Review, 55(4), 600-633. doi:10.1086/661632.

Plata, D. L., Jackson, R. B., Vengosh, A., & Mouser, P. J. (2019). More than a decade of hydraulic fracturing and horizontal drilling research. Environmental Science: Processes & Impacts, 21(2), 193-194. doi:10.1039/c9em90004g.

Pondy, L. R. 1966. A Systems Theory of Organizational Conflict. Academy of Management Journal, 9(3), 246-256. doi:10.5465/255122.

Pondy, L. R., Fitzgibbons, D. E., & Wagner, J. A. 1980. Organizational power and conflict: a bibliography. [Online] Available at: http://intimidationrituals.org/Literature.html. (Accessed: July, 2019)

Porter, Alastair Michael Douglas. 2013 Strategic Analysis Tools BMJ, 347(jul11 7), f3979-f3979. doi:10.1136/bmj. f3979.

PricewaterhouseCoopers. 2014. Are you still in the race? Agribusiness Insights Survey 2012. [Online] Available: www.pwc.co.za/agri-business. (Accessed April 2014).

Qian*, K., Zhang, F., Zhang, H., & Li, X. 2015. Pore aspect ratio inversion and Clay lamination evaluation based on a shale rock physics model — a shale case study from Southwest China. SEG Technical Program Expanded Abstracts 2015. doi:10.1190/segam2015-5834218.1.

Qingxiong Weng, & McElroy, J. C. 2010. HR environment and regional attraction: An empirical study of industrial clusters in China. Australian Journal of Management, 35(3), 245-263. doi:10.1177/0312896210384679.

Ramos, J.M., 2015. Transcendence of a Method: The story of causal layered analysis. In CLA (Vol. 2).

Raskin, P., Monks, F., Ribeiro, T. and van Vuuren, D., 2005. Global Scenarios in Historical Perspective Ecosystems and Human Well-Being: Scenarios-Findings of the Scenarios Working Group Millennium Ecosystem Assessment Series Ed S Carpenter, P Pingali, E Bennett and M Zurek.

Reed, K.K., 2009. A Look at Firm-Regulator Exchanges: Friendly Enough or Too Friendly? Business & Society, 48(2): 147-178.

Regenesis Consulting Group. 2012. [Online] Available at: http://www.regensisgroup.com. (Accessed: August, 2016).

Renewable Energy - IRENA Report. 2015. Africa Research Bulletin: Economic, Financial and Technical Series, 52(9), 21010B-21010B. doi:10.1111/j.1467-6346.2015.06695. x.

Reuter News Agency. 2011. [Online] Available at: http://www.reuters.com. (Accessed: June, 2016).

Reuters Africa. (n.d.). African Studies Companion [Online] Available at: https://www.reuters.com/article/us-europe-migrants-slave-special-report-idUSKCN10T137. (Accessed April 2014).

Reuters Africa. (n.d.). African Studies Companion Online available at. doi:10.1163/1872-9037_afco_asc_2926a

Rieu-Clarke, A., Moynihan, R. and Magsig, B.O., 2012. UN Watercourses convention user's guide. IHP-HELP Centre for Water Law, Policy and Sciences (under the auspices of UNESCO).

Rittel, H. W., & Webber, M. M. 1973. Dilemmas in a general theory of planning. Policy Sciences, 4(2), 155-169. doi:10.1007/bf01405730.

Rojas, G.A. and Iza, A.O., 2011. Governance of shared waters: Legal and institutional issues. IUCN, in collaboration with the IUCN Environmental Law Centre, Bonn, Germany.

Romppanen, S. 2017. What Goes Around, Comes Around - A Legal Analysis of the Rules Concerning LULUCF. The Finnish Journal of Environmental Law.

Rosenzweig, R., & Horton, J. O. 1999. Interviews with Exemplary Teachers: James O. Horton. The History Teacher, 33(1), 97. doi:10.2307/495004.

Royal Society Report UK. 2017. [Online] Available at: http://royalsocietyreport.org. (Accessed: June, 2019).

Sadler, B. and Dalal-Clayton, D.B., 2012. Strategic environmental assessment: a sourcebook and reference guide to international experience. Earthscan.

Sairinen, R., Tiainen, H. and Mononen, T., 2017. Talvivaara mine and water pollution: An analysis of mining conflict in Finland. The Extractive Industries and Society, 4(3): 640-651.

Salameh, M. G. 2004. Oil Crises, Historical Perspective. Encyclopedia of Energy: 633-648. doi:10.1016/b0-12-176480-x/00027-9.

Salameh, M. G. 2013. The United States' Shale Oil Revolution in Perspective. SSRN Electronic Journal. doi:10.2139/ssrn.2201990.

Salameh, M.G. 2014. Report on OPEC. [Online] Available: https://www.youtube.com/watch?v=496VbYGcC1I. (Accessed: May, 2019).

Salameh, M.G., 2015 Oil crises, historical perspective. [Online] Available at: www.iaeee.org.(Accessed: July, 2018)

Salameh. M.G., (2016) Interview with Newsweek. Salameh, M.G., (2015) Oil crises, historical perspective. [Online] Available at:

https://www.youtube.com/watch?v=XTKzfhHUANE. (Accessed: August, 2019)

Saul, J.S. and Bond, P., 2014. South Africa--the Present as History: From Mrs Ples to Mandela & Marikana. Boydell & Brewer Ltd.

Schmeier, S., 2012. Governing international watercourses: river basin organizations and the sustainable governance of internationally shared rivers and lakes. Routledge. London.

Scholes, M., Scholes, R.B. and Lucas, M., 2015. Climate Change: Briefings from Southern Africa. NYU Press.

Schreiner, G. O., & Snyman-Van Der Walt, L. (2018). Risk modelling of shale gas development scenarios in the central Karoo. International Journal of Sustainable Development and Planning, 13(02), 294-306. doi:10.2495/sdp-v13-n2-294-306.

Schueler, V., Kuemmerle, T. and Schröder, H., 2011. Impacts of surface gold mining on land use systems in Western Ghana. Ambio, 40(5): 528-539.

Schwartz, G. and Clements, B., 1999. Government subsidies. Journal of Economic Surveys, 13(2): 119-148.

Schwartz, J. and Schulman. J, 2012. Towards Freedom: Democratic Socialist Theory and Practice [Online] Available at: http://www.dsausa.org/toward_freedom (Accessed May 2013).

Schwartz, P., 1991. The art of the long view: planning for the future in an uncertain world. New York: Doubleday. [Online] Available at: http://books.google.co.za/books/about/The_Art_of_the_Long_View.html?id=Ez OvAA AACAAJ&rediesc=y (Accessed May 2013).

SEA on Unconventional Gas Extraction in the Karoo, South Africa. [Online] Available at: http://csir.org. (Accessed: February, 2019).

Senge, P., 1990. The Fifth Discipline. The Art and Practice of the Learning Organization. New York: Bantam Doubleday Dell Publishing Group.

Sewankambo, N. K., Gray, R. H., Ahmad, S., Serwadda, D., Wabwire-Mangen, F., Nalugoda, F.,Wawer, M. J. 2016. Mortality associated with HIV infection in rural Rakai District, Uganda. AIDS, 14(15), 2391-2400. doi:10.1097/00002030-200010200-00021.

Sezen, B. (2019, January 1). Scenario Artist. www.beldansezen.com

Shabangu, 2012. Speech by Minister of Minerals [Online] available at: www.gov.za/speeches (Accessed February 2015).

Shabangu, S. (n.d.). YouTube. [Online] Available at: https://www.youtube.com/watch?v=9Yckds4z7cU. (Accessed: January, 2018).

Shabangu: Denies Ramaphosa's Marikana Claims., S. (2014, August 24). YouTube. [Online] Available at: https://www.youtube.com/watch?v=vw4bZh2r7mE. (Accessed: March, 2016).

Shabangu: Shabangu to Frack the Karoo, S. (2014, February 4). YouTube. [Online] Available at: https://www.youtube.com/watch?v=9Yckds4z7cU. (Accessed: June, 2018)

Shale gas and EU law. (n.d.). Shale Gas, the Environment and Energy Security, 49-107. doi:10.4337/9781786433176.00009.

Shale Gas Exploration in Brazil., 2013. Curitaba in English [Curitaba]. Shale Gas Report. (2012, May 4). [Online] Available at: https://thediplomat.com/ (Accessed February 2015).

Sharma, G., 2010. Gender inequality in education and employment. Learning Channel. org, One World South Asia, 17.

Shaw, S.M. and Lee, J., 2012. Chapter 6: Health and Reproductive Rights. Women's Voices, Feminist Visions: 279-290.

Shell Oil Company. 2016. The Shale Report, Internal Communique. [Online] Available at: http://www.shell.com. (Accessed: January, 2017).

Shuang, Z., Yi, T., Chenyang, L., Tong, L., Fengjun, Z. and Yang, S., 2014. Simulation and assessment of shale oil leakage during in situ oil shale mining. Oil Shale, 31(4), pp.337-351.doi:10.3176/oil.2014.4.03

Sinha, S. K., & Sharma, A. 2016. Chapter 9 Shale Gas in the Energy Basket. Energy Security and Sustainability, 233-254. doi:10.1201/9781315368047-10.

SinoFTS Petroleum Services International. 2014. Retrieved from http://www.sec.gov

Sir. [Online] Available at: http://csir.org. (Accessed: June, 2017).

Slaughter, R. 1994. Predicting the future. Futures, 26(7), 792-795. doi:10.1016/0016-3287(94)90048-5.

Slaughter, R. A. 1996. Futures studies. Futures, 28(8), 751-762. doi:10.1016/0016-3287(96)00009-2.

Slaughter, R. A. 2005. World Futures Studies Federation: histories and futures. Futures, 37(5): 349-353. doi: 10.1016/j.futures.2004.10.006.

Slaughter, R. A. 2010. Evaluating "Overshoot and Collapse" Futures. World Futures Review, 2(4): 5-18. doi:10.1177/194675671000200403.

Slaughter, R.A., 1993. The substantive knowledge base of futures studies. FUTURES-GUILDFORD-, 25: 227-227.

Smith, J., Weiss, P. A., Buechner, H. K., Coleman, J. S., Forrester, J. W., Lorenz, K., Bornard, G. 1973. Computer Simulation Models and Hierarchically Organized Systems in Theory and Practice. Journal of Dynamic Systems, Measurement, and Control, 95(1), 101-102. doi:10.1115/1.3426634

South Africa. (2014). Job Creation and Local Economic Development: 329-332. doi:10.1787/9789264215009-44-en.

South Africa's Technical Readiness to Support the Shale Gas Industry. 2016. doi:10.17159/assaf.2016/0003.

South African Oil and Gas Alliance. 2017. [Online] Available at: http://saoga.org. (Accessed: June, 2018).

South West Africa Cases. Ethiopia v. South Africa; Liberia v. South Africa. Second phase. (n.d.). International Law Reports, 243-602. doi:10.1017/cbo9781316151648.005.

State of the Nation Address, South Africa. 2014. [Online] Available at: http://www.gov.za. (Accessed: June, 2017).

Statistics South Africa, StatsSA. 2018. [Online] Available at: http://www.statssa.gov.za. (Accessed: January, 2017).

Stephenson, M. 2015. Shale Gas and Climate. Shale Gas and Fracking: 111-123. doi:10.1016/b978-0-12-801606-0.00007-8

Stephenson, M., 2015. Shale gas and fracking: the science behind the controversy. Elsevier.

Steyn, D. G. 2001. Mountain Meteorology. Agricultural and Forest Meteorology, 107(4), 333-334. doi:10.1016/s0168-1923(01)00223-4.

Stratigraphic terminology of the Dakota Sandstone and Mancos Shale, west-central New Mexico. 1973. doi:10.3133/b1372j.

Strzelecki, A., 2014. Legal and economic aspects of the financial independence of communes in Poland. Law and Administration in Post-Soviet Europe, 1(1): 38-50.

Sullivan, T. (n.d.). Economist Intelligence Unit (EIU). CC Advisor. doi:10.5260/cca.199450

Sunter, C. (2010). South Africa and the world beyond 2010. Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering - ICSE '10. doi:10.1145/1806799.1806801

Surhone, L. M., Timpledon, M. T., & Marseken, S. F. (2010). Tragedy of the Commons: Garrett Hardin, The Commons, Diner's Dilemma, Enlightened Self-Interest, Population Control, Inverse Commons, Common Heritage of Mankind.

Sutherland, W.J. and Woodroof, H.J., 2009. The need for environmental horizon scanning. Trends in ecology & evolution, 24(10): 523-527.

Susskind, R. & Susskind, D. 2015. The future of professions. How technology will transform the work of human experts. Tidsskrift for Arbejdsliv, 20(3): 82-85. doi:10.7146/tfa.v20i3.110817.

Swain, A., 2012. Global climate change and challenges for international river agreements. International Journal of Sustainable Society, 4(1-2):72-87.

Swain, A.K. and Mehta, U.S., 2014. Balancing State, Utility and Social Needs in Agricultural Electricity Supply.

Swanson, D., Bizikova, L., Thrift, C. and Roy, D., 2014. Governabilities: the nexus of sustainability, accountability and adaptability: essential tools for successful governance in the 21st century. International Institute for Sustainable Development.

Talus, K. (2014). Research Handbook on International Energy Law. Gloucestershire, England: Edward Elgar Publishing.

Talus, K. (2016). Introduction to EU Energy Law. doi:10.1093/acprof:oso/9780198791812.001.000.

Talus, K. (n.d.). Internationalization of energy law. Research Handbook on International Energy Law, 3-17. doi:10.4337/9781781002209.00009.

Talus, K. ed., 2014. Research handbook on international energy law. Edward Elgar Publishing.

Tammiksaar, E., 2014. The birth of the Estonian oil shale industry-links to Russia and Scotland. Oil Shale, 31(2):195-207.

Tanzi, A. and Arcari, M., 2001, July. The United Nations Convention on the Law of International Watercourses: A Framework for Sharing. In the United Nations Convention on the Law of International Watercourses. Brill Nijhoff.

Tanzi, A., McIntyre, O., Kolliopoulos, A., Rieu-Clarke, A. and Kinna, R. eds., 2015. The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes: Its Contribution to International Water Cooperation. Hotei Publishing.

The Age, Section: Agenda, The Sunday Profile: Sheik Ahmed Yamani: Quietly resides the man who once held the world in his hands, (From The Telegraph), Quote Page 5, Column 2, Melbourne, Victoria, Australia. (Newspapers com). July 2000. [Online] Available at: https://gallery.its.unimelb.edu.au/imu/imu.php?request=multimedia&irn=86704. (Accessed: July, 2018)

The Diplomat, p. 4. Shale Gas Report. 2012, May 4. [Online] Available at: https://thediplomat.com/2012/11/a-global-energy-shift-2/. (Accessed: July, 2019)

The India Express. Shale in India. 2012, March 5. [Online] Available at: https://indianexpress.com/article/india/india-others/moily-to-visit-countrys-first-shale-gas-well-in-gujarat-on-november-26/

The Presidency. 2013. Framework agreement for a Sustainable Mining Industry entered into by Organised Labour, Organised Business and Government. Pretoria. [Online] Available at: http://www.thepresidency.gov.za/pebble.asp?relid=15671 (Accessed August 2013). (Accessed: June, 2018).

The Presidency. 2018. Investment Roadshows National Planning Commission. Pretoria. [Online] Available at: http://www.npconline.co.za/MediaLib/Downloads/Downloads/NDP%202030%20-. (Accessed December 2018).

The Rand Corporation, 2012. Through Access to Clean Electricity. [Online] Available at: http://www.geni.org/globalenergy/research/meeting-mdgs-through-access-to- electricity/MDG_Final_1208.pdf (Accessed: June 2015).

The Shale Report., 2015. Forbes Magazine. [Online] Available at: www.forbes.com. (Accessed May 2015).

The Times of London. (1999). [Online] Available at: http://www.thetimes.co.uk. (Accessed: January, 2019).

The Zondo Commission. (2019). The Zuma Testimony [Online] Available at: http://sastatecapture.org.za. (Accessed: March, 2019)

Thorn, T. H. (2015). Gas Shale Environmental Issues and Challenges. Fundamentals of Gas Shale Reservoirs: 381-395. doi:10.1002/9781119039228.ch18.

Tiainen, H. Sairenen, R. Novikov, V., 2014. Mining in Chartkal Valley in Kyrgystan Challenge of Social Sustainability. Science Direct. Resources Policy 39. 2: 80 - 87.

Tong, J., & Jiang, X. 2015. Organic Nitrogen Conversion During the Thermal Decomposition of Huadian Oil Shale of China. Oil Shale, 34(2), 97. doi:10.3176/oil.2017.2.01

Total Oil Company, France. 2019. Shale exploration and the new Gas Condensate Find. [Online] Available at: http://www.total.com. (Accessed: March 2019).

Trading Economics. 2019. Shale Economics [Online] Available at: http://www.tradingeconomics.com. (Accessed: April, 2019)

Transparency International. 2014. [Online] Available at: http://www.transparency.org. (Accessed: March, 2016).

Tunstall, T. 2016. Shale Development and Mexico. The Global Impact of Unconventional Shale Gas Development: 229-249. doi:10.1007/978-3-319-31680-2_10.

Twist. J. BBC. Eco-designs on future cities. United Kingdom. [Online] Available at: www. news.bbc.co.uk July 2005. (Accessed January 2018).

Turcotte, D., and Eldridge, M, 2014 UK government pushes for shale-gas production. (2 Physics Today. doi:10.1063/pt.5.028415

United Kingdom Water Policy Brief, White Paper. UK Water. 2017. [Online] Available at: http://ukwater.gov.uk. (Accessed: June 2017).

United Nations (Ed.). 2016. Time of Test, Era of Opportunity: Selected Speeches of United Nations Secretary-General Ban Ki-moon, 2007-2016.

UN, 2009. Ban Ki-moon warns of catastrophe without world deal on climate change. United Nations. [Online] Available at: http://www.telegraph.co.uk/earth/environment/climatechange/60045 53/Ban-Ki-moon-warns-of-catastrophe-without-world-deal-on-climate-change.html (Accessed September 2015).

UNDESA International Waters Project, International Waters: Review of Legal and Institutional Frameworks, 2011. [Online] Available at: http://www.undp.org/content/dam/aplaws/publication/en/publications/environment- energy/www-ee-library/water-governance/international-waters-review-of-legal-and- institutional-frameworks/IW_Review_of_Legal_Instl_Frameworks_Project_Report.pdf> (Accessed September 2015).

United Nations 2014. Concise report on the world population situation in 2014. Department of Economic and Social Affairs. Population Division. [Online] Available at: (Accessed May 2015).

United Nations 2014. World Urbanisation Prospects: The 2014 Revision, Highlights. Department of Economic and Social Affairs. Population Division. New York.

United Nations Conference on Sustainable Development (Rio+20). [Online] Available at: http://www.un.org. (Accessed March 2015).

United Nations Conference on Trade and Development. 2004. Financing commodity based trade and development: Innovative agricultural financing mechanisms. Geneva. November 16-17, 2004. United Nations, Trade and Development Board.

United Nations Development Program. 2012. Innovative financing for development: A new model for development finance? [Online] Available at: http://www.undp.org/poverty. (Accessed March 2014).

United Nations Development Program. 2012. Triple wins for sustainable development. Case studies of sustainable development in practice. [Online] Available at: http://www.undp.org/. (Accessed: October 2018).

United Nations Development Program. 2013. An argument for anchoring the post-2015 sustainable development framework in community-based action, innovation and empowerment. Discussion notes. [Online] Available at: http://www.worldwewant2015.org/node/300868. (Accessed: April 2015).

United Nations Development Program. 2015. Human development by human development? UNDP Human Development Office, New York. [Online] Available at: http://www.hdr.undp.org/en/content/what-human-development. (Accessed July 2016).

United Nations Development Program. 2015. Human Development Report 2015: Work for human development. United Nations Development Program, New York. [Online]Available at: http://www.hdr.undp.org/sites/default/files/2015_human_development_report.pdf. (Accessed August 2015).

United Nations Development Programme (UNDP). 2013. Human Development Report. 2013. The rise of the south: human progress in a diverse world. UNDP. Washington DC. [Online] Available at: http://www.hdr.undp.org/en/content/what-human-development. (Accessed December 2016).

United Nations Development Programme (UNDP). 2014. Human Development Report 2014. Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience. New York. [Online] Available at: www.undp.org. (Accessed October 2014).

United Nations Economic Commission for Africa (ECA). 2009. Africa Review Report on Mining:ExecutiveSummary.[Online] Available at: http://www.uneca.org/publications/africa-review-report-mining-executive-summary. (Accessed November 2013).

United Nations Environmental Programme, 2015. Sustainable consumption and production indicators for the future SDG’s. United Nations Environment Programme (UNEP) Discussion Paper. [Online] Available at: http://www.unep.org/resourceefficiency. (Accessed May 2015).

United Nations Framework Climate Change Convention. 2018. [Online] Available at: http://unfccc.org. (Accessed: March, 2017)

United Nations. 2011. Environment and energy and capacity development. Practitioners' Guide: Capacity Development for Environmental Sustainability. United Nations Plaza, New York. [Online] Available at: http://www.undp.org. (Accessed March 2015).

United Nations. 2013. Financing for sustainable development in the global partnership beyond 2015. UN System Task Team on the Post-2015 UN Development Agenda. [Online] Available at: http://www.un.org. (Accessed: March 2015).

United Nations. 2014. The Millennium Development Goals Report 2014. United Nations, New York.

United States Government. Department of Energy. 2014. Annual Energy Outlook 2014, with Projections to 2040. Washington, DC: Government Printing Office. [Online] Available: https://www.eia.gov/outlooks/aeo/pdf/0383(2014).pdf. (Accessed: May 2019).

UNU Monitor. (2002). Global Environmental Change, 12(3), 231. doi:10.1016/s0959-3780(02)00014-6
UNU Monitor. (2002). Global Environmental Change, 12(3), 231. doi:10.1016/s0959-3780(02)00014-6
Urama, K., Ozor, N. & Acheampong, E. 2014. Achieving sustainable development goals (SDGs) through transformative governance practices and vertical alignment at the national and subnational levels in Africa. African Technology Policy Studies Network (ATPS). Nairobi, Kenya. [Online] Available: http://www.sdplannet- africa.org/. (Accessed: April 2015).

Van Asselt, H. 2012. Editorial. Review of European Community & International Environmental Law, 21(1), 1-3. doi:10.1111/j.1467-9388.2012.00745.x

Van Asselt, H. 2012. Managing the Fragmentation of International Climate Law. Climate Change and the Law, 329-357. doi:10.1007/978-94-007-5440-9_13.

Van Asselt, H., 2014. The fragmentation of global climate governance: consequences and management of regime interactions. Edward Elgar Publishing.

Van Asselt, H., 2016. The design and implementation of greenhouse gas emissions trading. In The Oxford Handbook of International Climate Change Law:332-356. Oxford: Oxford University Press.

Van Asselt, H., 2016. The role of non-state actors in reviewing ambition, implementation, and compliance under the Paris agreement. Climate Law, 6(1-2): 91-108. doi.org/10.1163/18786561-00601006%20

Van Asselt, H. 2017, International Change Climate Law [Powerpoint Lecture Notes, Moodle, February, 2017].

Van Asselt, H. 2017. Editorial. Review of European, Comparative & International Environmental Law, 26(1): 3-4. doi:10.1111/reel.12197

Van Asselt, H. and Bossner, S., 2016. The shape of things to come: global climate governance after Paris. CCLR:46.

Van Asselt, H., 2018. The politics of fossil fuel subsidies and their reform. Cambridge University Press.

Van Asselt, H., Merrill, L., & Kulovesi, K. (n.d.). Fossil Fuel Subsidies and the Global Climate Regime. The Politics of Fossil Fuel Subsidies and their Reform: 140-155. doi:10.1017/9781108241946.010.

Van Asselt, H., Sindico, F. and Mehling, M.A., 2008. Global climate change and the fragmentation of international law. Law & Policy, 30(4): 423-449.

Van der Heijden, K., Bradfield, R., Burt, G., Cairns, G. and Wright, G., 2002. The sixth sense: Accelerating organizational learning with scenarios. John Wiley & Sons.

Van der Hoeven, M., 2013. World Energy Outlook 2012. International Energy Agency: Tokyo, Japan.

Van Koppen, B., Schreiner, B., & Fakir, S. 2010. The Political, Social and Economic Context of Changing Water Policy in South Africa Post-1994. Global Issues in Water Policy, 1-17. doi:10.1007/978-90-481-9367-7_1.

Van Ours, J. 2016. Editorial Report 2015. De Economist, 164(1): 105-107. doi:10.1007/s10645-016-9271-6.

Van Vuuren, R., 2016. Information warfare as future South African national security threat Doctoral dissertation, Stellenbosch: Stellenbosch University. [Online] Available

Vengosh, A. 2014. Salinization and Saline Environments. Treatise on Geochemistry, 325-378. doi:10.1016/b978-0-08-095975-7.00909-8

Vengosh, A. (n.d.). Introduction – a research agenda for shale gas in the European Union. Regulating Shale Gas: 1-18. doi:10.4337/9781786433190.00010.

Vengosh, A., 2014. Treatise on Geochemistry. Volume 11: Environmental Geochemistry, 11.9 Salinization and Saline Environments: 325-378. doi: 10.1016. B978-0-08-095975-7. 00909-8.

Vengosh, A., Warner, N., Jackson, R., & Darrah, T. 2013. The Effects of Shale Gas Exploration and Hydraulic Fracturing on the Quality of Water Resources in the United States. Procedia Earth and Planetary Science: 863-866. doi: 10.1016/j.proeps.2013.03.213.

Vermeulen, P., 2008. The Future of Possibility. Postmodern Culture, 18(2). [Online] Available https://muse.jhu.edu/article/245450/summary. (Accessed: May, 2018).

Vinogradov, S., Wouters, P. and Jones, P., 2003. Transforming Potential Conflict into Cooperation Potential: the role of international water law.

Visser, W. and Brundtland, G.H., 2009. Our common future (The Brundtland Report): World commission on environment and development. The Top, 50: 52-55.

Voros, J., 2003. A generic foresight process framework. Foresight, 5(3):10-21.

Wack, P. A. (1984). Learning to design planning scenarios: The experience of Royal Dutch Shell. Boston, Mass.] (Soldiers Field: Division of Research, Harvard Business School.

Wack, P.1985. Scenarios: Uncharted Waters Ahead, Harvard Business Review. September–October, 1985. [Online] Available: http://hbr.org/1985/09/scenarios-uncharted-waters-ahead/ar/1 (Accessed: October 2015).

Wack, P., as quoted by Schwartz, P. 1991. The art of the long view. New York: Bantam Doubleday Dell Publishing Group Inc. [Online] Available: http://www.rolandkupers.com/wp/wp-content/uploads/2013/06/Link-16.pdf (Accessed: October 2015).

Wagner, C.G. 2000. The age of eco-electricity, The Futurist, Volume 34, Issue 3, Article: Publisher: World Future Society, Washington.

Wakeford, J. 2016. The South African Energy Context. In Glazewski, J., and Esterhuyse, S. Hydraulic fracturing in the Karoo: Critical legal & environmental perspectives. Juta and Company (PTY) Ltd. p. 34-56

Wait, R., & Rossouw, R. 2019. A comparative assessment of the economic benefits from shale gas extraction in the Karoo, South Africa. Southern African Business Review, 18(2), 1. doi:10.25159/1998-8125/5651.

Wall Street Journal. (2013, August 8). Shale. New York Times. [Online] Available at: www.nytimes.com. (Accessed: January, 2019).

Wanfang., X, Gang., X, and Haitao., Y. 2014. High performance distributed power quality monitoring IED used in smart grid. China International Conference on Electricity Distribution (CICED). doi:10.1109/ciced.2014.6991803.

Wanyama, F.O., 2016. Cooperatives and the Sustainable Development Goals A contribution to the post-2015 development debate. [Online] Available at:

https://www.ilo.org/empent/Publications/WCMS_240640/lang--en/index.htm. (Accessed: May, 2019).

Ward, K. 2012. The World in 2050: From the Top 30 to the Top 100. HCBC Global Research: Global Economics. [Online] Available at: https://big.assets.huffingtonpost.com/world2050.pdf. (Accessed: May, 2018)

Warner, D. 2010. Shale Gas in Australia: a great opportunity comes with significant challenges. Preview. doi:10.1071/pv00004.

Warner, N. R., Christie, C. A., Jackson, R. B., & Vengosh, A. (2014). Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania. Environmental Science & Technology, 47(20):11849-11857. doi:10.1021/es402165b.

Warner, N. R., Jackson, R. B., Darrah, T. H., Osborn, S. G., Down, A., Zhao, K., Vengosh, A. 2012. Reply to Engelder: Potential for fluid migration from the Marcellus Formation remains possible. Proceedings of the National Academy of Sciences, 109(52), E3626-E3626. doi:10.1073/pnas.1217974110.

Warner, N.R., Christie, C.A., Jackson, R.B. and Vengosh, A., 2013. Impacts of shale gas wastewater disposal on water quality in western Pennsylvania. Environmental science & technology, 47(20): 11849-11857.

Weeks, R.V., 1990. Managing strategic and corporate change within a turbulent environmental context: A strategic management approach Unpublished Doctoral dissertation, University of Johannesburg.

Whitley, S. and Van der Burg, L., 2015. Fossil fuel subsidy reform: From rhetoric to reality. New Climate Economy, London and Washington, DC. Available at http://newclimateeconomy. report/misc/working-papers. All rights reserved New Climate Economy c/o World Resources Institute, 10, p.3.

Williams, J. H., Specht, J. E., Dreier, A. F., Elmore, R. W., & Moonaw, R. S. (1986). Registration of ‘Fremont’ Soybean. Crop Science, 26(3), 648. doi:10.2135/cropsci1986.0011183x002600030052x.

Wilson, T., & Sharma, S. 2017. Inferring Biogeochemical Interactions in Deep Shale Reservoirs at the Marcellus Shale Energy and Environment (MSEEL) doi:10.1130/abs/2017ne-290981

Winkler, I. T. 2017. The human right to water. Routledge Handbook of Water Law and Policy, 109-119. doi:10.4324/9781315651132-9.

Wiseman, K., & Glazewski, J. 1991. South African law pertaining to the causes and effects of pollution affecting water resources. Pretoria: CSIR.

Wooders, P. 2019. How Chinese exports are exposed to potential border carbon adjustments. Manufacture Engineering and Environment Engineering. doi:10.2495/meee131852.

World - Natural Gas imports by origin.2012. IEA Natural Gas Information Statistics. doi:10.1787/bf9b7c73-en[Online] Available at: https://www.iea.org/statistics/naturalgas/ (Accessed: April 2016).

World - Natural Gas Statistics.2015. IEA Natural Gas Information Statistics. doi:10.1787/1e53a4f2-en. [Online] Available at: https://www.iea.org/statistics/naturalgas/ (Accessed: April 2016).

World – Natural Gas imports by origin (Edition 2016). (2012). IEA Natural Gas Information Statistics. [Online] Available at: https://www.iea.org/statistics/naturalgas/ (Accessed: April 2016).

World Bank Development Report, 1999. Tawfik, M. Is the world wide web reallyworldwide? [Online] Available at: http://www.unesco.org/webworld/points_of_views/tawfik_1.html (Accessed: April 2016).

World Bank, 2001. [Online] World Development Report 2000/2001. [Online] Available: http://siteresources.worldbank.org/INTPOVERTY/Resources/WDR/English-Full-Text Report/ch2.pdf. (Accessed: February 2017).

World Bank, 2002. Enhancing learning opportunities in Africa distance education and information and communication technologies for learning. [Online] Available at at:http://siteresourcesWorldBank.org/AFRICAEXT/Resources/dlicteducation.pdf (Accessed: February 2018).

World Bank. 2014. Investissements directs étrangers en Afrique: pays riches en ressources/pays pauvres en ressources. 2014. doi:10.1787/aeo-2014-graph21-fr.[Online] Available at:.http://documents.worldbank.org/curated/en/873821468193130433/pdf/860600BRI0FREN00Box382147B00PUBLIC0.pdf. (Accessed: 12 June 2017)

World Bank. 2016 Doing business (database). World Bank, Washington, DC. [Online] Available at: http://www.doingbusiness.org/. (Accessed July 2016).

World Bank. (2018). GAS Statistics. Retrieved from http://www.worldbank.org. 18 December 2018.

World Economic Forum. (2015). The New Energy Mix. [Online] Available at: http://www.weforum.org. (Accessed: May 2016).

World Economic Forum. 2016.The global challenge on food security and agriculture. Geneva, Switzerland. [Online] Available at: http://www.weforum.org/agriculture. (Accessed June 2016).

World Future Society. 2004. The art of foresight. A special report from the World Future Society. 7910 Woodmont Avenue, Bethesda, Maryland 20814, USA. [Online] Available at: http://www.wfs.org. (Accessed April 2015).

World Trade Organisation. (2017). [Online] Available at: http://www.wto.org. (Accessed: March, 2017).

Xu, W., Xu, G. and Yuan, H., 2014, September. High performance distributed power quality monitoring IED used in smart grid. In 2014 China International Conference on Electricity Distribution (CICED):706-710.

Yamineva, Y. and Kulovesi, K., 2013. The New Framework for Climate Finance under the United Nations Framework Convention on Climate Change: A Breakthrough or an Empty Promise? In Climate change and the law:191-223. Springer, Dordrecht.

Yamineva, Y., 2014. The governance of scientific assessment in the context of the Intergovernmental Panel on Climate Change: lessons for international cooperation in science, technology and innovation.

Yamineva, Y., 2016. Climate Finance in the Paris Outcome: Why Do Today What You Can Put OffTill Tomorrow? Review of European, Comparative & International Environmental Law, 25(2): 174-185.

Yamineva, Y., 2017. Lessons from the Intergovernmental Panel on Climate Change on inclusiveness across geographies and stakeholders. Environmental Science & Policy, 77: 244-251.

Yang, X., Li, B., Peng, C., & Yang, Y. (2017). Application of a wide-field electromagnetic method to shale gas exploration in South China. Applied Geophysics, 14(3), 441-448. doi:10.1007/s11770-017-0633-x.

Yu, M., Weinthal, E., Patiño-Echeverri, D., Deshusses, M.A., Zou, C., Ni, Y. and Vengosh, A., 2016. Water availability for shale gas development in Sichuan Basin, China. Environmental Science and Technology, 50(6): 2837-2845.

Yu.I., X, E., 2014. Field Borehole Testing of Anisotropic Shale Rock. In Shale Energy Engineering 2014: Technical Challenges, Environmental Issues, and Public Policy: 310-317.

Zhou, C. Y. 2015. Retorting of Pulverised Oil Shale in Fluidised bed pilot plant. Oil Shale, 26(2), 108. doi:10.3176/oil.2009.2.03

Zibakalam, S. 1994. Relativism due to under determination of theory by data. International Studies in the Philosophy of Science, 8(3): 211-228. doi:10.1080/02698599408573496.

Zonn, I. S., & Semenov, A. V. 2016. Shale Gas Production in Poland. The Handbook of Environmental Chemistry, 67-73. doi:10.1007/698_2016_60.

Zuma, J.,1999. Speech by Deputy President to the Inaugural South Africa-Nigeria Joint Commission, Nigeria, [Online] Available at: www.gov.za/speeches (Accessed: February 2017).

Zwane, E. 2015. Speech by Minister of Minerals [Online] Available at: www.gov.za/speeches (Accessed: February, 2017)

APPENDIX ONE: INTERVIEW WITH THE EXPERTS

Research Project Information Sheet.

Over five-year period, the following respondents were interviewed as part of the permanent panel, or ad hoc interviews at international conferences and workshops, University of Finland Classroom courses, and research field trips.

The interaction with other universities and departments within the Nelson Mandela University followed a structured program.

Interview with Professor Maarten De Wit, Head of the AEON Centre

Field trip to Jansenville with Mr Morkel, PhD Candidate on UOG Extraction in the Karoo, South Africa.

University of Delft TU, Delft, Netherlands

University of Basel, Switzerland

University of Eastern Finland, Joensuu, Finland.

Columbia University, New York, New York. USA.

Stanford University, San Francisco, USA.

Oregon State University, USA

Ambassador Sabatucci, R. (2019). [Delegation of the European Union to the African Union. Harmonisation of CFTA with EU Trade Policy.]. Method: Interview: World Export Conference, Addis Ababa, Ethiopia.

Ambassador, Adams, T. (2017). Retired Ambassador of Switzerland to Mozambique; Board Member of the IISD, Winnipeg; Lead Researcher in Diplomacy Think Tank, New York.
Method: 4 Interviews. Lecturer on Sustainability at the Summer school at University of Basel, Switzerland, 2017.

Anon, A. (2016). Senior member of the South African Oil and Gas Alliance. (SAOGA). Methods: Numerous face-to-face interviews. Discussions centred around regulatory frameworks and developers.

Anon, A. (2018). Head of the Renewables Energy programme at the Central Energy Fund.
Research questions centred around fossil fuel subsidy reform and the barriers to renewable energy in South Africa.

Anon, A. (2018). Head of IGAS, Part of the Central Energy Fund of South Africa. Three rounds of interviews were conducted to verify the latest trends in gas globally, Africa and South Africa. FFRS questions were also posed.

Assiego, B. (2018). Lex Petrolea and Petroleum Contract Law.
Methods: Three rounds of Interviews. UEF Class Lectures. General Examination.

Barrow, L. (2019). Director, African Development Bank.
Method: Interview. Further Energy models for Africa. Bank appetite for UOG extraction in Africa.

Belinskij, A. (2017). International Water Law. Water Energy Food Nexus Approach. Water Conflict in the Mekong River Valley.
Methods: Six Interviews. Six Seminars in peer to peer style. UEF Class Lectures.

Bulltail, C. (2018). PhD Candidate under Professor Jackson. Indigenous tribal women in UOG extraction in the U.S.
Methods: Interview and Workshop

Chizema, R. (2019). Chief Technical Advisor & Head of ICU-UNIDO, Department of Trade and Industry of the African Union.
Method: Interview. Social Inclusion of Women in the African Energy Sector.

Compton, D. (2018). Professor, Wits Business School, Board Member of Eskom.
Method: Interview. Discussion to articulate the Curriculum into Wits Programme from undergraduate at universities.

De Vos, D. (2018, July 4). Mayor De Vos, Sarah Baartman Municipality. Case study towns of Graaf Reniet and Jansensville. Participated and contributed to the BRICS Capacity Building Conference, which was geared to gathering insights into the requirements of the youth in the community.
Methods: Two interviews with Mayor De Vos. BRICS workshop on Capacity Building. The conference followed the two focus groups with the youth of the Jansenville and Graaf Reniet. A presentation of the research was made to the Executive Community of the Sarah Baartman Municipality. A university degree programme was at the outcome of this series of engagements.

De Witt, M. (2011, July 1). The Great Shale Debate in the Karoo. AEON Institute, Nelson Mandela University. Port Elizabeth, South Africa De Wit, M. J. (1999). Geologie en Mijnbouw (Geology and Mining), 76(4), 369-373. doi:10.1023/a:1003290014097 De Wit, M. J. (2011). The great shale debate in the Karoo. South African Journal of Science, 107(7/8). doi:10.4102/sajsv107i7/8.791 De Wit, M. J. (1999). Event stratigraphy of Gondwana keynote papers. Journal of African Earth Sciences, 28(1), 1. doi:10.1016/s0899-5362(99)00016-0 De Wit, M. J. (2011). The great shale debate in the Karoo. South African Journal of Science, 107(7/8). doi:10.4102/sajsv107i7/8.791 [The Science behind the Shale In the Karoo Debate.]. Retrieved from https://doi.org/10.4102/sajs.v107i7/8.791
Professor Maarten De Wit, of the EON Institute at Nelson Mandela University started the fracking debate. The Local Regional Government funded R16m towards setting up baseline research for the upcoming UOG extraction in the region. De Wit presented a conference in 2015 and engaged the research community and heads of civil society. Chief Margaret commented on ancestors, water and religious beliefs. Environmental lawyers raised environmental issues.

Deal, J. (2016). Treasure the Karoo. Anti-Fracking Pressure Group.
Methods: Several rounds of telephonic interviews through-out the research

Esterhuyse, S. (2014, April 6). Editor of.

Esterhuyse, S. (2016). Editor of Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives and Book Chapter 10 Lead Author on "Potential Impact of Unconventional Oil and Gas Extraction on Karoo Aquifers".

Author of many papers on surface water in South Africa. Research question centred around water in UOG extraction.

Fakir, S. (2014, May 8). Lead Research at WWF, Cape Town. Retrieved from http://karoospace.co.za/karoo-shale-gas-economics-q-saliem-fakir-part/ Method: Face to face interview. Telephonic follow-up interviews

Glazewski, J. (2014). Glazewski, J., & Esterhuyse, S. (2016). Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives Glazewski, J., & Esterhuyse, S. (2016). Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives. Glazewski, J. (1994). Natural resource management: Towards an effective legal regime. Johannesburg, South Africa: Land and Agriculture Policy Centre. Glazewski, J. (n.d.). Sustainable development and proposed shale gas extraction in South Africa: prospects and challenges. Shale Gas and the Future of Energy, 209-229. doi:10.4337/9781783476152.00022 Glazewski, J., & Collier, D. (n.d.). South Africa. Climate Change Liability, 319-348. doi:10.1017/cbo9781139084383.017 Glazewski, J., & Esterhuyse, S. (2016). Hydraulic Fracturing in the Karoo: Critical Legal and Environmental Perspectives. Professor Glazewski, leader author of the book on UOG extraction and environmental law in South Africa. Both books are widely referenced throughout the research.

Green, L. (2018). [Contributor Book Chapter 18. In Hydraulic Fracturing in the Karoo. Critical Legal and Environmental Perspectives. Esterhuyse & Glazewski, 2016.]. Method: Telephonic Interview. Critique of the Vengosh et al, 2013 report.

Honkonen, T. (2017). International Environmental Law 1; Principles of Environment Law. The Common but Differentiated Responsibility, The Precautionary Principle, The Polluter Must Pay Principle.
Methods. Three Rounds of Interviews. UEF Class Lectures. General Examinations.

Howarth, R. W. (2018). A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas. Energy Science & Engineering, 2(2), 47-60. doi:10.1002/ese3.35.
Method: Skype Interview. Methane leakage and developing research.

Inayatullah, S. (2015). Inayatullah, S. (2007). Questioning the future: Methods and tools for organizational and societal transformation. Taipei, Taiwan: Tamkang University. Inayatullah, S. (1988). Sarkar's spiritual dialectics. Futures, 20(1), 54-65. doi:10.1016/0016-3287(88)90042-0 Inayatullah, S., & Milojević, I. (2015). CLA 2.0: Transformative Research in Theory and Practice. Inayatullah: At TEDx Noosa, S. (2013, May 12). YouTube [Video file]. Retrieved from https://www.youtube.com/watch?v=ImWDmFPfifI&t=307s Inayatullah: Future with Sohail Inayatullah. DBTV, Live., S., & Parisey Tariq. 2019. (2018, May 27). YouTube [Video file]. Retrieved from https://www.youtube.com/watch?v=voUb9-XvWIw Inayatullah: Introduction to Futures Thinking. Excerpts from Speeches and Interviews, S. (2012, January 30). YouTube [Video file]. Retrieved from https://www.youtube.com/watch?v=L5MJ_APlLc4 Inayatullah, S. (Ed.). (n.d.). CLA 2.0. Inayatullah; Future in the Making. FTA 2018, S. (2018, August 5). YouTube [Video file]. Retrieved from https://youtu.be/Qc_rNQNg8is Inayatullah, S. (1986). The adaptive corporation. Futures, 18(1), 102-105. doi:10.1016/0016-3287(86)90068-6 Inayatullah, S. (1988). Sarkar's spiritual dialectics. Futures, 20(1), 54-65. doi:10.1016/0016-3287(88)90042-0 Inayatullah, S. (1997). Future generations thinking1. Futures, 29(8), 701-706. doi:10.1016/s0016-3287(97)00049-9 Inayatullah, S. (2000). Deconstructing the year 2000. Futures, 32(6), I. doi:10.1016/s0016-3287(00)00032-x Inayatullah, S. (2004). The causal layered analysis (CLA) reader: Theory and case studies of an integrative and transformative methodology. Taipei: Tamkang University Press. Inayatullah, S. (2015). What works: Case studies in the practice of foresight. Inayatullah, S., & Milojevic, I. (2000). Metafuture.org: Futures studies. Maroochydore, DC Qld: Sohail Inayatullah and Ivana Milojevic. Methods: Interview: Skype. Six Pillars, 2015. Teaching of the Sarkar Method. Workshop with CSIR - Pretoria, 2015. Masterclass: CLA, Johannesburg, Ifundi, 2015. Meditation Session and Talk: Spirituality in Future Studies. Masterclass: CLA, Cape Town, 2015. Masterclass: CLA, with Professor Adendorff. NMU, 2016 Interview: Port Elizabeth: 2016.

Jackson, R. (2018). Professor, Stanford University and Expert on UOG in US Co-author with Vengosh. Jackson, R. B., Osborn, S. G., Vengosh, A., & Warner, N. R. (2011). Reply to Davies: Hydraulic fracturing remains a possible mechanism for observed methane contamination of drinking water. Proceedings of the National

Academy of Sciences, 108(43), E872-E872. doi:10.1073/pnas.1113768108 Jackson, R. B., Osborn, S. G., Vengosh, A., & Warner, N. R. (2011). Reply to Davies: Hydraulic fracturing remains a possible mechanism for observed methane contamination of drinking water. Proceedings of the National Academy of Sciences, 108(43), E872-E872. doi:10.1073/pnas.1113768108 Vengosh, A., Warner, N., Jackson, R., & Darrah, T. (2013). The Effects of Shale Gas Exploration and Hydraulic Fracturing on the Quality of Water Resources in the United States. Procedia Earth and Planetary Science, 7, 863-866. doi:10.1016/jproeps.2013.03.213 Warner, N. R., Christie, C. A., Jackson, R. B., & Vengosh, A. (2013). Impacts of Shale Gas Wastewater Disposal on Water Quality in Western Pennsylvania. Environmental Science & Technology, 47(20), 11849-11857. doi:10.1021/es402165b Warner, N. R., Jackson, R. B., Darrah, T. H., Osborn, S. G., Down, A., Zhao, K., … Vengosh, A. (2012). Reply to Engelder: Potential for fluid migration from the Marcellus Formation remains possible. Proceedings of the National Academy of Sciences, 109(52), E3626-E3626. doi:10.1073/pnas.1217974110.
Methods: Interview at Stanford University, San Francisco. Verification of laboratory results on Air Quality. Discussion with doctoral students on the trends in methane leakage.

Leino-Sandberg, P. (2017). The extra-territorial effect of EU Law. International Public Law.
Methods: UEF Class Lectures: International Public Law. 4 Essay Assignment

Markley, O. W. (1996). Global consciousness: An alternative future of choice. Futures, 28(6-7), 622-626. doi:10.1016/0016-3287(96)84461-2

Leading Futurist based in the U.S. Methods: Skype interview. Main research questions centred around futures-based methods and spirituality in FS.

Matasche, G. (2019). Minister of Minerals and Energy. Days of Courageous Conversation, 2019. Bishop's Court Cape Town.
Minister elaborated on the IPP plan and the future energy mix.

Maugeri, L. (2014). Author of many books on UOG extraction in the U.S. Harvard Professor at the Belfer Institute Maugeri, L. (2010).

Beyond the age of oil: The myths, realities, and future of fossil fuels and their alternatives. Santa Barbara, CA: Praeger. Maugeri, L., & Belfer Centre for Science and International Affairs. (2012).

Oil: The next revolution, the unprecedented upsurge of oil production capacity and what it means for the world. Cambridge, MA: Harvard Kennedy School, Belfer Centre for Science and International Affairs. Maugeri, L., & Belfer Centre for Science and International Affairs. (2013).

The shale oil boom: A U.S. phenomenon. Maugeri, L., & EBSCOhost. (2006).

The Age of Oil: The Mythology, History, and Future of the World's Most Controversial Resource. Portsmouth: Greenwood Publishing Group, Incorporated. Professor Maugeri's over-arching concern was the lack of water resources for the extraction in the Karoo. Three of his books are widely referenced through the research.

Ngcukana, C. (2018). CEO of Utility Firm. Method: Interview. SSFR and electricity in South Africa.

Onwuegbuzie, H. (2019). Speaker at WEC, Addis Ababa. Method: Interview. Conference Speaker: SME and development finance.

Osman, O. (2016). CEO, Free State Development Corporation Method: Interview. SME support and development.

Oyelaran-Oyeyinka, O. (2019). Special Adviser to the President of the African Development Bank. Method: Interview, Financial Services for Energy in Africa

Palty-Guzman, C. (2018). IEA, 2018 -2023 Gas Projection Forum. Columbia University, New York. Methods: Interview. U.S. UOG Success Factors.

Peltonen, L. (2017). Sustainability and Natural Resources. Methods: Face to face interview. UEF Class Lectures. 7 Peer to peer presentations.

Peltonen, L. (2018). Community Relations and Conflict Mediation in Natural Resources. How extractive companies can assist rural communities to meet the SDGs.
Methods: Three interviews. Seminar. General Examinations.

Pizmony-Levy, O. (2018). Professor of Sustainability at Columbia University, New York. Pizmony-Levy, O. (2011). Bridging the Global and Local in Understanding Curricula Scripts: The Case of Environmental Education. Comparative Education Review, 55(4), 600-633. doi:10.1086/661632.
Method: Interview. Participant in a workshop on Sustainability Co-ordinators in 1200 schools in New York, New York.

Ramcilovik-Suominen, S. (2018). Theories and Methods for Social Studies of Environmental issues.
Methods: Interviews into the various research methodologies with communities in Finland and Africa. General Examination and Seminar.

Ramos, J. (2015, December 7). The research questions were centred around the role of scenario art in FS.
Method: The skype discussion led to the development of the article for the Journal of Future Studies.

Rompannen, S. (2017). European Environmental Law.
Methods: Interview. UEF Class Lectures. General Examination.

Rosa, R. (2018). [Partner, PwC.].
Method: Interview. Verification of the OUG business case with and expert. UOG support and development for supply chain development.

Rossouw, R. (2017, April 14). A comparative assessment of the economic benefits from shale gas extraction in the Karoo, South Africa. Southern African Business Review, 18(2), 1. Retrieved from http://10.25159/1998-8125/5651
Methods: Telephonic Interview. Question centred around the cost-benefit analysis which was conducted by the authors in 2012.

Sairinen, R. (2017). Environmental Policy Instruments and Natural Resources. Mining and Communities. SDGs and Rural Communities. Methods. Three rounds of Interviews. Essay Assignment.

Scholes, B. (2014). Dr Bob Scholes, UJ Lecture and Lead Researcher on the CSIR SEA on OUG Extraction in the Karoo. Methods: Interview. The South African government commissioned a multi-disciplinary researcher through the CSIR, under the stewardship of Dr Scholes.

Talus, K. (2017). Talus, K. (2014). Research Handbook on International Energy Law. Gloucestershire, England: Edward Elgar Publishing. Talus, K. (2016). Introduction to EU Energy Law. doi:10.1093/acprofoso/9780198791812.001.0001 Talus, K. (n.d.). Internationalization of energy law. Research Handbook on International Energy Law, 3-17. doi:10.4337/9781781002209.00009 [EU Law, EU Energy Law, International Energy Law].
Director of CIEL, Energy Centre, University of Eastern Finland. Methods: UEF Class Lectures: Face to face interview: UOG Extractive from EU perspectives. General Examinations.

Tau, P. (2017). President of the United Nations Local Government Association. Methods: Interview. CDM. Resilience. Adaptation and Mitigation of cities in South Africa.

Tura, H. (2018). EU Food Law.
Methods: Interview. UEF Class Lectures. General Examination

Van Asselt, H. (2019). Van Asselt, H. (2012). Managing the Fragmentation of International Climate Law. Climate Change and the Law, 329-357. doi:10.1007/978-94-007-5440-9_13 Van Asselt, H. (2017, February 1). International Change Climate Law. Powerpoint Lecture Notes, Moodle, 2017]. Van Asselt, H. (2012). Editorial. Review of European Community & International Environmental Law, 21(1), 1-3. doi:10.1111/j.1467-9388.2012.00745x

Van Asselt, H. (2017). Editorial. Review of European, Comparative & International Environmental Law, 26(1), 3-4. doi:10.1111/reel.12197 Van Asselt, H., Merrill, L., &

Kulovesi, K. (n.d.). Fossil Fuel Subsidies and the Global Climate Regime. The Politics of Fossil Fuel Subsidies and their Reform, 140-155. doi:10.1017/9781108241946.010 [Climate Change Law, International Energy Law].
Methods: UEF Class Lectures: Climate Change Law. The Paris Agreement (2015) The Emission Trading Scheme. Supervisor on Law Master's Thesis. General Examinations.

Vikman, N. (2018). Soundscapes and Environmental Cultural Studies. Endangered species of Fauna and other insects.
Methods: Two Interviews. UEF Class Lectures. Peer to Peer Learning. Intra-University Seminar.

Wustenberg, M. (2018). International Energy Law and Policy.
Methods: Interview. UEF Class Lecture. Seminar. General Examination.

APPENDIX TWO: BUILDING CAPACITY UOG EXTRACTION WORKSHOPS IN SUPPORT OF REGIONAL ECONOMIC DEVELOPMENT FOR RURAL AREAS

Research Project Information Sheet.

Curation of BRICS CLIMATE ACTION TERTIARY EDUCATION PROGRAMME for BRICS and BRICS PLUS Countries. Radisson Hotel, Cape Town. 4 – 5 JULY 2018

Developing Capacity via a Higher Learning Platform for the Renewable Energy Sector.

In examination of the local content in petroleum and mining contracts, very little is left to chance by international developers. To that extent, qualified expatriate staff are shipped in. Given the requirement for highly skilled professionals and labor, talent is brought in and shipped out at the end of the project. The net effect is that minimal transfer of skills takes place at local community level.

To avoid communities being left on the periphery and just at arm's length of corporate social responsibility, South Africa must plan effectively, developing a sustainable skills pools, drawing from the inward steam of secondary school leavers each year. Firstly, there should obligations to developers and these should be effectively covered in legal framework which are currently at draft stage. There are many types of contracts which can be entered into: license contracts, profit sharing contracts and outsourced contractor contracts.

The new policy of free higher education provides for new skills development, and this opportunity should be harnessed in the quest to develop a sustainable supply chain industry supported by young entrepreneurs to the renewables energy sector in South Africa. Modern learning programs cater for the fast-tracking of skills, in order to meet demand. South Africa, under the new President is rapidly analyzing its energy security priorities. On a clearer trajectory, nuclear is being set aside, the shale discourse is being revitalized, which however, in the light of climate change management still presents critical uncertainties. It may take a couple more years before civil society, business and government reach consensus as to whether or not shale provides the correct solution for the South African case.

The recent few weeks has seen dramatic impetus in the renewable energy sector and whilst policy- makers start to formulate regulatory frameworks, there is the requirement for skills development on a structured higher learning basis. Noting the various abilities of the students and their educational backgrounds, noting that there is a place for all in the various strata from technical to senior management, a program is required to meet the needs of this new and sustainable business sector.

It has been identified at the BRICS Academic Forum, held last week in Johannesburg, that South Africa needs to urgently define its energy policy and that the solution must be in line with the climate change management strategies, as the country is currently tracking 4 degrees above pre-industrial times whilst the rest of the world is trying reduce the target from 2 degrees to 1,5 degrees. The discourse has been the sharing of information in the renewable energy sector, given that India leads the way in Solar and Wind energies and Brazil is on second place in wind energy and also has a very robust bio-energy sector, which South Africa has yet to give due consideration. Russia has illustrated university programs from its Moscow State University, with over hundred master's students and fifty doctoral students specializing the various subjects of RE.

Therefore, a platform of learning exists and provides an established pool of best practice, under auspices of the BRICS University Network. Further, discussions have held as side meetings in preparation for a seminar to develop such a curriculum. Five professors presenting the BRICS countries have volunteered and pledged their commitment, drawing on specific academic work done in this domain, as part of a core group to participate and shape the program. This seminar also forms part of the series of planned seminars on topics for further investigation, which has emanated as follow up to the BRICS Academic Forum 2018 between the months of June to October 2018.

WORKSHOP AGENDA

Day One: 4 JULY 2018

9:00 – 9:30: Opening Address of the BRICS University Network

9:30 – 10:00 Setting out workshop objectives.

Realities and feasibility

Critical milestones for consideration

Perceived barriers and suggested solutions

Presenter: Professor Nirmala Gopal

10:00 – 10:15 Introduction to Renewable Energy: Case study of Masdar Institute. Specialized Scientific Institute in the UAE dedicated to development of Renewable Energy.

Presenter: Franck Naidoo

10:15 – 10:30 A case for a developed supply chain network. An Industry perspective.

Presenter: Franck Naidoo

10:30 – 10:45 Tea Break

10:45 – 11:00 Academic Program: Moscow State University Programme (Academic programme)

Presenter: Leonid Grigoryev

11:00 – 11:30 Brazil: How did Brazil developed capacity? (Preparing for Implementation)

Presenter: Murilo Komniski

11:30 – 12:00 India: Practical Learnings in Implementation (Technology: Success stories for easy implementation)

Presenter: Ankit Pandey

12:00 – 12:30 South Africa. Required instrinics of a Practice Training of the programme

Presenter: FET Delegate

12: 00 – 13:00 Plenary: Summary of Key Learnings for implementation and Programme Design with two groups and 5 mins presentation.

13:00 – 14:00 Working Lunch: Discussion and interrogation of the programme Design

14:00 – 16:00 Drafting the programme

16h00 – 18h00 Interrogating the Merits of the programme

Day Two: 5 JULY 2018

8:30 – 10:00 Reviewing the workshop objectives.

- Realities and feasibility
- Opponent: Murilo Kominiski
- Critical milestones for consideration
- FET Delegate
- Perceived barriers and suggested solutions
- Opponent: Ankit Pandey

10:00 – 10:30 Tea Break

10:30 – 11:00 Overcoming milestones

11:30 – 12:00 Final course design leading to Implementation

12: 00 – 13h00 Implementation Date. Seeking alignment and Sign-off

13h00 – 13h30 Working lunch

13h30 – 14h30 DHET feedback and endorsing the programme

14h30 – 17h30 Way forward and tasks for the follow-up implementation sessions.

- Set up a SA Task Team
- Set up a framework of objectives
- Set up dates for follow up meetings
- Set up the pilot venue, programme

Join close of the BNU

Close of seminar

A) The Proposed Curriculum

The Proposed Curricullum (Draft)

Year One	Credits	Year Two	Credits	Year Three	Credits
Law Stream					
Climate Change Law 1	5	Mining and Community Relations 1	5	Master's Thesis: Climate Change****	30
Energy Law 1	5	Natural Resources Governance	5		
Renewable Energy Law 1	5	Foresight 1	5	Foresight 2	5
Legal Academic Writing	2	Petroleum Contracts (Elective)	5		
Supply Chain Management 1	5	Carbon Trading 1	5	Carbon Trading 2	5
Introduction to REMP		Emmission Trading Scheme (Elective)	5	TAX and Subsidies (Elective)	3
	2	Business Management 1	5		
International Relations 1	4	International Relations 2	5	International Relations 3	5
Economics 1	5	Renewable Energy Law 2	5	Renewable Energy Law 3	5
Sustainability 1	5	WTO 1	2	WTO 2	2
International Environmental Law 1	5				
South African Environmental Law 1	5				
	48		47		55
Policy & Adminstrative Stream **					
Sustainability 1	5	Sustainability 2	5	Master's Thesis: Sustainability and Co	30
Climate Change Law	5	Mining and Community Relations 1	5	Economics 2	5
Energy Law	5	Natural Resources Governance	5	TAX and Subsidies (Elective)	3
Renewable Energy Law	5	Foresight 1	5	Foresight 2	5
Legal and policy Academic Writing	2	Petroleum Contracts (Elective)	5		
Economics 1	5	Carbon Trading 1	5	Carbon Trading 2	5
Supply Chain Management 1	5	Emmission Trading Scheme (Elective)	5		
Introduction to REMP		Business Management 1	5		
Accounting 1	5	Accounting 2	5	Accounting 3	5
International Relations 1	5	International Relations 2	5	International Relations 3	5
	42		50		58
Entrepreneurship Stream***					
Climate Change Law	5	Mining and Community Relations 1	5	Master's Thesis: Clean Development Mechanism and the CBDR Environmental Principle or Setting up of the Emissions Tading Scheme for SA.	30
Energy Law	5	Natural Resources Governance	5	ISO ACCREDITATION	1
Renewable Energy Law	5	Foresight 1	5	Foresight 2	5
Sustainability 1	5	Petroleum Contracts (Elective)	5		
Technical/Academic Writing (Elective)	2	Carbon Trading 1	5	Carbon Trading 2	5
Introduction to REMP	2	Emmission Trading Scheme (Elective)	5		
Economics 1	5	Business Management 1	5		
Supply Chain Management 1	5	Supply Chain Management 2	5	Supply Chain Management 3	5
International Relations 1 and Mobility	5	International Relations 2 and Mobility	5	International Relations 3 and Mobility	5
Health, Safety, Security & Environment 1	5	Health, Safety, Security & Environment 2	5	Health, Safety, Security & Environment 3	5
	44		50		56

Grading System

Pass	one/five	50 -59%
Satisfactory	two/five	60 -69%
Good	three/five	70-79%
Very Good	four/five	80-89%
Excellent	five/five	90-100%

Notes:

* The Law Stream provides for all Energy and Climate change law (including Paris Agreement and Clean Development Mechanism).

** The policy and adminsitrative stream must be able to provide for taxes and subsidies. Must be able to manage pricing just like Eskom does with electricity pricing.

*** The Entreprenuership Stream provides for HSSE, ISO, Int'L Relations and Mobility and Entrepreur Support

**** The Thesis Topic is a Broad and Relevant Topic capturing the essence of the particular stream. The Thesis is linked to mobility and must be supported by two published articles in years 1 & 2.

APPENDIX THREE: IISD LETTER OF INTRODUCTION

IISD
International Institute for Sustainable Development

IISD.ORG
Twitter: IISD_news
Facebook: IISDnews

To Whom It May Concern,

The International Institute for Sustainable Development (IISD) is undertaking a scoping study on the changing role of coal and renewable energy industry in the South African energy sector. The study will review the resources, costs and relative merits the technologies; the role of subsidies in the current energy system; and the broader political economy of the energy sector with the aim of raising sustainability related issues in the current debates around the energy sector.

IISD are pleased to be collaborating with Franck Naidoo in this research. Franck will be undertaking a series of meetings and data gathering exercises to the research on behalf of the energy team of IISD.

I would be most grateful if you could extend your help and support to Franck as he conducts his research.

Sincerely,

Peter Wooders

Group Director, Energy, International Institute for Sustainable Development

WINNIPEG GENEVA OTTAWA NEW YORK

APPENDIX FOUR: RESEARCH QUESTIONS

Research Project Information Sheet.

Methods

- Respondents were selected from SEOs, Unions, Political Parties, Academics Private Practitioners with the within the wind and solar sectors.
- One-on-one interviews
- Some interviews were audio recorded
- Many respondents commented on an anonymous basis.

Questions

a. Can you briefly explain the current energy mix in the area of your domestic residence?
b. What are the impacts of a coal dominated energy future for South Africa?
c. Can you explain the path as you see it towards and more sustained energy future?
d. Can you please comment on your understanding of the subsidies and support that the South African government affords to the fossil fuel energy companies?
e. How should this support be extended in support of the upcoming shale sector?

APPENDIX FIVE: EXPERT VALIDATION OF SCENARIOS

Societies	**Area of Expertise**
UNFCCC	Climate Change Law
UNFCCC; Mission 2020	Environmental Law and Policy
IISD, Winnipeg, Canada	IISD Board Member
IISD, Geneva, Switzerland	IISD Global Subsidies Senior Researcher
Stanford University, San Francisco, California.	Methane leakage and overall shale research.
Columbia University, NY, NY	Sustainability in Five Boroughs of New York
WWF	Environment and Ecology
CSIR SOE	Energy and Scenario Planning
CEF SOE	SEO. Head of Renewable Energy
IGAS SOE	Head of IGAS
South African Oil and Gas Alliance	CEO
World Bank	Global Manager
Ifundi	Youth Capacity Building
Ifundi	Youth Capacity Building
University - Eastern Finland	Environmental Policy
University- Derbyshire	Statistics and methodology
Graaff-Reinet	Political Risk Consultant
SANEBI	Riverine Rabbit and Karoo Ecology

(Source: Researcher's Construction, 2019)

APPENDIX SIX: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN THE KAROO TOWNS OF THE SARAH BAARTMAN MUNICIPALITY

Research Project Information Sheet.

Methods: Presentation to the Executive Mayoral Community, Sarah Baartman Municipality.

Date	4 July 2018
Location	Graaf-Reniet, Sarah Baartman Municipality
Time	10h00
Number of Participants	16 Members of the Executive Mayoral Committee
Methods	Presentation to the Executive Mayoral Committee
Outcomes	Permission granted to conduct two focus groups with the youth of Jansenville and Graaf Reniet, Sarah Baartman Municipality.

(Source: Researcher's Construction, 2018)

APPENDIX SEVEN: FOCUS GROUP ONE: JANSENVILLE, SARAH BAARTMAN MUNICIPALITY

Research Project Information Sheet.

Methods: SARKAR METHOD, VISIONING AND BACKCASTING

Date	5 July 2018
Location	Jansenville, Sarah Baartman Municipality
Time	09h00
Number of Participants	40
	Introduction: Introduction and purpose of the subject matter Introduction and explanation of scenario art in the research group Rule of engagement. Tools of Translation Getting acquainted: Semi-circle 8 round tables. Working in groups, self-assembled Sarkar Group Back-casting and Visioning
Facilitators	Researcher and Translator: Ward Councillor Mayer

(Source: Researcher's Construction, 2018)

APPENDIX EIGHT: FOCUS GROUP TWO: GRAAF RENIET, SARAH BAARTMAN MUNICIPALITY

Research Project Information Sheet.

Methods: SARKAR METHOD, VISIONING AND BACKCASTING

Date	5 July 2018
Location	Graaf Reniet, Sarah Baartman Municipality
Time	16h00
Number of Participants	40. Age group: 18 – 34 years.
Methods	Induction: Introduction and purpose of the subject matter. Introduction and explanation of scenario art in the research group. Rules of engagement. Tools of Translation Getting acquainted: Semi-circle 8 round tables. Working in groups, self-assembled. Sarkar Group Back-casting and Visioning
Facilitators:	Researcher and Translator: Ward Councillor Mayer.

(Source: Researcher's Construction, 2018)

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5 February 2020 CC Regist 2001/005599/23

TO WHOM IT MAY CONCERN

This is to certify that the dissertation written by Franck Naidoo and entitled
:

POSSIBLE HYDRAULIC FRACTURING FUTURES FOR SOUTH AFRICA TOWARDS 2055

was copy-edited by the undersigned. At the same time a reconciliation of citations and the accompanying Reference List was undertaken. The Reference List was also assessed for technical correctness according to the NMU guidelines.

The writer was provided with the corrections/amendments which required attention. The corrected document, which differed considerably from the original, was subsequently copyedited again and a number of additional corrections were advised.

The undersigned takes no responsibility for corrections/amendments not carried out in the final copy submitted for examination purposes.

Dr Alan Weimann