Gordon Institute of Business Science
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The role of the South African mining industry in the sustainable transition to a low carbon economy

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A research project submitted to the Gordon Institute of Business Science, University of Pretoria, in partial fulfilment of the requirements for the degree of Master of Business Administration.

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ABSTRACT

The research study was aimed at understanding the role of the South African mining industry in the transition to a low carbon economy with the objectives of establishing the enablers to a sustainable transition, positioning the transition management framework as the anchor framework upon which the mining industry should pivot its transition efforts through the advocacy of stakeholder engagement, and establish the niche innovations that are being driven by the mining industry in order to drive the transition to a low carbon economy. To attain these objectives, the study was qualitative in nature and study asked four research questions anchored in the theory of transition management. The study found that mining businesses determine materiality of risk differently given their competitive position. The study further provided evidence that inadequate stakeholder engagement takes place between mining businesses and their stakeholders with regards to the development of climate change strategies. As far as niche innovations were concerned, the study found that mining businesses are leveraging a number of niche innovations through the establishment of strategic partnerships with businesses with a large research and development pool. Lastly, the study found evidence that an enabling regulatory environment is necessary for the successful transition to a low carbon economy and that leadership is necessary at a governmental level to provide policy clarity insofar as a social-technical transition is concerned.

KEYWORDS

Just transition, Sustainability, Transition management, Low carbon economy

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Ndashe Ndyamba **1st December 2021**

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CHAPTER 1: INTRODUCTION TO RESEARCH PROBLEM

1.1 Introduction

A low carbon economy is touted as the only way forward that puts countries at a higher level of competitiveness (Global Competitiveness Report, 2019). The Global competitiveness report (2019) shows that countries that have a higher share of renewable energy as a percentage of total consumption in their energy mix have been shown to have a higher Global competitiveness index (GCI). South Africa was ranked 60th on the competitiveness index with a renewable energy share of 17.2% in 2019 (Global competitiveness report, 2019). The mining industry plays an important role in the South African economy with a significant addition to the country's GDP and employment figures. It is stated by PWC (2021), a report compiled by pwc that between July 2019 and June 2021:

- South Africa's mining industry contributed R803.3bn and R985.3bn in FY2020 and FY2021 respectively to GDP.
- South Africa's mining industry had an estimated 1, 594 million and 2,300 million direct and indirect jobs created and/or sustained.
- South Africa's mining industry contributed and estimated R229.1bn in FY2021 to the government fiscus through the collection of both direct and indirect taxes.

The mining industry is therefore seen as an important catalyst for driving economic growth and ultimately competitiveness. Playing the role of a catalyst will require the mining industry to quickly transition to a low carbon economy in a manner that is sustainable However, the mining industry's transition to cleaner forms of energy production and consumption poses a transitional risk for South Africa's mining industry (PWC, 2021). This transitional risk is brought about because the highest polluting industries are also large contributors to the South African economy (PWC, 2021). Value chains in coal, metals and petroleum-based transport were identified as the industries facing the greatest transitional risk in an employment impact vulnerability impact assessment (PWC, 2021). To address the problem of a sustainable transition, this research study focussed on the role of the South African mining industry in the transition to a low carbon economy. The two key policy frameworks for South Africa's economic development and the transition to a low carbon economy are the National Development Plan (NDP) which was published in 2012 NDP (2030) and the Integrated Resource Plan (IRP) which was drafted in 2019 (Department of Minerals and Energy [DMRE], 2019).

The transition management framework is a theoretical framework wherein transitions are taken through a four stage non-linear process at strategic, tactical, operational, and reflective stages (Loorbach, 2010). Silvestri et al. (2008) define transition management as a reflective

process of governance that aims to influence the dynamics in society by encouraging multiple experimenting amongst actor, searching, and the creation of a knowledge process aimed towards the creation of a sustainable future. The strategic level of the transition management framework referred to by Loorbach (2010) deals with long term vision setting coupled with long term planning. The NDP and the IRP are policy frameworks that ascribe to the strategic level of the transition management framework. The tactical level of the transition management framework deals with actions of dominant actors (Loorbach, 2010). Such dominant actors in the energy landscape in South Africa include Eskom, labour unions, mining companies, and communities where energy generation and mining operate. The operational level of the transition management framework deals with experimentation of innovative technologies and how to protect these innovations from dominant actors through the initiation of protection spaces (Loorbach, 2010). The reflective level of the transition management framework deals with the feedback process that governs a transition with the main objective of learning and implementing gaps that develop during the implementation process in order to achieve the vision set at the strategic level (Loorbach, 2010).

From a transition management point of view, South Africa has not undergone a social-technical transition in its energy system at the level that is being called for by the climate change problem of transitioning to a low carbon economy. From this perspective, transition management is yet to be used to understand social-technical transitions in the energy landscape of South Africa. It therefore means that a large theoretical contribution is yet to be made in this arena. This objective of this study was to add to the body of knowledge on transition management as it applies to the South African mining industry as the industry transitions to a low carbon economy.

1.2 Problem definition

The Paris climate agreement puts the rate at which global warming should happen at less than 2 degrees centigrade below pre-industrial levels (PWC, 2020). In 2019, the world was decarbonising at a rate of 2.4 percent which is considerably higher than the requirements of the Paris agreement. The Intergovernmental Panel on Climate Change (IPCC) is a body of the United Nations (UN) and generally considered as the authority body when it comes to climate change. In their sixth assessment report which will be completed and released in 2022, the IPCC presented its findings at the recent Congress of Parties 26 (COP26) in Glasgow, Switzerland at which they stated that:

1) The world will reach and most probably exceed warming of 1.5 degrees above pre-industrial levels within the next 20 years (Masson-Delmotte et al., 2021). Under a high

emissions scenario, the IPCC estimates that warming will be reached much quicker than 20 years.

2) To limit global warming to 1.5 degrees by 2100 is still possible, but radical transformational change and not small-scale efforts is required (Masson-Delmotte et al., 2021). The world has a carbon budget of 400 Gigatons of carbon-dioxide (GtCO2) in order to limit global warming to 1.5 degrees with current emissions standing at 36.4 GtCO2 per annum meaning that in approximately 10 years, this budget will be exhausted (Levin, 2021).
3) The science about climate change which includes the understanding of extreme weather conditions related to climate change has a very high confidence level (Masson-Delmotte et al., 2021). New technology has been developed and used to understand climate change to the extent that there now exists a high probability of prediction of climate change impacts.
4) Climate change impacts that are currently being experienced will affect every aspect of the world if transformational change is not undertaken and that it is unequivocal that climate change has been brought about by human actions (Masson-Delmotte et al., 2021). The report by the IPCC is signed off by all 195 member countries so the use of words such as unequivocal is a milestone in itself. Previous reports by the IPCC indicated levels of confidence as being low, medium, and high. The use of unequivocal in the language signifies the strong scientific position of the IPCC on climate change.
5) Any fraction of a degree of warming will result in catastrophic and costly impacts (Masson-Delmotte et al., 2021; Levin, 2021).

Energy generated from fossil fuels has continued to play a significant role in the energy mix with renewables only accounting for a little over 11 percent of the energy consumed globally. In figure 1, the energy generation mix in South Africa shows that coal continues to be a significant source of energy.

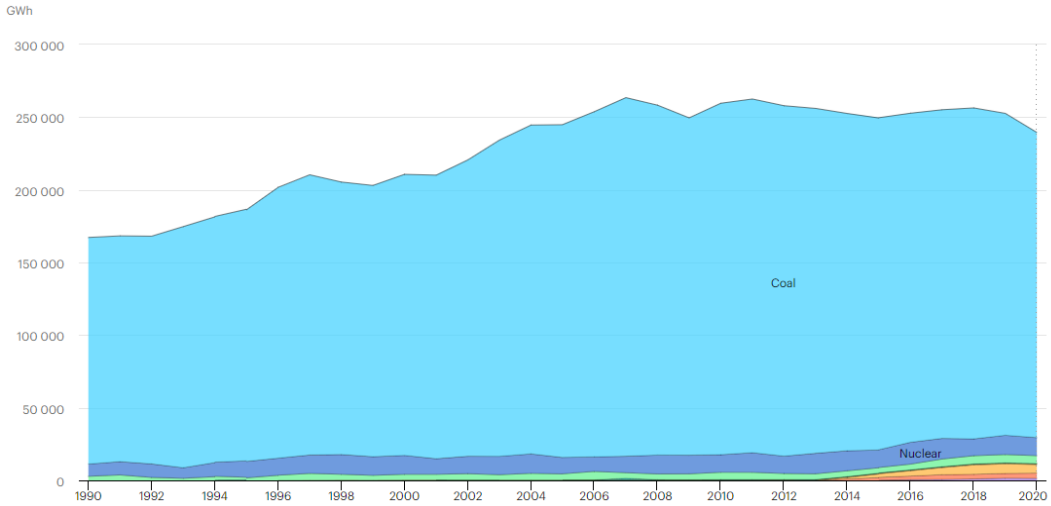

Figure 1: Energy generation from different sources in South Africa (IEA, 2021)

The call for climate action has reached many industries and cannot be ignored. In a report by Delevinge et al. (2020), they warn that "building a climate strategy is not a quick exercise, but not doing so is futile" (p. 1). Apart from the environmental risks that the world will be exposed to if the world does not decarbonise at the required rate, the economic viability of many companies will be largely affected by a lack of action (Delevinge et al., 2020).

The South African mining industry is a major consumer of electricity. While it is true that a major focus of the integrated resource plan and other climate agreements place a lot of emphasis on de-carbonisation through the reduction of coal fired power stations; there is a tremendous movement in society and business to do more. South Africa is endowed with a plethora of natural resources which will aid the transition to a low carbon economy. These natural resources will widely be used as raw materials in the manufacture of many renewable energy technologies. Steel, Aluminium and copper are but some of the metals used in the production of renewable energy technologies (Gulati, 2018). The transition to a low carbon economy therefore presents the mining industry with risks and opportunities. The risks include import taxes on local metals, lack of investment in new mines as well as environmentally induced extreme climate conditions. The opportunities are looked at from a sustainable angle such as fuelling the economic prosperity of the mining industry while at the same time ensuring that the transition takes place in an environmentally and socially equitable manner. Given that the lack of climate action will result in unquestionable devastation to the environment, the mining industry is required to respond in one way or the other. The twin questions of how the mining industry transitions and what processes the industry uses in this transformational effort are fundamental to this research.

The IPCCs fourth assessment report on climate change defined decarbonisation as the decline of the average carbon intensity relating to primary energy over time (Metz, 2007). The decarbonisation process can be deemed as a transition from a largely carbon concentrated energy production and consumption process to one in which carbon is minimised. Such a transition needs to be governed by appropriate frameworks and/or theories. Transition management is a framework that seeks to protect niche industries through four developmental phases (Goddard & Farrelly, 2018). The idea behind transition management is argued by Goddard and Farrelly (2018) as the sustainable stability of niche innovations which is achieved through the prevention of lock in mechanisms of established technologies as well as ensuring adequate participation of all stakeholders. This view is supported by Shum (2017) who states that transition management seeks to deal with elements that affect the market. In the context of decarbonisation, Shum (2017) states that this view stems from the social and environmental costs of fossil fuels in the negative.

This can be countered by the imposition of carbon taxes on industries heavily reliant on fossil fuels. From this perspective, Shum (2017), Goddard and Farrelly (2018) agree that the protection of niche innovations is key to ensuring sustainable transitions. However, Goddard and Farrelly (2018) contend that even though the transition management framework at a conceptual level is able to ensure sustainable transitions, it suffers in its practical implementation given its heavy reliance on the participation of technical experts and business. As such, it fails to adequately consider the voices of wider society and other relevant participants during the implementation process (Goddard & Farrelly, 2018). This is especially important in South Africa where communities around mining towns are hugely dependent on these mines. If mines fail to adequately deal with the transition to a low carbon economy through the inadequate implementation of the transition, they risk losing their relationships with these communities. To this extent, the concept of a just transition becomes important. The just transition concept has been defined as a concept that seeks to elevate social justice in the transition to a low carbon economy (Mohammed, 2021).

South Africa is unique in this setting given its energy generation landscape. As seen in figure 1, coal remains a dominate actor as a source of energy in South Africa. Transitioning from coal to alternative sources of energy will require a framework that leads to sustainability and advocates for social justice for those affected. The mining industry in South consumes approximately 15 percent of the energy produced by Eskom (Ratshomo & Nembahe, 2019). The mining industry is thus key and well positioned as an industry in leading the transition into a low carbon economy owing to its energy intensiveness. The transition of the mining industry to a low carbon economy will reduce the burden Eskom has on coal fired energy generation

and stimulate a social-technical chain reaction in the transition to a low carbon economy. This chain reaction is shown in this studies literature review which contends that social technical transitions lead to interactions at meso, mono, and niche levels which are characterised by whole society changes brought about by new economies (Chang et al., 2017).

The problem that this study aimed to address was understanding how the mining industry will address climate change in a sustainable manner. The research study pivoted on the climate strategies that mining companies have developed and interrogated those strategies against the requirements of transition management and just transition in order to establish a determination on whether those strategies will or will not be sustainable.

1.3 Business need

South Africa derives a significant amount of revenue through the export of commodities with nearly 40 percent of exports in 2016 coming from the shipment of precious metals (Huxham & Nelson, 2019). South Africa produces a large percentage of its electricity from coal fired power stations. It is therefore expected that the transition to a low carbon economy will greatly affect mining companies whose portfolio is mainly comprised of coal assets. However, given the fact that mining is a tremendous contributor to GDP, mining firms that produce other commodities will be affected by climate change action as well. Climate change action will come from various sectors of the economy such as investors of mining companies, the communities within which they operate as well as other regulatory bodies. Added to this, trade agreements which South Africa has with its trading partners will come under tremendous scrutiny to adherence to climate agreements (Huxham & Nelson, 2019). The highlighted reasons give impetus to this research study from the business need point of view in giving insight into the role the mining industry will have in the transition to a low carbon economy and importantly the role of business in ensuring that such a transition is sustainable. Mining firms need to fully understand the risks that the transition places on their existence as businesses as well as the opportunities that may arise from this transition. Furthermore, this research will provide insight into how mining companies plan on ensuring that the transition is not only just but also that it takes place in an environmentally and socially acceptable manner.

1.4 Theoretical need

The research field of understanding sustainability transitions has seen four main frameworks for studying intricate societal transitions (Chang et al., 2017). This research is anchored in the body of knowledge dealing with sustainability transitions. The four sustainability transition frameworks for studying societal transitions are the multi-level perspective (MLP), multi-phase concept (MPC), strategic niche management (SNM) and transition management (Chang et al., 2017). From the four frameworks, transition management has recently emerged as a

framework that can best be used to understand social-technical transitions taking into account long term thinking and short term oriented actions (Chang et al., 2017). It has also emerged as a contender for understanding social-technical transitions because it encompasses elements of the other three frameworks i.e., MPL, MPC, and SNM within its framework.

Following the development of the NDP and IRP, the government of South Africa has established the Presidential Climate Commission (PCC) to advocate for policies that will drive the transition to a low carbon economy. The participation of stakeholders is an important aspect of the transition management framework as it is through full participation that a sustainable outcome can be established (Goddard & Farrelly, 2019). This participatory nature of the transition management framework, coupled with the fact that it encompasses elements of the other three framework has academic implications for further research in transition management in relation to how the transition to a low carbon economy can aid the understanding of whether sustainable transition can be achieved using transition management.

1.5 Objectives of the research

The COP26 conference which was held in Glasgow in 2021 built on the work of the Paris agreement which had set a target of limiting global temperatures at 1.5 degrees centigrade above pre-industrial levels (Gulati, 2018). South Africa being a signatory to the Paris agreement, has developed a road map to facilitate the transition to a low carbon economy and recently revised the country's national determined contributions ahead of COP26 to between 420 CO_{2e} to 350 CO_{2e} (South Africa Government, 2021). This road map involves various stakeholders including but not limited to private companies, public institutions, and ordinary citizens. Given the laid out business and academic need for this study, the objectives of this study were to:

a) Understand what the key enablers for a transition to a low carbon economy in South Africa's mining industry are and how these enablers are anchored within the transition management framework.
b) Identify common areas of understanding which relate to niche innovations that the South African mining industry can collectively drive in order to promote a shared approach to achieving the transition to a low carbon economy.
c) Position the transition management framework as the foundation upon which to South Africa's mining transition should be pivoted.

The above outlined objectives of this study resulted in the formulation of four research questions which are outlined in Chapter 3 of this report.

1.6 Research setting

South Africa's mining industry is a significant consumer of energy accounting for about 15 percent of energy consumed (Ratshomo & Nembahe, 2019). Its is also a significant contributor to the South Africa's GDP, direct and indirect employment, and direct and indirect taxes (PWC, 2021). The industry employs close to half a million direct employees with GDP contribution of approximately 8.3 percent (Minerals Council South Africa, 2021). It is also highlighted by PWC (2021) that because of the intensity of energy consumption and the derived economic benefits that the industry provides for South Africa, a transition to a low carbon economy poses a transitional risk for the industry. The process leading to a low carbon economy will be consequential for labour, income distribution, and small business (Galgóczi, 2020). Newell et al. (2013) argues that a just transition is critical in the transition to a low carbon economy as it identifies with the different trade-off that must be made amongst different competing interests.

South Africa generates approximately 71 percent of its power from fossil fuels (Department of Minerals and Energy [DMRE], 2019). The mining industry has been and remains a major consumer of this electricity because of lock in arrangements from fossil fuel production (Institute for Economic Justice, 2018). The structure of electricity generation is such that the twin aspect of coal mine and power station in close proximity to each other has been the bedrock of energy generation for many years. This structure has its own entrenched rules and policies; referred to as regimes by (Chang et al., 2017).

In South Africa, the Department of Minerals and Energy (DMRE) gazetted the integrated resource plan in 2019 with the aim of facilitating the transition to a low carbon economy by detailing the energy mix requirements of the country (Department of Minerals and Energy [DMRE], 2019). Through various iterations, the DMRE is currently in bid window No 5 for the procurement of renewable energy sources that will aid the transition.

Being a large employer, a significant contributor to GDP, with a heavy dependency on fossil fuel generated power, and a large community footprint covering mining operations, and the presence of a developed policy framework that determines the Country's future energy mix, the mining industry was a forerunner for a research study into the transition to a low carbon economy. Therefore, the research setting for this study was South Africa's mining industry.

1.7 Definition of key constructs

This research study makes mention of key constructs in its formulation. The following are the key constructs which will aid the reader in understanding how they are used:

Sustainability transitions: meaning a radical transformation towards a sustainable society that is brought about through man-kinds response to challenges that confront society (Chang et al., 2017).

Social-technical: meaning a system that recognises the linkages between human beings as members of society, technology, and laws (Canitez, 2019).

Actors: meaning organisations, institutions, entrepreneurs, people belonging to a system (Markard et al., 2012).

Regime: meaning a system e.g., an energy system with its entrenched rules, regulations, and ways of doing things (Markard et al., 2012).

1.8 Structure of the report

The rest of the report outlines the literature study conducted within the context of the research topic. The literature study is explored in chapter 2 and begins with the academic anchor of the research study on sustainability transitions which then delves into the frameworks on sustainability transitions and the concept of just transition. In chapter 3, the four research questions that this study aimed to answer are posed together with their intended objectives. Following the framing of the research questions, the research methodology and design is discussed in chapter 4 of the report where the sampling strategy, time horizon, determination of the population, the data collection instrument, analysis of data and the limitations of the study are discussed. The results of the research study obtained from the data collection instrument are presented in chapter 5 and a discussion on the results presented is formulated in chapter 6. The report ends conclusions of the research study and recommendations for future research in chapter 7.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter details the literature study underpinning the research topic. It begins by looking at the broader literature into sustainability transitions and what they entail. The literature on sustainability transitions identifies that four main frameworks that have been used by researchers to study social-technical transitions. These four frameworks are the multi-phase perspective, the multi-level perspective, strategic niche management, and transition management. This chapter explains these frameworks and ends with an integration of the literatures and a conclusion.

2.2 Sustainability transitions

The energy, transportation, agricultural and water sectors can be classified as social technical systems at a conceptual level consisting of networks of actors, institutions as well as material objects and competence (Geels, 2004; Markard, 2011; Weber, 2003, as cited in Markard et al., 2012). These three elements of the system i.e., actors, institutions, and material objects interact together, and it is this interaction that brings about the functionality of the world within the context of providing a service to society (Markard et al., 2012). A central pillar of transition research is the social-technical regime (Markard et al., 2012). The social-technical regime studies the linkages that exist amongst evolutionary economics, history, and the sociology of technology (Markard et al., 2012). Markard et al. (2012) states that the social-technical regime concept accepts that linkages exist amongst practices of engineering, scientific research and knowledge, and technological processes. The second central pillar of transition research is the concept of a niche (Markard et al., 2012). At a conceptual level, niches are thought of as being protected spaces where radical innovations are born while being protected from external forces which can be exerted by incumbent regimes (Markard et al., 2012). These protected spaces are akin to incubators which are found in hospitals for new-born babies. From a business perspective, there can be thought of as business incubators. Established innovation hubs such as the Council for Scientific and Industrial Research (CSIR) in South Africa are but one example of a niche.

According to Markard (2018) there is a growing understanding that most sectors of the economy will need to structurally change in order to be sustainable. In earlier transitional studies work, Markard et al. defined a sustainability transition in 2012 as “long term, multi-dimensional, and fundamental transformation processes through which established social-technical systems shift to more sustainable modes of production and consumption” (p. 956). Markard (2018) later adds to this definition and describes a sustainability transition as “a

purposive transition that incorporates social technical change and is associated with the sustainable development goals" (p. 628). While keeping the original definition of social-technical change, Markard (2018) makes a distinct addition to the original definition by capturing the important element of sustainability as defined by the United Nations sustainable development goals. This important distinction is crucial in understanding that a mere social-technical transition will not suffice but rather that it should be sustainable and pivot on the three elements of economic, social, and environmental sustainability insofar as ensuring sustainable means of producing and consuming are maintained. Transition is further defined by Chang et al. (2017) as a continuous complex process where change happens in society at multiple levels. When this change in society is sustainable, the transition is said to qualify as a sustainable transition. Sustainable transitions are typically underpinned by four main characteristics (Markard et al., 2012; Chang et al., 2017). These characteristics are:

1) That transitions involve deep multi-dimensional structural changes at a multiple disciplinary level. Therefore, in the case of transition to a low carbon economy, such changes would affect government policy and direction, private and private companies research and technological development, societal integration to mention but a few.
2) That transitions require multi-stakeholder interaction. This interaction can be driven through industry bodies that are able to bring the various stakeholders together in pursuance of a common understanding and goal.
3) That transitions take a tremendous amount of time to be fully implemented with Markard et al. (2012) stating that such period can be in excess of 5 decades. A review of the climate change agreements shows that the transition to a low carbon economy has a milestone of net zero emissions by the year 2050 with global emissions required to be halved by the year 2030 (PWC, 2020). This certainly signifies that a transition is on the horizon insofar as climate change is concerned. Typically, such transitions involve the creation of new product ecosystems wherein new products complement existing products in some instances and replace them in other instances.
4) That transitions take place in a technologically enabling environment that requires synergies around innovations to be established. Technologies that will enable the transition to a low carbon economy include concentrated solar panels, wind energy production, and the use of green hydrogen.

Unlike technological transitions, social-technical transitions typically involve the development of secondary and tertiary technologies to complement the primary social-technical transition. The development of road infrastructure, refuelling systems, traffic lights etc., are typical secondary and tertiary technologies that were brought about by the social-technical transition of the use of automobiles from carriages (Markard et al., 2012). Another major differentiator of social technical transitions is that they involve a change in the practice of users. Warren et

al. (2016) make a point of this by stating that while the dynamics of technological change are crucial, emphasis on social-technical transitions is on a broader societal participation rather than the internal driver of niche innovations.

Transitions can be viewed from 3 different perspectives i.e., meso, micro, and macro (Goddard & Farrelly, 2018). At a meso level, transitions are driven by the thinking that advocates for business-as-usual practices and that these must be maintained through the optimisation of current systems and technologies. The view postulated by Goddard and Farrelly (2018) is supported by Harrahill and Douglas (2019) who describe it as weak sustainable development. Harrahill and Douglas (2019) argue that this business-as-usual approach has largely driven the thinking around sustainable development where transitions of energy production and consumption from fossil fuels is thought of as a consequence of governmental, fiscal, and scientific pressures. The meso level is dictatorial in that the dominant actors are able to prevent uptake on new technologies due to high barriers to entry in such industries.

At a micro level, Goddard and Farrelly (2018) argue that innovative technologies are protected through the different developmental phases until a structural shift in the industry occurs. The barriers to entry are significantly lowered at the time this structural shift happens which gives emergent technologies a better chance of survival. This view, termed strong sustainable development by Harrahill and Douglas (2019) who argue that such development can only be brought about through policies that shift the power of dominant actors through advocating of institutional change by protecting niche technologies. The interaction of the micro level and the macro factors such as strong institutions, monetary policy and competitiveness leads to the destabilisation of existing modes of energy production and consumption (Goddard & Farrelly, 2018). This view is supported by Byskov and Kammermann (2021) who state that political subtleties and lobbying groups that form coalitions are critical in the interaction of the micro and macro factors.

Sustainability transitions studied over the last 20 years conclude that four main theoretical frameworks are used to study sustainability transitions (Chang et al., 2017). The approaches as stated by Chang et al. (2017) are the “Multi phase approach, Multi-level perspective, strategic niche management and transition management” (p. 360)

2.2.1 Multi-phase concept

The multi-phase concept (MPC) contends that sustainable transitions take effect in a four-step process characterised by an S-curve as depicted in figure 2 with the first step being the pre-development phase (Chang et al., 2017), in which the co-evolutionary dynamics of the regime results in the increase of interdependencies within the regime leading to the regime

approaching criticality (Van der Brugge & Rotmans, 2007). Upon reaching criticality, the regime structure becomes increasingly unstable resulting in the regime becoming weak (Van der Brugge & Rotmans, 2007).

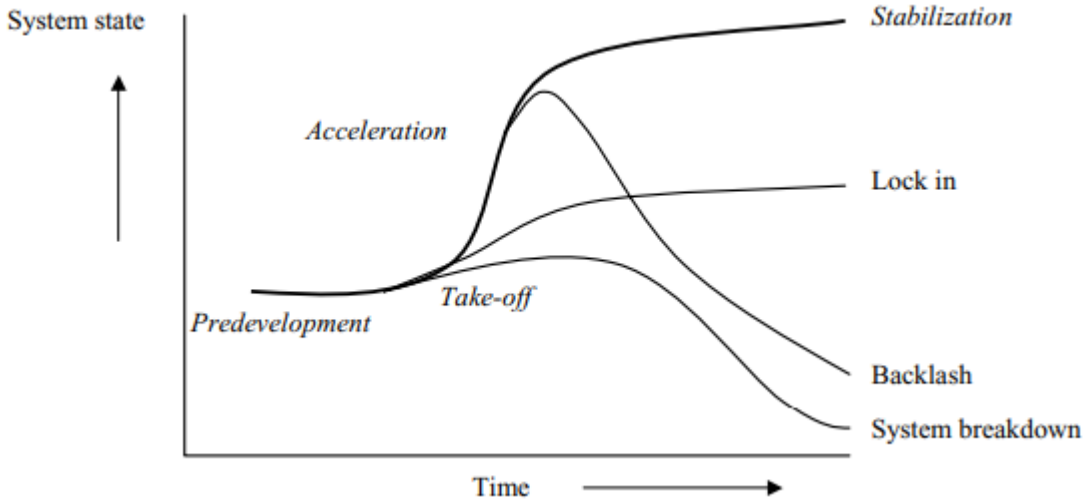

Figure 2: multi-phase concept of energy transitions (Van der Brugge & Rotmans, 2007)

This phase is characterised by plenty sustainability initiatives with little movement in the general market (Chang et al., 2017). Van der Brugge and Rotmans (2007) stated that innovations during the take-off phase were still in their infancy i.e., they were not adequately embedded and developed to the extent that they could compete with the incumbent regime sufficiently. Therefore, the predevelopment phase would typically involve technological innovation growth of various systems with the aim of improving the systems stability and reliability. This phase is followed by the take-off phase which is characterised by small shifts in the structure of the transitions coupled to an improved appetite for uptake of the technologies or systems (Chang et al., 2017). It is argued by Van der Brugge and Rotmans (2007) that technological innovations begin to cause disruption to the status quo which leads to the creation of a new normal on a large scale as the incumbent regime becomes critical.

Van der Brugge and Rotmans (2007) argued that three important transition pathways are determined at the take-off stage and this determination is dependent on both the co-evolutionary developments within the regime and the ability of the available actors to survive. The first of these pathways that was suggested by Van der Brugge and Rotmans (2007) is the pathway that results in lock-in where a co-existence is maintained amongst a competing network of innovations. The second pathway suggested by Van der Brugge and Rotmans (2007) is acceleration where there exists one innovation network which is supported by other small scale innovation networks thereby facilitation the growth of the overall network. The third pathway suggested by Van der Brugge and Rotmans (2007) is that which results in system

breakdown. Van der Brugge and Rotmans (2007) argued that in a world where innovation networks fight for scant resources and where such networks are not self-sustaining, no adequate substitute exists to destabilise the incumbent regime, which results in the breakdown of the newly emerging innovation network.

Following this phase i.e., the take-off phase, with acceleration as the chosen pathway, a great deal of momentum begins to build in the transition with significant structure shifts, which phase is referred to as the breakthrough phase which finally results in a new equilibrium in the fourth phase which is known as the stabilization phase (Chang et al., 2017). The stabilisation phase is characterised by the settling down of the newly established regime wherein the processes of transformation are turned into continuous improvement processes (Van der Brugge & Rotmans, 2007). It is importantly noted by Van der Brugge and Rotmans (2007) that a breakdown of the newly established regime can result if the equilibrium is not reached i.e., backlash.

2.2.2 Multi-level perspective

The multi-level perspective (MLP) of sustainable transitions identifies three dynamics i.e. niche, social technical landscape and social technical regime that are necessary to answer the question of “how” transitions occur (Canitez, 2019). From a process theory point of view, the MLP has both a global and a local component (Geels, 2019). The MLP ascribes to the fact that social technical transitions are described by 3 analytical levels and numerous temporal phases at a global level while specific activities and the interactions of mechanisms within these specific activities comprise the local level (Geels, 2019). The early work of Geels conducted in 2004 (as cited in Geels et al., 2016) postulated that transitions happen at several levels through the interaction between innovations at a niche level, regimes in current existence and exogenous regimes. The niche was described by Weinstein and Bumbus (2016) as an emergent innovation under experimentation. This view was later supported by Geels (2019) who described a niche to be technologies that are protected from the conventional marketplace of dominant actors and are nurtured to develop them into dominant actors through research and development.

According to Chang et al. (2017), niches are established sites of nurturing technology. In a niche, research and development are protected and shielded from external pressures of markets until such innovations can be proven as viable. Niches are thought of as being the drivers of transitions. In the context of renewable energy, these include concentrated solar, wind, hydrogen, and battery storage Chang et al. (2017). The social technical regime is described as the regulations, laws or rules that are developed by industries, policy formations as well as society and knowledge hubs Chang et al. (2017). In the mining context, these rules

and regulations include the Mineral resource and petroleum development act, the Integrate resource plan, and the Paris agreement. The social technical land scape includes issues relating to infrastructure, rural to urban migration, employment, and re-skilling. Comparing the thinking put forth by Canitez (2019) and Geels (2016), it can be seen that there is common consensus around the definition of a niche innovation; Canitez (2019) definition of a social technical landscape is referred to as existing regimes by Geels (2016) while the social technical regime is referred to by Geels (2016) as an exogenous regime.

The MLP states that sustainable technological transition occurs in a non-linear fashion driven through a dynamic interaction amongst the three levels (Canitez, 2019). This view is supported by Geels (2016) who also argued that different transition pathways are a result of different methods of interplay among the niche innovation, the social technical landscape, and the social technical regime. To this extent, Geels (2016) stated that four paths to a transition are possible when different interaction occurs. These four paths to a transition as postulated by Geels (2016), are technological substitution, transformation, reconfiguration, and de-alignment & re-alignment.

Geels (2016) further stated that technological substitution results from a disruptive niche innovation. An example of this being the advent of the electric vehicles and plug in hybrid vehicles in mobility transitions and milk produced from plants in agro-food transitions (Geels, 2019). According to Geels (2016), transformation results from an internal landscape pressure on incumbent actors which forces these actors into adjusting the current regime. This happens where niche innovations are not adequately developed with an example of this being the use of decentralised energy production such as the recently promulgated law in South Africa allowing for self-energy generation up to 100 MW. Reconfiguration results when there is enough landscape pressure on the existing actors wherein niche innovations are absorbed into the current regime (Geel, 2016). This will typically result in the reconfiguration of the existing architecture of the current regime.

The need to have energy produced from different sources in South Africa which is put forth in the integrated resource plan is a clear example of the reconfiguration of the existing regime. It is quite evident that this reconfiguration will result in a different energy architecture insofar as integration of the grid from different sources is concerned. Finally, de-alignment & re-alignment is as a result of the continued presence of niche innovation in the current landscape (Geels, 2016). This prolonged presence will ultimately result in the establishment of a new landscape with different regimes playing a role in this landscape. This goal is what is envisaged in the Congress of Parties meeting that established the Kyoto protocol which is to see a transition from a climate change perspective that does not result in an increase in the

worlds temperatures. At least from an energy production point of view, this will result in an increase renewable energy production share in the energy mix by 2050.

It is however accepted that a transition will not happen just because of the presence of a niche. This is so because the already established systems are deeply entrenched that this aspect must first be structurally broken to create space for the niche. Furthermore, Geels (2019) added to this view by stating that several lock-in mechanisms ensure that only incremental innovation occurs in the existing systems i.e., that of dominant actors. This view is supported by Weinstein and Bumpus (2016) who argue that the social technical regime of the current energy producing regime provides rigidity to the technological uptake of niches due to its extensive monopoly of scale. Geels (2019) put the position of Weinstein and Bumpus (2016) differently by postulating that technology and economic interaction mechanisms driven by capital costs of infrastructure, equipment and knowledge adds to the rigidity for technological uptake. These technology and economic lock-in mechanisms arise due to common interests of dominant actors which act against transitional change.

Another important factor which was identified by Weinstein and Bumpus (2016) as a hindrance to technological uptake of niches is the limited liability of owners in energy corporations and those that provide capital to these corporations. Geels (2019) referred to this limited liability as “Social and cognitive lock-in mechanisms” (p. 189). Geels (2019) further elaborated on this by stating that the development of norms arising from social togetherness of dominant actors prevents the uptake of new technologies. Further on, Wainstein and Bumpus (2016) argued that the lack of shareholder liability prevented feedback from ecological systems i.e., that which deals with the change in climate which in turn makes the existing system less likely to adopt a different path. The many reasons put forth in literature underline perhaps the biggest criticism of the MPL. This criticism was correctly framed by Rosenbloom et al. (2016) that despite the MPL’s thorough conceptualisation of social-technical change, the framework did not adequately deal with the role that bureaucracy and the political machinations that characterise transitions.

The MLP holds that the existing dominant structure would have to be disturbed before the niches created to aid the low carbon transition can be widely accepted. In fact, Weinstein and Brumpus (2016) raised an important argument that corporations will look to maximising owners returns through the advocacy of lock in arrangement with fossil fuel generation and will employ market “tactics” to prevent the emergence of renewable technologies. Ajaz and Bernell (2021), in support of Weinstein and Brumpus (2016), further postulated that the incumbent regimes tactics would include:

- *Reproduction:* The incumbent remains largely stable due to the absence of external pressure.
- *Transformation:* The incumbent responds by altering the path of the niche as the niche is not adequately developed. This is done to provide the incumbent with a way to slowly adapt to the changing structure without adversely affecting the structure of the incumbent regime.

The argument here is that the survival of some mining companies from an owner's perspective is dependent of a prolonged transition to ensure maximisation of returns. This position is however in constant battle to the advocacy of limiting emissions by 2030 and net zero by 2050 (PWC, 2020).

The landscape aspect of the MLP is the broader environment that influences the developed niches. The landscape is largely driven by societal pressures such as the need to address climate change (Canitez, 2019). The multi-level perspective does suffer from criticism from the point of view that it does not advocate for urgency in transitions (Ajaz & Bernell, 2021).

2.2.3 Strategic niche management

Strategic niche management (SNM) is another approach to understanding transitions who's objective is to understand the elements that make niches a success (Chang et al., 2017). Strategic niche management first appeared in the 1990s when an understanding was being sought as to why innovations such as the electric vehicle could not make it from the research and development phase to mass production (Ruggiero et al., 2018). Early research by Kemp and Schot (1998) found that very few vehicles were able to be sold by car manufacturers despite announcements on how environmentally friendly they were. Kemp and Schot (1998) argued that there existed numerous barriers to entry for vehicle technologies at the time. These barriers as identified by Kemp and Schot (1998) included technological factors, lack of an enabling government policy and regulatory framework, cultural and psychological factors, production factors, and poor infrastructure and maintenance regimes. To this effect, Kemp and Schot (1998) argued that the diffusion of technologies that stemmed from niche innovations could best be achieved through the understanding and application of strategic niche management. Kemp and Schot (1998) further went on to define strategic niche management as "the creation, development, and controlled phase out of protected spaces for the development and use of promising technologies by means of experimentation with the aim of 1) learning about the desirability of the new technologies and 2) enhancing further development and the rate of application of the new technology" (p. 186). According to Kemp and Schot (1998), the aim of strategic niche management was on ensuring an iterative process of learning that was to be brought about by collaboration amongst actors. This learning

process was performed in “protected” spaces with an objective of ensuring that institutional connections and adaptations are formed to further develop new technologies (Kemp and Schot (1998). According to Stiles (2020), the main objective of SNM according is the facilitation of niche innovations into the mainstream beyond the level of experimentation. To the extent of developing an objective, Kemp and Schot (1998) and Stiles (2020) agree that strategic niche management seeks to develop niche technologies in a protected space and get buy in from all stakeholders i.e., government, social actors, scientists, lobby groups etc., without who’s buy-in such technology would not be able to stand on its own in the mainstream and would therefore not be able to compete against incumbent regimes.

Strategic niche management has later been defined by Stiles (2020) as a deliberate effort aimed at developing upcoming technologies that are more sustainable than current existing ones. One of the key fundamental differences between the definition put forth by Kemp and Schot (1998) and that of Stiles (2020) is the introduction of sustainable technologies in the latter. This is especially important because the advent of new technologies should not result in the destruction of economic, environment, and social aspects of society as we know it. Indeed, the transition to a low carbon economy should be conducted in a way that pivots new technologies to subscribe to the definition stated by Stiles (2020). It must however be mentioned that even though Kemp and Schot (1998) did not explicitly mention sustainability in their definition, they raised the element of sustainability in the stated objectives of strategic niche management.

According to (Stiles, 2020), one of the methods through which SNM is made possible is through the creation of policies that are friendly to the development of innovations. Kemp and Schot (1998) agrees with this assessment and further argued that the role of government in this instance is to first understand that niches are a foundation for interactive activity which are shaped by many actors. Therefore, Kemp and Schot (1998) found that governments should not aim to control niches but rather adopt policies through a five-step process of “a) the choice of technology, b) the selection of the experiment based on the choice of technology, c) the set-up of the experiment, d) scaling up of the experiment, and e) the breakdown of protection of the incumbent regime” (p. 186). To this effect, many countries use SNM to improve their competitive edge through the advocacy of policies such as an increased spend on research and development (R&D) as a percentage of GDP. Such policies are enacted to counter barriers to the adoption of new innovations (Stiles, 2020).

In their arguments, Ruggiero et al. (2018) stated that upcoming innovations are prevented from upscaling due to rules that govern the dominant social technical regime which consists of policy makers, scientists, companies, and users of the technology. Stiles (2020) agrees with

Ruggiero et al. (2017) by further stating that market demand dynamics and cultural practices are further barriers to the adoption of niche innovation. Ruggiero et al. (2017) does however agree with the multi-level perspective which states that transitions happen due to the dynamic interaction of players wherein the social technical regime offers a resistance to change. A key take-away from Ruggiero et al. (2018) is that social technical change happens but that it does so in market niches. It is further argued that the establishment of such market niches only happens when new innovations offer significantly greater benefits for a particular purpose or for a group of end-users (Ruggiero et al., 2018).

In addition to the position articulated by Ruggiero et al. (2018), Xue et al. (2016) argued that three processes are key for niche innovations to be successful: these include “voicing and shaping of expectations, building of social networks, and the learning process” (p. 3). The voicing and shaping of expectations, which is referred to as the coupling of expectations by Kemp and Schot (1998) involves the mapping of the new technology where the actors interested in the technology promise and drum up expectations that will be brought about by the new technology. Kemp and Schot (1998) argued that the promise of new technology must be supported by credible facts that emanate from credible testing and should adequately highlight the social, environmental, and economic benefits. It is clear that for niches to be successful, they must be widely accepted by the social technical regime and should offer a process of learning in driving sustainability.

The building of social networks, which was referred to as network formation by Kemp and Schot (1998) involves bringing together actors with vested interests in the technology and have enough passion to protect the technology from dominant incumbent regimes. In support of Kemp and Schot (1998), Holden et al. (2021) argued that strong strategic alliances are critical in the success of new technologies and it is almost impossible for one actor or a group of actors to have the ability to implement such technology. In building social networks, it becomes important to involve the intended users of the technology as well as environmental groups (Furnaro, 2020; Kemp & Schot, 1998). The learning process is referred to as the development of the articulation process by Kemp and Schot (1998). It involves the articulation of the policy of the government on the new technology and the adoption process Kemp and Schot (1998) e.g., National development plan in South Africa, the determination of specifications and other technical aspects for the new technology Kemp and Schot (1998) e.g., increase of self-generation from renewables to 100 MW by the Department of Minerals and Energy, the articulation of societal culture and psychology in what the new technology means, and the articulation of the supply chain for the new technology Kemp and Schot (1998) i.e., production, market, and distribution.

It therefore becomes crucial to understand whether renewable energy technologies offer advantages to mining companies and whether these advantages are deemed enough to formulate a market niche. It is important to differentiate between market niche and social technical niche. The latter being innovations that are currently in experimentation phases that then develop into the former (Ruggiero et al., 2018). Strategic niche management advocates for the protection of social technical niches but states that once these innovations reach market niche, they are able to drive social technical change (Ruggiero et al., 2018).

Similar to the development phase of the MPC, the aspects of development in the early phases of an innovation are rarely noticed due to the considerable barriers that exist during these stages (Geels, 2016). Niche management is one particularly powerful approach to transitions in situations where the current technology is not capable of solving a societal problem (Geels, 2016). In the case of climate change for example, fossil-based fuel energy generation has continuously contributed to global warming; the extent of which is that different technologies that do not depend on fossil fuels need to be developed in order to transition to a low carbon economy.

2.2.4 Transition management framework

Transition management is another sphere of approaches to transitions that has been studied over the last few decades (Canitez, 2019). Silvestri et al. (2018) defined transition management as a reflective process of governance that aims to influence the dynamics in society by encouraging multiple experimenting amongst actor, searching, and the creation of a knowledge process aimed towards the creation of a sustainable future. Transition management according to Jhagroe and Loorbach (2015) advocates that the duo process of using a top down approach to planning and market based tactics is not enough in solving complex societal problems such as climate change. In developing an understanding of how societal actors deal with complex societal issues, Loorbach (2010) proposed a transition management framework based on four types of actions which are relevant to societal transitions. As depicted in figure 1, these actions were postulated by Loorbach (2010) as being strategic, tactical, operational, and reflective. Transition management actions exist within a set of transition management principles (Silvestri et al., 2018).

Silvestri et al. (2018) found that a set of eight principles form the foundation of transition management, which principles include

> a) content and process are inseparable; b) long term thinking guides short term policy; c) objectives should be flexible and adjustable; d) timing is critical, using equilibria or disequilibria; e) creating of protected spaces for change agents to build up alternative

regimes; f) steering from outside a societal system is not effective; g) focus on social learning; h) participation from the interaction of stakeholders is necessary. (p. 4).

It is upon the foundation of these eight principles from which the determination of the four actions i.e., strategic, tactical, operation and reflective are determined and different transition management process methodologies are established (Silvestri et al., 2018).

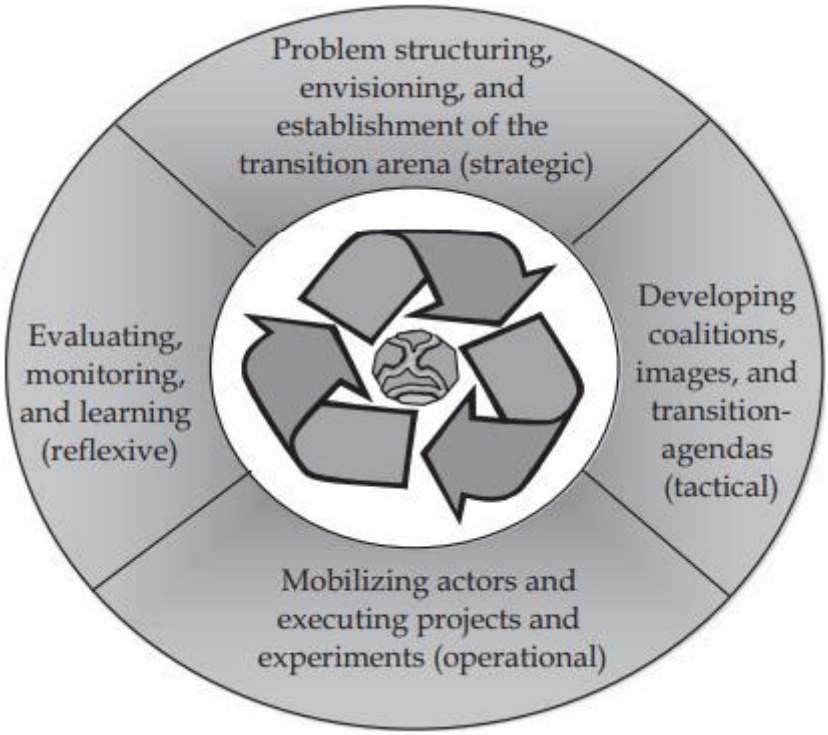

Figure 3: Transition management framework (Loorback, 2010)

Strategic activities were defined by Loorbach (2010) as those activities that involve the setting out of a vision. They involve long term goal setting, long term planning, policy formulation, and stakeholder consensus. In the case of a transition to a low, the Kyoto protocol is a case in point for a long-term goal where a vision to reach net zero emissions by 2050 is articulated. From this vision, long term planning is instituted where member states pledged the reduction of emissions per capital in the form of national determined contributions (NDC). South Africa further developed the Integrated resource plan in 2019 as a policy document to drive the reduction of fossil fuel power generation in line with the National development plan (NDP) to drive economic development. (Loorbach, 2010) contended that at a strategic level, debates on the role innovation will play in achieving the intended vision is implicitly implied rather than systematically structured. It is implicitly implied that net zero must be achieved by 2050 in the Kyoto protocol with suggestions of various innovations i.e., renewables, electric vehicles etc., to achieve this vision but further detail of exactly how this must be systematically structured is

not provided. This in essence encapsulates the strategic action of transition management in the context of societal transitions.

Following the establishment of the strategic actions, (Loorbach, 2010) stated that tactical actions must be established. According to (Loorbach, 2010), tactical actions relate to actions that involve dominant structures and societal subsystems. In South Africa, dominant structures referred herein include regulatory bodies such as the National Energy Regulator of South Africa (NERSA), specification setting bodies such as SABS, Eskom, and any other special groups that have a vested interest in the production and consumption of energy. Loorbach (2010) further stated that societal subsystems relate to sources of energy such as coal mines, gas producers, and policy developing entities such as the Department of trade and industry (DTI). The actions developed by subsystems at a tactical level are mostly confined to being achieved within a specified period and thus mostly never concern themselves with the overarching societal transition (Loorbach, 2010). It therefore becomes important that the actions of actors at a subsystem level are aligned at a system level i.e., strategic level in order to facilitate sustainable societal transitions.

Operational actions have a shorter term horizon and are usually performed through experimentation and projects (Loorbach, 2010). Innovation activities are the main component of operational actions where niches are housed and taken through the pre-development, take-off, breakthrough, and stabilisation phases. Lastly, the transition management framework as postulated by Loorbach (2010) suggests that reflective actions take place through the monitoring and evaluation of the vision set out in the strategic actions, the policies developed in the tactical actions and the innovations developed to achieve the vision in the operational actions. These reflective actions save as a feedback loop in refining the strategic, tactical, and operational actions insofar as a drive towards establishing a sustainable societal transition is concerned. It is important to note that the transition management framework as depicted in figure 1 does not constitute a linear process with a sequence of events. It is a cyclical framework where adjustments to the vision a made depending on whether the results obtained during the execution of tactical and operational actions are in line with the stated strategic goal(s) (Loorbach, 2010).

Transition management as postulated by Shum (2017) involves elements of the MPC approach and the strategic niche management (SNM) approach wherein innovations housed in niches that have potential are taken through the four stages of the MPC are protected and were this protection of innovations can take different forms. Twinomucunguzi et al. (2020) took the view of Shum (2017) even further by stating that in practice, transition management involves not only the MPC concept and SNM as identified by Shum (2017) but includes the

MLP as well. In as far as the protection of niche innovations is concerned, Shum (2017) proposes the establishment of subsidies as a protection mechanism for niche innovations in the context of energy transitions. It was recognised by Shum (2017) that renewable energy systems have a large upfront capital requirement and therefore, to protect the adoption of such systems, policy should be directed at subsidising the initial upfront capital expenditure of these systems. Secondly, Shum (2017) proposed the use of income subsidies. These approaches would take the form of paying the generating company for all the energy supplied into the grid or the excess energy supplied into the grid (Shum, 2017).

Goddard and Farrelly (2018) postulated that transition management is a purposive approach to transitions. Transition management is underpinned by an understanding that any transition requires involvement of key stakeholders to be sustainable. This involvement as stated by Goddard and Farrelly (2019) should focus on the elements of participation, reflection and adaptation of a governance approach that is intertwined. However, Canitez (2019), stated that studies of transition management have often found that this important aspect of participation becomes a hindrance In ensuring sustainable transitions because exhaustive participation does not take place. This view was supported by Goddard and Farrelly (2019) who argued that while the transition management approach is touted as democratic, it is often criticised as giving preference to technical and entrepreneurial participants and leaves behind the voices of the societal actors. This view was also supported by Harrahill and Douglas (2019) who argued that the conversations around transitions are often dominated by businesses who advocate that their position is the only viable solution.

Theoretically, transition management can be able to deliver energy justice only if the voices of all stakeholders are considered during decision making processes (Goddard & Farrelly, 2019). It therefore becomes important that this gap identified by Canitez (2019), Goddard and Farrelly (2019) as well as Harrahill and Douglas (2019) that pertains to the “total” participatory nature of transition management be closed in order to ensure a sustainable outcome in a transition.

2.2.5 Just transition

The increasing attention to the attainment of climate justice does not adequately define the fact that doing so in a socially just manner means that energy justice must be provided for the more that 1.6 billion people worldwide (International Energy Agency [IEA], 2012, as cited in Newell et al., 2013). Furthermore, the process leading to a net zero carbon economy by 2050 will have tremendous ramifications for labour, income distribution, and small business (Galgóczi, 2020). Newell et al. (2013) argued that the notion of a just transition has become synonymous with the pursuance of climate justice as it identifies with the different trade-off that must be made amongst different competing interests. Building on the work of Newell et

al. (2013), Galgóczi (2020) postulated that the journey to a net zero carbon economy i.e., that which entails accomplishing the objectives of climate change plans and bringing climate change under control will only be possible if this process is just and balanced. To this effect, Stevis and Felli (2015) stated that discussions around just energy transition have remarkably not involved labour unions, which unions represent a large proportion of workers in the energy industry and thus representing the rights of such workers.

South Africa has indeed taken from this statement in the formation of the Presidential Climate Commission (PCC). The commission is tasked with advocating the just transition policy for South Africa and the framework within which this just transition will be pursued. The dialogues being initiated by the PCC such as the dialogue on policy dynamics, the dialogue on coal value chain, the dialogue on employment and livelihoods, and the dialogue on financing a just transition etc., aim to achieve exactly what Stevis and Felli (2015) found to be the gap in discussions around the just energy transition by ensuring a multi-stakeholder participation which is inclusive of labour and communities in such dialogues.

Discussions around a just transition began during what Goddard and Farrelly (2019) described as the “environment vs jobs” (p. 112) discussions in the 1990s in Canada. The scenario involved a pipeline from Tar Sand in Canada and had brought together differences amongst three labour unions and environmental activists (Clarke & Lipsig-mummé, 2020). The just transition framework sought to establish a balance between environmental legislative requirements at the time and the security of jobs for workers. The work on the just transition culminated in the insertion of the words “just transition” in the Congress of Parties 2010 conference in Paris (COP10), which was strengthened even further by adding it to the preamble of COP15 (Clarke & Lipsig-mummé, 2020) . This was hailed as a victory for labour as it was significantly advocated for by the international trade union movement and doing so opened the door for labour to play a more strategic position in discussions around jobs and the environment.

Patel (2021) found that “at its core, the just transition concept is concerned with elevating social justice in the global transition to sustainable economies and societies” (p. 6). This notion of a just transition stated by Patel (2021) is supported by the statement made by the General Secretary of International Trade Union Confederation (ITUC) as postulated in Clarke and Lipsig-mummé in 2021 that;

> The just transition will not happen by itself. It requires plans and policies. Workers and communities dependent on fossil fuels will not find alternative sources of income and revenue overnight. This is why transformation is not only about phasing out polluting sectors, it is also about new jobs, new industries, new skills, new investment and the

> opportunity to create a more equal and resilient economy (Just Transition Centre, 2017, as cited in Clarke and Lipsig-mummé, 2021, p. 356).

This statement underpins the huge political dichotomy that exists amongst leaders. For example, when the former United States president Donald J. Trump motivated for the United States to abandon the Paris agreement on climate change, he did so from a backdrop of a loss of jobs and stifled economic growth that might result from climate change mitigation and adaptation plans (Thomas, 2020). Galgóczi (2020) postulated that the just transition concept is two dimensional in its functionality. Dimension number one deals with outcomes of the transition i.e., how a new low carbon economy should look like from a new employment and social landscape point of view while the second dimension deals with the process i.e., how to get from the current economy to a new low carbon economy (Galgóczi, 2020).

It was stated by Patel (2021) that over the last few decades the concept of a just transition has been broadened by numerous authors into a proactive position that results in wider benefits for all citizens during the development of a sustainable economy. While the initial focus of a just transition was on workers, the just transition has been broadened to elevate the concerns of workers, the effect on communities within which industries that are meant to transition are located, and the effect on small and medium enterprises operating within these communities (Patel, 2021). As far as South Africa is concerned, the government set up the National Planning Committee (NPC) in 2010 which drafted the National Development Plan (NDP) in 2012 (Patel, 2021). A prescript of the NDP which deals with an equitable transition to a low carbon economy in South Africa resulted in a national dialogue on a just transition which took place between 2017 and 2019 where various stakeholders were consulted on the just transition process with a large focus on the province of Mpumalanga (Patel, 2021).

The Mpumalanga province in South Africa is home to Sasol's synfuels mega complex, Eskoms 12 coal fired power stations and numerous coal mines. Mpumalanga was identified as a critical province during the just transition dialogue process owing to the impacts of air, water, and soil pollution that results from mining activities, energy, and fuel generation (Patel, 2021). Table 1 shows a summary of the approaches to the just transition in South Africa at different levels i.e., national, regional, and industry. It also shows the problems addressed and the immediate outcomes for South Africa. More importantly, Patel (2021) argued that "the dimensions, strategies, and timing of the just transition, and especially the reduction in emissions through 2050, remain poorly defined and contested" (p. 9). The argument put forward by Patel (2021) does not take away from the fact that South Africa has developed an interactive document in the form of the integrated resource plan, which is based upon the work of the NDP, however,

political discourse in driving the implementation of the IRP has largely lacked cohesiveness and thus the argument put forward by (Patel, 2021).

Table 1: Dimensions of a just transition at different levels (Patel, 2021)

	Industry	**Regional**	**National**
Immediate problem	An industry must downsize if pollution and emissions costs are fully internalised, and workers bear the cost through job losses	A community depends on an industry that is no longer sustainable	Transition to new, sustainable economy, especially energy systems, will only be viable if ultimately it benefits the majority
Broader aims	Voice for working people in transition process; decent alternative livelihoods; greater equality for vulnerable groups	More diversified and resilient economy; local people have voice in transition; more equitable incomes and wealth with continued growth	Disruption of the transition ultimately lays the basis for a more equitable, inclusive, and dynamic economy
Political debates	What institutional structure can ensure a just transition Extent of social protection for affected workers Usefulness of retraining How to fund programmes and at what level	What institutional structure can drive economic diversification? How to identify viable clusters and value chains for diversification Role of small/emerging vs large/established businesses Role of different spheres of the state How to resource	Should the focus be on the energy transition alone; on reducing emissions in other industries (agriculture, cement, etc.); on building resilience to impacts of climate change (droughts, flooding, etc.); or on measures that build a more inclusive economy even if they do not link to climate change (e.g., land reform, BIG, etc.) What governance systems can drive the transition more effectively while securing a real participatory democracy?
Political economy	Organised workers can often block change if they will end up bearing the cost without support	How to prioritise affected regions if they are not among the poorest in the country? Managing the risks of industrial policy	Managing risks and costs of disruptive change Maintaining a coalition for change

2.3 Integration of literature

Evidence from the surveyed literature shows distinct commonalities among the 4 main frameworks used to study transitions. The MPC advocates for the transitions to be guided through 4 phases of development beginning with the pre-developmental phase, moving onto the take-off phase, thereafter the breakthrough stage and culminating into the stabilisation stage. The MLP framework discusses the need for dynamic interaction between the niche, the social technical regime, and the social landscape. The MPL framework is criticised for not be urgent in driving transitions and establishes that the social technical regime of powerful incumbent players plays a crucial role in hindering the adoption of niches. The strategic niche management framework establishes that it is important to establish protection around social technical niches in their development to market niches. It also identifies and agrees with the MPL framework that a powerful social technical regime hinders the development of social technical niches into market niches. The market niche view of the strategic niche management framework also identifies and agrees with the MLP frameworks take off stage of development. The surveyed literature however does not elaborate on how the management of these transitions can be undertaken using the MPC, MLP or strategic niche management in leading to a sustainable outcome.

The transition management framework to an extent explains the management of a transition with advocacy for sustainability firmly placed on the aspects of participation for all stakeholders. The transition management framework bears the hallmarks of the strategic niche management and MLP but has the added component that for sustainable transitions to occur, it is essential that there is adequate consultation and participation from all the stakeholders. Literature on the just transition agrees with elements of the transition management framework of sustainability of social technical transitions being largely dependent on multi-stakeholder participation of actors i.e., civil society, labour, scientists, policy makers, entrepreneurs, SMMEs, and communities.

The South African energy landscape, of which mining plays a crucial role in both production and consumption is a very unique setting. On the one hand as shown in figure 1, the production of energy from fossil fuels is largely dominated by coal. On the other hand, energy consumption by mining accounts for 15 percent of total energy produced (Ratshomo & Nembahe, 2019). This signifies that a transition to a low carbon economy requires huge structural shifts in the energy landscape. Having reviewed the literature, it is evident from the MPC, MPL, and SNM are not adequate to address this huge structural shift in South Africa's mining industry for the aforementioned reasons. This study therefore pivoted on the transition management framework as the anchor theory to guide this study. The research questions

developed in the next chapter i.e., chapter 3 are thus borne from the transition management framework.

2.4 Conclusion

The literature review section has explored a number of aspects in relation to the topic of a transition to a low carbon economy. South Africa's mining industry constitutes a large portion of fossil fuel mining in terms of coal as well as a large consumer of energy in terms of other commodities. To this effect, the mining industry is a critical player in South Africa's transition to a low carbon economy. This study aimed to gain insights on how this role was being fulfilled by the South African mining industry against the backdrop of the literature reviewed in as far as transition management was concerned. Furthermore, literature into what constituted a just transition reviled that there exist commonalities between the transition management framework and the just transition concept especially where dialogue with organised labour, SMMEs, and communities is concerned. To this effect, this study further aimed to understand the extent to which the transition management approach of South Africa's mining industry allowed for elements of the just transition concept through the allowance of a participatory dialogue with key stakeholders.

The study asked four questions to establish this understanding. These four questions and their intended objectives will now be dealt with in Chapter 3.

CHAPTER 3: RESEARCH QUESTIONS

3.1 Introduction

Given the importance that the mining industry plays in the South African economy, the purpose of this study was to understand the way in which the South African mining industry is approaching the transition to a low carbon economy in relation to the transition management framework. The transition management framework postulated by Loorbach (2010) is a non-linear 4 step process of strategy, tactics, operational and reflection. It is argued by many scholars in the reviewed literature that sustainability transitions can be studied using four frameworks of the MPC, MPL, SNM and transition management. As established in the concluding remarks of chapter 2, the anchor theory of this research study is transition management owing to the criticisms levelled against the MPL, MPC, and SNM.

To this extent, four research questions were developed with the aim of adding to the academic debate on transitions through the transition management framework.

3.2 Research questions

Research Question 1*: How do mining companies decide if climate risk is material to their business?*

Strategic activities were defined by Loorbach (2010) as those activities that involve the setting out of a vision. They involve long term goal setting, long term planning, policy formulation, and stakeholder consensus

The objective of this research question was to understand the fundamentals of strategy and the foundations upon which such strategy is built in line with the vision setting outlined by Loorbach (2010). Risk management is a cornerstone of any decision-making process and as it outlines how organisations will implement mitigating actions commonly known as controls for the identified risks. Implementation of controls has many implications on organisations. Some of these implications include cost from a capital budgeting point of view, cost from an insurance point of view insofar as business interruption cover is concerned, cost from a taxation point of view insofar as carbon taxes are concerned, as well as cost from a weighted average cost of capital point of view where access to capital markets is concerned. Other implications safety of personnel from adverse effects of climate change, and environmental degradation and/or damage.

Research Question 2*: How are mine companies climate strategies aligned to transition management framework?*

The transition management framework has been criticised for not being democratic by only allowing views by dominant actors to dictate how transitions should be undertaken (Goddard

& Farrelly, 2019; Harrahill & Douglas, 2019). The objective of this question was to establish to what extent were the findings of Goddard and Farrelly (2019) and Harrahilll and Douglas (2019) play a role in the climate change strategies of mining companies.

Research Question 3*: What mechanisms are being put in place by mining companies to ensure a just transition to a low carbon economy?*

Galgóczi (2020) postulated that the just transition concept is two dimensional in its functionality with the first dimension dealing with outcomes of the transition i.e., how a new low carbon economy should look like from a new employment and social landscape point of view and the second dimension deals with the process i.e., how to get from the current economy to a new low carbon economy (Galgóczi, 2020).

The objective of this research question was to understand the just transition fundamentals of the transition to a low carbon economy. The just transition framework has been touted by the international labour organisation as a framework that does not cause distress to workers and/or communities in which industries that are transitioning are located.

Research Question 4*: What niche innovations are mining companies supporting to enable the transition to a low carbon economy?*

This study pivots upon the transition management framework as the anchor framework for studying transitions as evidenced from the literature study. A key element of the transition management framework in its advocacy for sustainable societal transitions is the requirement that niche innovations should be protected and harnessed until they can “stand on their own” and are able to fight dominant actors.

Transition management as postulated by Shum (2017) involves elements of the MPC approach and the strategic niche management (SNM) approach wherein innovations housed in niches that have potential are taken through the four stages of the MPC are protected and were this protection of innovations can take different forms. Twinomucunguzi et al. (2020) took the view of Shum (2017) even further by stating that in practice, transition management involves not only the MPC concept and SNM as identified by Shum (2017) but includes the MLP as well. In as far as the protection of niche innovations is concerned, Shum (2017) proposes the establishment of subsidies as a protection mechanism for niche innovations in the context of energy transitions

To this extent, the objective of this research question was to gain an understanding of which niche innovations were being housed by mining companies and how these niche innovations were being protected from dominant actors.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

This chapter focusses on the research methodology that was adopted for this study. More specifically, it focusses on the use of interpretivism as the chosen research philosophy. It further provides a justification on the adoption of a qualitative research strategy to investigate the objectives and the research questions of the study. The chapter further elaborates on the time horizon, population, unit of analysis, measurement instrument, data collection, data analysis and ends with a description of what the methodological limitations of the research study were.

4.2 Research design and philosophy

According to Saunders and Lewis (2018), there are five research philosophies in business research. Of the five philosophies, the research philosophy that was followed for this study was the interpretivism philosophy. The objective of the interpretivism philosophy is to study social trends as they happen in their naturally occurring environment (Saunders & Lewis, 2018). The interpretivism philosophy, is also known as paradigm, as argued by Malterud (2016) in that it supports beliefs about experiences from human subjects, who experience these beliefs in their own contexts from different perspectives. The objective of this study was to understand the role of the South African mining sector in the sustainable transition to a low carbon economy.

Scotland (2012) clarifies the interpretivism further by explaining that it has ontology which is what constitutes knowledge and epistemology which is how knowledge is developed. In this study, what constituted knowledge was the lived experience of the mining industry during the time of climate change and what constituted the how knowledge is developed is the impact of those realities in their environment which is mining industry. This is the basis of collection of the empirical data using the semi-structured interviews.

The human participants who provided information did so in their own contexts. They also did so from their perspectives with a view of providing insight on the role that the mining industry will play in the sustainable transition to a low carbon economy in South Africa. It therefore holds as stated by Saunders and Lewis in 2018 that the “social actors” (p. 109) are the individuals who work in the mining industry and who’s involvement and decision-making shapes the role of mining in the transition to a low carbon economy which further supported the use of the interpretivism philosophy as the required research philosophy for this study.

4.3 Approach to theory development and purpose

According to Saunders and Lewis (2018) there are three types of theory development. Deduction is a form of theory development involving five sequential steps of theory

development beginning with the formulation of research questions derived from already existing theory (Saunders & Lewis, 2018). This approach is summarised by Malterud (2016) as the development of theory that begins with a generally acceptable law in order to explain observations.

In this study, a literature review of the existing theory has established that there are 4 main areas of theory that describe studies of transitions. These four areas are however not fully exploited from a study of transitions perceptive, let alone transitions which involve a large structural societal shift as the one that this research was studying. From these four areas, the study pivots on transition management with a view of understanding the extent to which climate change strategies of mining companies are aligned to the transition management framework. Using already existing theory from the transition management framework, upon which the climate change strategies can be analysed, research questions were developed for this study from the body of theory therefore adopting a deductive theory to research development.

Induction is an area of theory development that involves the observation of general patterns and the testing of these patterns to develop theory while abduction involves a mixing of induction and deduction (Saunders & Lewis, 2018). The transition to a low carbon economy in the mining industry in South Africa is a relatively new phenomenon. As such, the observation of patterns to facilitate inductive or abductive research would require a considerable amount of time. This is another reason why deduction is deemed an appropriate approach to theory development for this study.

Saunders and Lewis (2018) describe exploratory research as that which involves unearthing information which is not well understood by the researcher. The sustainable transition to a low carbon economy in South Africa is a relatively new phenomenon and is not well understood. While theoretical frameworks on how to manage transitions exist, very little work has been done in understanding how the South African mining industry fairs in developing their strategies to ensure a sustainable transition. Several pronouncements on transitioning to a low carbon economy have been made by many resource majors i.e., Anglo-American's development of a hydrogen truck, Sasol's accelerated decarbonisation plan etc., albeit the extent to which these plans align to a theoretical framework on sustainable transition was not fully understood. This purpose of this study was to unearth this information using exploratory research. As an exploratory study, data was collected using semi-structured interviews with questions which built on insights sought by the four research questions. It is stated by (Kallio et al., 2016) that semi-structured interviews are the most frequently used method of collecting information in qualitative research. Even though semi-structured interviews may be viewed as

easy, it is important for the researcher to take into consideration several criteria in the preparation of an interview guide (Kallio et al., 2016).

4.4 Research strategy

Qualitative research is stated by Beuving and De Vries (2020) as a broad effort whose aim is to explain social reality using language as a medium. This objective of the study was to gain insights into the role of the mining industry in the transition to a low carbon economy. These insights were gained from the insider perspective where the participants to the study provided the researcher with an understanding of how they have approached this role in relation to study's research questions through semi-structured interviews based on their organisational experiences. Based on the definition given Beuving and De Vries (2020), this study adopted a qualitative method of research. Basias (2018) argues that qualitative research is best positioned to answer questions which seek to understand what, how, when, or where of a phenomenon. Basias (2018) further argues that research in developing areas can best be undertaken using the qualitative approach. Transition management in the context of a low carbon economy is a relatively new phenomena in South Africa. Furthermore, transition management theory is still at a hypothetical stage and might require 10 to 20 years before is it completely validated (Chang et al., 2017). The research questions that were posed for this study emanated from the literature review and inquired about the how and what of transition management in line with the argument put forth by Basias (2018) that qualitative research best answers questions of what and how a phenomenon occurred. Given the research questions posed for this study as well as the novel nature of transition management in the context of South Africa, a qualitative study was necessary in line with the argument put forth by Basias (2018).

4.5 Time horizon

This study followed the cross-sectional research design. Saunders and Lewis (2018) states that cross-sectional research provides a "snapshot" of a particular research setting where data is collected from multiple sources at a particular point in time. In this study, data was collected over a short period of time from multiple sources in the mining sector. Climate change strategies are developed and approved by senior executives or managers in the resource industry given the implications, financial or otherwise that are placed on the business. Frequent access to senior executives and managers is difficult and that makes the tracking of changes over time difficult, this in turn made the use of a longitudinal study for this research inappropriate. Furthermore, climate change strategies as with most business strategies have a long-term life span and changes in one year to these strategies are rare. As such, semi-structured interviews were used to collect data from executives and senior managers in a

given time. Given that time was a limiting factor in this research, as well as the fact that data was collected in a short period, the cross-sectional approach was deemed appropriate

4.6 Population

A population is a complete set of group members wherein the intention is for the researcher to make interpretations (Saunders & Lewis, 2018). Given this definition, the population intended for this research were all the mining companies operating in South Africa. According to the mineral's council of South Africa (Minerals Council, 2021), there are 80 mining companies who are members of the council. These mining companies are spread across various commodities including but not limited to coal, platinum, zinc, iron ore, vanadium, diamonds & chrome. All these mining companies formed the population of this study. It must however be noted that given the cross-sectional nature of this study, whose limitations of time and where data was collected over a short period of time, the members of the population that were targeted to form a sample were from a sub-group of this population.

4.7 Unit of analysis

A characteristic of the interpretivism research philosophy is that the unit of analysis are the individuals or objects that have a shared experience. These can be individuals, groups, businesses or organisations, communities, or artefacts (Zikmund et al., 2010). In the case of this study, the mining companies that have a shared experience in as far as the transition to a low carbon economy is concerned are those that have developed climate change strategies in response to the sustainable transition to a low carbon economy, the unit of analysis was therefore the mining companies faced with transition to a low carbon economy. To be specific, transition applicable to mining companies who have made decisions related to strategy, integration of environmental, social and governance mechanisms (ESG) into strategy and sustainable development practitioners. The sources of information were individuals working in the mining companies that enabled a better understanding of transition to a low carbon economy.

4.8 Sampling method

The population described for this research study stemmed from members of the Mineral's Council of South Africa, a number which stands at 80. It is however noted that some mining companies in South Africa are not members of the mineral's council and as such were not the focus of this study primarily because very little was known about their operating philosophies let alone their stance on driving a transition to a low carbon economy. In a case such as this, Saunders & Lewis (2018) states that a non-probability sampling technique is appropriate as a sampling method. Non-probability sampling is characterised by the researchers judgement to make decisions on which sample will best answer the proposed research questions (Sunders

& Lewis, 2018). When this is done, the sampling is referred to as purposive sampling as the researcher will make the decision on the sample based on certain considerations such as:

- Is the mining company listed – listed companies face reporting scrutiny from stakeholders on a range of metrics which increases access to data.
- Does the mining company have an ESG mechanism/framework/policy?

These mining companies were represented by individuals in management roles that are involved in strategy and risk as it related to climate change. The sample included mining companies involved in different mining commodities such as diamonds, coal, platinum, and vanadium. Coal mining companies were included in the sample as they bear the brunt of the transition to a low carbon economy. It is widely reported that fossil fuels are the biggest contributors of emissions and their views on the transition were important in establishing relevance to the research questions. Platinum mining companies were included because their produce metals that are used in limiting emissions in vehicles. Their views were important in establishing relevance to the research questions insofar as they saw the transition. Other mining companies included in the sample were mining companies that produce raw materials that will drive renewable energy end products such as battery storage, solar panels, hydrogen innovations, and wind generation. Furthermore, industry bodies that provide finance as well as those that govern legislation in mining were included in the sample.

To determine the appropriate sample size, it is important to understand the concept of data saturation. Data is said to be saturated when no additional themes are found to change the response pattern of the units of analysis (Francis et al., 2010). Data saturation is used in qualitative research to estimate the required sample size (Guest et al., 2020). This concept of data saturation as noted by Boddy (2016) becomes useful in the determination of the sample size in qualitative research. A method to determine data saturation in qualitative interviews proposed by Guest et al. (2020) states that 12 interviews are adequate to ensure data saturation and the emergence of themes in qualitative research. Boddy (2016) does however provide criticism for using saturation in estimating sample size by noting that saturation does not provide adequate guidance at a conceptual level for estimating the sample size prior to undertaking the research. The practical limitations noted by Bobby (2016) are cost and time related in that it is difficult to ascertain these when a sample size has not been predetermined prior to undertaking the research. To this effect, Bobby (2016) proposes another view on the determination of sample size after studying a considerable amount of qualitative research studies. This view is based on the fact that a sample size of above 12 respondents is adequate for qualitative studies (Bobby, 2016).

Based on the work of Bobby (2016) and widely accepted concept of saturation, a sample size of 12 respondents was used for this study against which the data will be tested for saturation. The 12 respondents were chosen based on their role in the development and execution of climate change strategies from senior executives and managers. The participants were also chosen from organisations that had been in business for more than 5 years with a clear strategic view of climate change issue. This is because they have a greater appreciation of the direction the organisation must take in the transition to a low carbon economy. The table below shows the levels of personnel that participated in the interviews.

Table 2: Sample participants from different companies

Identifier	Level in organisation	Commodity
Company 1	Executive for mining, metals, and energy	Funder
Company 2	General Manager: Technical and sustainability	Coal
Company 3	Chief Executive Officer	Coal
Company 4	Manager – Energy and decarbonisation	PGMs
Company 5	Executive Vice President – Sustainability	PGMs & Gold
Company 6	Executive Head – Corporate affairs	Coal
Company 7	Chief Executive Officer	Coal
Company 8	Manager – Portfolio strategy and sustainability	Diversified Energy
Company 9	Executive Head - SHE	Bulk metals
Company 10	Manager Integration	Diversified PGMs
Company 11	Senior Manager - Renewables	Energy Production
Company 12	General Manager	Copper

4.9 Measurement instrument

The methods which can be used by a researcher to collect data are referred to as the measurement instrument, which in this study was an interview guide. Data was collected using an interview guide by conducting semi-structured interviews. The interview guide consisted of a list of ten questions, and these were administered in the natural environment of the participants. The objective of these questions aligned with the theoretical framework of transition management insofar as multi-stakeholder engagements, protection of niche innovations and re-skilling of labour. The interview was designed to gain the thoughts of participants to assist in answering the study's research questions through the lived experiences of the participants. (Dejonckheere & Vaughn, 2019) support the use of semi-structured interviews as a data collection method and further state that such data obtained using this measuring instrument is crucial to exploratory research and can be validated through triangulation of other data sources. To this effect, an interview guide (Annexure A)

was developed and administered in a semi-structured format using an online platform given the restrictions of the covid-19 pandemic.

Dikko (2016) stated that a measurement instrument designed for the collection of data should pass for both reliability and validity in order to be considered a good measure of data collection. Reliability deals with the ability of the measurement instrument to measure the concepts it is meant to measure with consistency and without bias (Dikko, 2016). Validity deals with the ability of the measurement instrument to adequately represent the concepts being measured (Dikko, 2016). Reliability and validity can of a measurement instrument can be established through a re-testing of the measurement instrument with the same sample and using a pilot study respectively. The piloting of a measurement instrument is defined as a miniature version of the full study with the objective of identifying unclear and ambiguous statements from the measurement instrument and establishing how well the measurement instrument will function (Teijlingen & Hundley, 2001, as cited in Dikko, 2016). Given the aforementioned reasons, the measurement instrument that was developed for this study was piloted to 4 individuals who resembled the envisaged sample. These individuals gave input into the phrasing of the questions and opinions on whether the questions where unclear or contained ambiguous statements. The feedback received from the piloting of the measurement instrument found that the measurement instrument was sound to be adopted for the main study and therefore no changes were made to the measurement instrument.

To this end, semi-structured interviews resulted in the collection of the empirical data with predetermined questions which lead to the coverage of the studies themes which inturn assisted with answering the study's research questions.

4.10 Data collection

Data was collected through semi-structured interviews conducted face to face on an online platform. Microsoft Teams meetings were used as the preferred online platform. The semi structured interviews took the form of a list of 10 questions that allowed for additional questions to be asked with the objective of garnering better insight into the position of the interviewee. The semi-structured interviews were recorded using the recording function in Microsoft teams and the interviewee was required to grant permission for such recording to take place. Furthermore, the interviewee granted written permission for the interviews to take place and additional permission was sought from the organisation to conduct research in each of the participants organisations. The average time taken for all the interviews was 36 mins.

An interview guide is an important tool for collecting data which is relevant to the research questions in qualitative research. This importance as argued Rn et al. (2016) is underpinned by the fact that it provides a cornerstone for consistency in the interview as well as provides a

linkage between the research problem, the developed research questions and the surveyed literature. To this extent, the interview guide was developed to provide the linkage between the research problem of how the mining industry in South Africa was planning on addressing the decarbonisation efforts in line with the 2050 targets set by the Kyoto protocol of achieving net zero emissions, the developed research questions which are elaborated on in chapter 3 of this study as well as the literature survey which pivoted on transition management as a framework for sustainable transitions. A key aspect in the development an interview guide as stated by Rn et al. (2016) is the researchers familiarity with the research topic. This familiarity was borne from an extensive survey of literature spanning more than 30 different sources.

Further familiarity with the research topic was gained through analysis of many hours of video from the International Energy Association (IEA), the Intergovernmental Panel on Climate Change (IPCC), South Africa's Presidential Climate Commission (PCC) and other industry led webinars on climate change. The first question of the interview guide was open ended with the subsequent questions more detailed in support of the literature on transition management. Further questions that were developed aimed to gain a deeper understanding of what the participants of the organisations deemed crucial to ensure a sustainable transition as well as the path to such sustainability. To ensure that there is accuracy in the data collected, clarity was sough on answers given during the interviews when it became evident that the interviewee may have forgotten some facts. Triangulation was established through the analysis of climate change plans and strategy documents of the companies represented by the participants.

4.11 Data Analysis approach

The recordings of the interviews where then transcribed by the researcher one interview at a time. The empirical data collected was then analysed using the four-step content analysis approach proposed by Bengtsson (2016). Following the transcription process, the coding of the data was conducted and analysed for data saturation. The transcribed data collected from the semi-structured interviews was prepared as text before analysis could be performed. (Sunders & Lewis, 2018) state that in the preparation of data, it is important to be consistent and apply the preparation formats the same to all the data collected. The data collected should be arranged in a manner that captures the dates of the interviews, the time, questions asked should be separate from the answers and the use of capital letter to signify what the interviewee ascribed importance to in the interview.

After the sorting of data, the process of data analysis which involves data codes was conducted. Codes are words or short phrases that encapsulate key attributes of verbal information. Following the establishment of data codes, the data was codified or categorised.

Categorisation of data was based on emergent themes wherein similar themes were grouped together. Qualitative relationship analysis was conducted using software in the form of ATLAS.ti.

4.12 Quality controls

Saunder and Lewis (2018, p.134) define validity as the "extent to which (a) data collection method or methods accurately measure what they were intended and (b) the research findings are really about what they profess to be about."

Data collection through semi-structured interviews can get lost in translation. To this effect, data collected was recorded to avoid any loss of information. Rogers and Roethlingsberger (1991) argue that barriers to communication can result from a natural tendency to evaluate. This evaluation comes in the form of judgement, approval, or disapproval of another person's statement (Rogers & Roethlingsberger, 1991). This can create a data quality situation for research dependent on semi-structured interviews. To prevent this, the semi- structured interviews was conducted in a manner that was facilitated through dialogue to allow for feedback and seeking of clarity where information was not clear. Furthermore, the developed interview guide was used to conduct all the interviews for the research study i.e., each participant was asked the same questions, which allowed for reliable and valid data.

There were four strategies that were employed to establish trustworthiness in the study. These included credibility, transferability, dependability, and conformability as argued by (Lemon & Hayes, 2020). From these strategies, credibility is the strategy that aims to establish the underlying truth of the research i.e., the establishment of the research's internal validity (Lemon & Hayes, 2020). Lemon and Hayes (2020) state that credibility seeks to subscribe a level of confidence to the research finding of the phenomenon which is under investigation. One of the methods used to establish confidence in research findings that is suggested by Lemon and Hayes (2020) is triangulation. It is defined by Lemon and Hayes (2020) as a strategy through which data from different sources converges. This view is supported by Moutinho et al. (2018) who argue that data from mixed collection methods is crucial in the establishment of credibility in a research study. To ensure triangulation, publicly available mining company information relating to climate change strategy, investor days ESG pronouncements, and information relating to transition to a low carbon economy was consulted in conjunction to the semi-structured interviews that were conducted. This was done to ensure the convergence of data and reduce the risks of having conclusions from a singular source of data as suggested by (Moutinho et al., 2018).

Transferability of the empirical findings was ensured by having different commodity sectors as part of the interviews as explained already and presented in Table 2. Unlike quantitative

studies which seek generalisability, the transferability was adequate in this study, and would allow to transfer to similar settings, within the context of the limitations which are discussed later in the study. Confirmability is the last strategy of the trustworthiness, which is focused on ensuring that there is evidence of the level of confidence that the findings in the study are based on the interviews or the narrative of the participants rather than on the bias of the researcher. In this study this was done by using an evidence-based findings wherein the quotations from the transcripts (verbatim) were included to support the findings of the study. This was done throughout the findings in Chapter 5.

4.13 Limitations

Given the fact that information relating to sustainability may at times be confidential, the lack of forthcoming information from the respondents was a limitation to gaining a broad insight into study. A typical example of this was when some of the participants indicated that they could not disclose certain information that might affect their competitive edge. Organisations that were far along the transition to low carbon spectrum typically highlighted that some of the information surrounding niche innovations could not be disclosed and only what was reported in their climate change strategies could be reported on.

The covid-19 pandemic created both a positive and negative situation insofar as access to senior management is concerned. In the positive, it allowed for ease of access to senior management as an online interview link could easily be sent to such executives after consulting with their personnel assistants. This however resulted in a negative situation in that this access limited the amount of time that these executives could give to any one person and still continue with running of their organisations. As such, time of the interviews became a limitation as most executives could not allow more that 45 minutes of their time to answer the interview questions. This resulted in a situation wherein the full depth of answers to some questions was not obtained.

Interviews conducted with executives require seasoned interviewers who understand the interviewing process and how to pose questions. To this effect, in as much as the researcher practiced, read about and watched interviewing videos, they were not a seasoned interviewer to the extent that they have done interviews before and thus this became a limitation to the study.

CHAPTER 5: RESULTS

5.1 Introduction

The purpose of the study was to understand the role of mining industry in the sustainable transition to a low carbon economy. This is because the low carbon economy is envisaged as the future that is necessary for competitiveness and sustainability. The study was investigated using a qualitative method where 12 semi-structured interviews were conducted with the senior executive management in the mining industry. The empirical data collected was then analysed using the four-step content analysis approach proposed by Bengtsson (2016). The findings are presented in this chapter, starting with the overview of the sample. This is followed by the summary of the sub-themes and themes and their related findings. The chapter then closes out by answering the research questions.

5.2 Overview of the empirical data

The overview of the empirical data was reviewed by focusing on the relevance of data, the extent of the data and linkage of the data to the objectives. The data was collected from senior executive management in the mining industry which includes chief executives, general managers, vice presidents in sustainability and other management roles as well as funders in mining, metals, and the energy industry. These participants were from different mining sectors such as coal, platinum group metals (PGMs), gold, copper, bulk metals, and energy production (Table 3 in methodology). The participants were experienced and in relevant roles that had the necessary information required in the study. This confirmed the relevance of the data in line with the guidelines by Guetterman (2015) on the credibility of the sample.

The total interview time was 430 minutes with an average of 36 minutes per interview. The shortest interview was 12 minutes, and the longest interview was 52 minutes (Table 1). This indicates that there was sufficient time spent on the interviews to get the necessary information that can help to answer the research questions that were presented in Chapter 3.

Table 3: Times of the interviews

Total number of interviews	12
Total time (minutes)	430 minutes
Average time (minutes)	36 minutes
Shortest interview (minutes)	12 minutes
Longest interview (minutes)	52 minutes

There was consistency of focused words across the interviews which included the transition, carbon, coal, economy, energy, government, industry, mining, power, renewables, risk, social and sustainable. These words were aligned to the objectives of the study which focused on the role of the South African mining industry in the sustainable transition to a low carbon economy (Figure 4). These words were consistent across the 12 interviews indicating the consistency of the interviews.

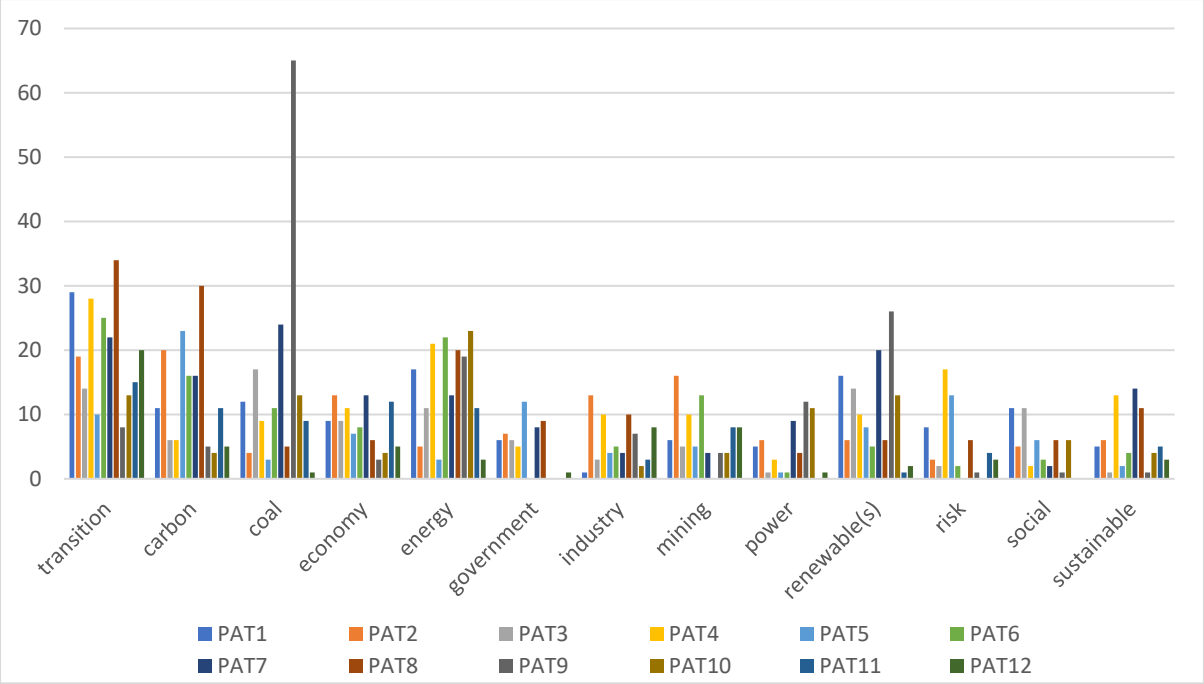

Figure 4: Relevant words in the empirical data linked to the objectives

5.3 Development of the themes of the study

The collected empirical data was coded initially without filters and then combined to form 81 unique codes of the study. These codes are presented in appendix IV. The codes were then combined by relationship and relevance to form code groups which are also known as sub-themes (Table 2).

Table 4: Sub-themes and themes of the study

Sub-themes	**Themes**
Feasible- partially feasible – not feasible Adverse social impact – unemployment Lack of skill set Enabling Regulation	Theme 1: Feasibility of sustainable transition to low carbon
Pressure from funders and investors Energy self-reliance	Theme 2:

Increased cost of production	Climate risk material to business
Liquidity of the business Cost effective alternatives ESG investment in developing countries Policy alignment by government	Theme 3: Enablers to sustainable transition
Leveraging regulatory framework on renewable energy Risk model to assess climate risk Align climate risk to funding Extract synergies between project for value	Theme 4: Climate strategies aligned to transition management framework
Commitment as responsible citizen Strengthen hybrid of energy sources Skilling and reskilling of workers Quantification of carbon emissions with targets Develop integrated risk plan Engage in energy savings Effective community & stakeholder engagement Protection of stakeholders against harm	Theme 5: Mechanism for just transition
Electrolyte for vanadium redox batteries Transition to alternative source (gas) Agri voltaic innovation Asset development - green technology minerals Innovation then eliminate the use of diesel – haulage trucks Innovative in solar and electric energy	Theme 6: Niche innovation hub supporting transition

There were 28 sub-themes that were developed, and these sub-themes were combined to form the six themes of the study. The six themes were the feasibility of sustainable transition to low carbon, climate risk material to business, enablers to sustainable transition, climate strategies aligned to transition management framework, mechanism for just transition and Niche innovation hub supporting transition.

5.3.1 Feasibility of sustainable transition to low carbon

Feasible- partially feasible – not feasible transition

The participants contextualised the feasibility of sustainable transition to low carbons by looking at both low carbons i.e., economy in line with the national determined contributions and total decarbonisation. The conversation with the participants was that it was feasible to transition to low carbon. However, there were multiple and mixed views on what this would entail and the realistic time frames that are possible to achieve this transition. Firstly, some of the participants believed that the low carbon economy is possible however, the total de-carbonisation is not feasible.

> "There's an issue of a low carbon economy and a total de-carbonization. In my view, a total de-carbonization is not feasible." - PAT1

> "Globally, in terms of 2050, I think we would have reached a certain milestone, not, not fully transitioned" – PAT5

The lenses that were used to determine where the transition be in 30 years, with soft goal for some transition looked at in year 2030 and a stretch target of year 2050. Despite this view, there were also views that were advanced that with everything that is going on, and the urgent need to address the climate change issues, countries and business do not have 30-years (2050) to transition, they need to address this sooner and drive the transition to lower carbon quicker. Some of the participants highlighted that the time frames are not feasible not because there are far but because climate change require urgent attention and 30 years is too far.

> "…Yes, I do. And actually, I don't even think it's possible. I think it's an imperative for South Africa to do. I think 30 years is too long, by the way. I don't think that we've got that type of time…" – PAT4

The other side of the discussion was that it is not practical and feasible because of the adverse impact on the economy, communities, and people's livelihood. This is also seen as unfair when the pressure to transition is coming from developed nation's (first world class) who have been through the industrialisation age using coal and other high carbon emitting commodities and now that they are well off, are curbing the development of countries such as South Africa.

> "…if you look at the so-called first world countries, they've been through the industrialization, based on energy and, and steel yes, and you need coal to have steel, you need coal to have reliable efficient, cheap electricity." – PAT8

The participants highlighted several factors that will make the feasibility of sustainable transition to low carbon difficult especially in the short term i.e., 2030 with some even including the long term, i.e., that is the next 30 years (2050). These includes the adverse social impact – unemployment, lack of skill set and enabling regulations.

Adverse social impact – unemployment

The feasibility of the transition to the low carbon economy is also highly dependent on whether there will be an adverse social impact especially with unemployment which is linked to both poverty and inequality in South Africa. With the country already struggling with high unemployment rates and struggling economy, the effort and feasibility for the transition especially in the short term (2030) is highly dependent on the economic recovery and impact especially within the mining industry which remains one of the biggest employers but working under strained conditions with high costs of production. Transition to renewables can result in job losses especially in areas such as utilities in mining businesses.

> "…As people are losing jobs in coal mines and all of that, they're going into the new economy. New energy vehicles that's what they're called now, electric vehicles, how do we support? So localization into new energy economy is how we want to support this, this, this transition…" - PAT1

> "…So, if you look at, you know, renewable energy solutions and the requirement on labour is basically close to zero. We will have a huge impact on the social aspects, in terms of the job losses that it will result.... "– PAT3

There was a view from the participants that the feasibility of the transition also needs to be elevated about the businesses within the industry to a national coordinated approach, in assessing the jobs and potential loss and the social impacts, as the businesses tend to be selfish with the focus solely on the bottom line.

Lack of skill set

The other critical factor that will determine the feasibility of the transition is the skill set of the employee and the implementing stakeholders. Some of the participants highlighted that the businesses do not have the necessary skill sets and capabilities required to be effective and competitive in the new low carbon economy, and that is the hindrance to the transition.

> "…We don't have the skillsets that are required and for us to be able to operate in a clean energy environment…" – PAT3

> "…The skill resources or should I say, the manpower requirement is significantly lower on the renewables…" - PAT10

Enabling Regulation

The enabling regulation for transition to low carbon is also seen as central, both for willingness to change being mandatory and enabling regulation for promote change. With regards to expectation of change, currently there is no existing regulation for mandatory transition, and the participants were of the view that because of that it is more optional or a choice than mandatory and as such not much effort will be done by businesses especially if it affects their profitability negatively. Having a regulation can improve the feasibility of the transition. At the same time having an enabling regulation such as the one recently seen with the increase of the threshold for generation to 100 megawatts is positive for transition. This allows the businesses to transition, with some participants highlighting that their willingness and appetite can increase if the self-generation capacity is increased beyond 200 megawatts without ministerial approval as this will make an even better business case for renewables.

> "…I think the government is taking the first step in lifting the, the threshold that we used to have of one megawatt to 100 megawatts, which, lately it has been discussions that, that can be increased to 200 megawatts…" – PAT2

What is evident is that there are mixed views on the feasibility of the transition to the low carbon economy and these are driven by factors such as social impact, skill set and enabling regulation.

Despite all of this, what is clear is that challenges with climate change and requirement for sustainability will ensure that the mining industry does not look the same in the next 20 to 30 years.

> "…I think it is sustainable, but I don't think the mining industry will look the same by 2040, 2050…" - PAT1

5.3.2 Climate risk material to business

In was evident from the empirical data from the participants that climate risk is material to businesses especially within the mining industry. The decision was based on the realities that were highlighted by the participants, which include pressure from the funders, energy self-reliance, and the increased costs of products due to carbon border taxes.

Pressure from funders and investors

The participants highlighted that there is growing pressure from both funders and investors who are keen to take into consideration climate risk and responsible citizen practices of businesses that require funding or investing in South Africa's mining industry. If the business is not willing to transition, funders will restrict the availability of capital and that becomes material to the business.

"…The globally accepted number or year is 2050. Then you have an individual, then you also have, of course the pressure of funders and investors, which are also pushing the same sort of agenda…. they will just restrict the availability of capital…" – PAT 1

"…We saw a lot of funders pulling out. So now we starting to really look at it, to take it seriously. It has an influence on how we want to mine…" - PAT3

"…Get It to this stage or even co-invest, it looks like it is an excitement undertaking, and the funders are really amenable [to fund renewable] but to coal it is taboo…" - PAT6

Energy self-reliance

Energy self-reliance is also seen as material to climate risk for a business because mining as an activity is generally a high energy intensive business. Unreliability or high cost of energy are both not ideal for the business. This reliability of energy is a problem in South Africa with continuous electricity load shedding from Eskom who are the exclusive supply of the energy in the country. In the past two years the country saw the worst loadshedding with no end in sight at this stage. This means that the changes to reliable energy which the business has more control of, is material and this has led to an increase in the solar projects with the participants expecting that these projects will gain pace in the next few years. There is a view that there is general excitement that will see the self-reliance being achieved.

"…And then you have at mining and manufacturing level at company level, the various solar projects, hundred-megawatt project. And I think we will see them gaining pace, in the next year..."– PAT1

"…You know, one can see that with the excitement, you know, that has been, seen or demonstrated by the industry in relation to the lifting of the self-generation threshold, by the President…" – PAT2

"…And then of course the technology itself has to be sustainable in a way, and I mean, you look up, you hear about people talking about solar and wind and right now storage is a big issue…" - PAT6

Increased cost of production

Some of the participants believed that South Africa will probably at company level move very aggressively towards the renewable energy because of carbon border tax. This will have a material issue in the business, with the participants advising that it will increase the cost of production and influence the already suppressed margins in the mining industry.

"…I think carbon border tax will become a problem for South African companies. And because, you know, it will increase the cost of the cost of production, not doubt, and in order to maintain your price and your margin, you have to be seen to be doing something in renewable, to decarbonize…" – PAT 1

5.3.3 Enablers to sustainable transition

The enablers of the sustainable transition were identified at the company level with the liquidity of the business and cost-effective alternative energy sources and related low carbon sources. Enablers were also identified at a country level and these included the policy alignment by government and ESG investment in developing countries

Liquidity of the business

With climate change and conditions for capital weighing heavily on businesses, it has become important to make sure that the developed climate change strategies are aligned to the transition management framework. An important factor for consideration is the liquidity of the business and the state of its debt. This is a crucial enabler for the decision-making process and the setting of direction for the business.

"…Of importance, you know, for mining industry to have liquidity, stable market is important, you know, would like to see coal, you know, maintaining prices that can enable, you know, mining companies or coal mining companies to garner enough, cash resources to be able to tackle projects…" – PAT2

"…There's also the issue of capital investment. So, money is a big enabler in this particular instance, because if you look at our industry in South Africa, most of them have aged with very old technology…" – PAT5

Cost effective alternatives

South Africa's current economic growth challenges are making it extremely difficult to conduct business. it is therefore important to have a cost-effective alternative that can be compared for just transition.

"…The third enabler, of course it is the obvious if you do a cost comparative, if all this low carbon energy alternatives are cheaper than what we are currently getting then, certainly the transition will happen…" – PAT12

Policy alignment by government

In South Africa there are two government departments that work together for the delivery of energy/electricity to businesses. These departments are the Department of Minerals and

Energy as well as Department of Public Enterprises, with the latter responsible for state owned entities such as Eskom. The participants highlighted that there is often a disconnect between the different ministries when it comes to the energy strategy. There is lack of clarity and coherence on the strategy related to renewals and use or usefulness of the high carbon – fossil energy. There are messages of clean coal with some of the participants believing this to be a misnomer versus the full transition to the low carbon economy. This has already been alluded to as being which tricky with its feasibility being influenced by the skill set and the potential social impact.

> "…a department or political alignments is also key because what we are seeing in the moment is a disconnect between what different ministers are saying… - PAT4

> "…the biggest risk they keep mentioning, it's the regulators, regulators in a sense that whatever we may want to implement, it's either you or an unknown in South Africa" – PAT5

> "…Maybe we need to clearly define what we mean by low carbon, whether we are talking about displacing coal, or do we still in include what [Minister of Mineral Resources and Energy] talks about clean coal, which is a misnomer…" – PAT6

ESG investment in developing countries

Additionally, at a country level the other enabler is the Environmental, social, and corporate governance (ESG) investment in the developing countries. Some of the funding frameworks that have been adopted within developing countries and also by some of the country's biggest investors and funders such as Public Investment Corporation (PIC) and Industrial Development Corporation of SA (IDC) incorporate a large element of ESG targets.

> "…Obviously the aim there is to make sure that we comply with all the ESG requirements with the level of carbon emissions to be as low as possible…" – PAT2

> "…The ESG investment to developing countries is the first one. Although it's my feeling that is being misused by a number of institutions, as a way to not unleash funding, to developing countries..." - PAT12

Despite this, some of the participants did highlight that there might be a potential misuse of the ESG investment to the developing countries, and even though transition is necessary it needs to be done with care and authenticity. They do believe that the transition will not happen abruptly and an approach where ESG funding is used as a weapon is not helping. This is quite evident from the rumblings of the Department of Minerals and Energy who have not been shy to point out that they are not comfortable with such an approach.

"…I don't think it will happen abruptly like that; I think you would have noted that the Minister is not so chaffed with all those discussions simply because of the lack of the developmental agenda…" - PAT6

5.3.4 Climate strategies aligned to transition management framework

The participants agreed that the climate strategies need to be aligned to the transition management framework. This is done by leveraging the regulatory framework on renewable energy, risk model to assess climate risk, align climate risk to funding and extract synergies between project for value.

Leveraging regulatory framework on renewable energy

The business needs to first ensure that they leverage the regulatory provision, with the participants indicating that the previous threshold of renewable energy generation was not maximised. Granted there might be several factors that might have contributed to this such as economies of scale or related vale propositions, but this should be the norm as it will enable the government to continuously improve the regulation.

"…We have not really maximized even on the previous threshold, you know, one megawatt. We are not really planning to put another call for a coal fired power station, we are still looking at the renewables..." - PAT2

Risk model to assess climate risk

The participants indicated that in the mining industry, businesses need to have a risk model that they can use to assess the climate risk. Some businesses such as those of participant 10 and participant 11 already have the model in place which they use for learning from past failures that they initially put in place to mitigate the risks.

"…We have risk models we use within our organization to assess climate risk, but most importantly, we learn from failures in other organizations when it comes to mitigation and endeavour to implement controls from these learnings as well." – PAT10

"…We have developed an organization organizational risk management model through which we have identified that climate risk is in our business top five risks…" – PAT11

Some of the businesses have assessed climate change risk and it is within the top five risks for the business. This is a clear indication that it is taken very seriously, and it is continuously under review, control, and improvement.

"…We have developed organisational risk management model through which we identified the climate risk in our business top five…" - PAT12

Align climate risk to funding

The climate strategies should also be aligned to funding to ensure an effective transition to low carbon economy. This is because most of the external funders incorporate this risk in their model, such as the IDC, when assessing cashflow and other finance related analysis. It is also important to align the internal funding or financial processes so that there is no disconnect between the internal business and its operating environment.

> "…And so, it's the same thing with us at IDC where climate change risk is probably factored into our assessments of cash flows, our, our price, our, our pricing of the risk when we give you your interest rate and all of or the return expectations. It's just that it is not done in a way, which is focused on a way, which is clearly articulated that here is our climate risk assessment." – PAT 5

Extract synergies between project for value

To make it worthwhile, it is important that the climate strategies for transition are aligned to value, wherein the business must extract synergies between project for value. As such, there must be synergies between operations that are quite close to each other when implementing green energy projects. This will make sure that contradictions and duplications are avoided and where a project can cater for multiple needs then that project is preferred. This can ensure that what is being done is sizeable and caters for the needs of the operations within the mining business.

> "…So, in terms of our strategy, so the strategy that we've got, and let me say that a strategy framework from the current discussion that has been taking place is that we've got to look at synergies between operations that are quite close to each other…"– PAT2

5.3.5 Mechanisms for just transition

The participants explained some of the mechanisms that are being put in place by mining companies to ensure a just transition to a low carbon economy. These include commitment as responsible citizen, strengthened hybrid of energy sources, skilling and re-skilling of workers, quantification of carbon emissions with targets, development of an integrated risk plan, engaging in energy savings, effective communities, stakeholder engagement, and protection of stakeholders against harm.

Commitment as responsible citizen

One of the first identified mechanism for transition was the commitment as a responsible citizen. This is imperative for businesses as there is currently no prevailing law that is dictating to the business to transition to the low carbon economy. This means that the commitment

much come from within, and the business plays a critical role in the climate change response for sustainable development.

"…First of all, we all want to be named a responsible corporate or a trusted corporate and it starts with, what do I commit to, what do I execute at the end of the day? So, the social part plays, yeah quite a significant impact in this whole transitioning...." – PAT5

Strengthen hybrid of energy sources

The participants who had explained that it will not be possible to have complete decarbonisation due to societal impact – unemployment, enabling regulation and lack of skills set. It was also highlighted that a just transition mechanism can be established though the strengthening of a hybrid source of energy in which there can be a combined usage of renewables and some coal - carbon energy sources.

> "…You cannot altogether, substitute coal. Coal will still be there because you need something that is reliable, always there. I can say coal should provide a baseload and that all the growth that we're going to experience should be supported by renewable, for me, that is a just transition" – PAT8

Skilling and reskilling of workers.

The transitioning to the low carbon economy means getting to new territories and unchartered waters for most businesses with their employees not well equipped to handle the proposed new normal.

> "…So yes, upskilling and reskilling it's the most important thing for us to start working on now, even for projects that we're going to implement in five years' time…" – PAT5
>
> "…So, you got to re-skill, redeploy people into new sectors..." – PAT4
>
> '…We have therefore started including our employees who we may need in the future to start managing those kinds of projects. We're already skilling [them] into managing a secular economy project, like for example, waste tyres or also bio-reach, process solid waste into fertilizer and also the manufacturing of biofuel…" – PAT7

This is not only the problem of the existing workers, but there is also a problem at an institutional level, for the potential new entrants to the workplace. There is a need for alignment of the curriculum in a top down and bottom-up combined approach. This also includes having capable lecturers that can be able to take people through this new normal. As such, there is a need to skill the new entrants and reskill the existing workers.

> "…Years before we even start embarking on this, you've got to unpack this properly and make sure that we understand, you know, from A to Z as to what would be exactly required and got to get institutions aligned as well, educational institutions to make sure that the skills that we need are made available…" - PAT2

To help with some of this work, participant seven [PAT7] explained that some of the businesses have also started bursary programmes working with universities in science and engineering and related research to create an enabling environment for transition to future low carbon economy.

> "…We have bursary programmes; we work with the universities in terms of research. So, securing sort of your engineering, your science-based skills that will then drive the sort of future economy" – PAT7

Quantification of carbon emissions with targets

As just transition to a low carbon economy is not an event but rather a journey the participants highlighted that one of the mechanisms is to develop a framework that can help to calculate and quantify the carbon emission by the business and its possible related carbon tax.

> "…So, we are busy, you know, to develop a framework that would make sure that all the areas, that gives input into calculation of this carbon emissions and carbon tax to make sure that those are covered, and we know, and we know where we sit…" – PAT2

Develop integrated risk plan

Several businesses have already identified climate change as one of the top risks within their businesses which has enabled climate change to be on the radar of senior executive management teams in the mining industry businesses. Climate change has become so crucial that renumeration committees of companies have identified it as a lever to set executive pay scales. As such, when it comes to risk, there is already an established approach were risks associated with sustainable business and its long-term prosperity are documented with their appropriate controls. The risk plan thus becomes a cornerstone of any decision-making process and as it outlines how business will implement mitigating actions to the identified risks

> "…So, from a, from a risk perspective, we like all organizations, we have a strategic risk register and integrated strategic risk register [and] at an operational level, there's an, there's an operational structure that really supports how those risks are mitigated..." – PAT4

> "…Sasol has a very comprehensive risk management framework in terms of what we utilize. Our risk management framework really talks to the 3-step process of plan, do,

review, and ultimately implement solutions. So, we are very clear in terms of how we, how we approach risks associated with any, any part of any part of the business to ensure that we have a sustainable business in the long term." – PAT 7

Engage in energy savings

Businesses are meant to make profit and return value to shareholders. It therefore holds that the transition to a low carbon economy must be able to make business sense. As a result, the participants highlighted the importance of engaging in energy savings. This will make sure that there are quantifiable financial savings to the business. This applies to both the internal stakeholders as well as external stakeholders including potential investors to the South African market. The efforts do not necessarily need to be ground-breaking and can be done even at a small scale, as every small change matters, and can cumulatively result in substantial outcomes.

"…It, it must be able to enable economic growth. So, nobody's going to come to South Africa and invest on anything when there is no affordable, sustainable electricity supply…" – PAT6

"…The least you can do is to obviously engage in energy saving, you know initiatives, whether through the offices that you occupy in your small space at a mine…" – PAT12

Effective community and stakeholder engagement

In ensuring a just transition to a low carbon economy it is critical that effective community and stakeholder engagement is employed as one of the main mechanisms. So, the businesses must make a concerted effort in engaging quite extensively within community structures. This engagement is fundamental because outcomes of strategic initiatives such as a transition to a low carbon economy can receive backlash from external stakeholders if there is lack of consultation and buy-in.

"…When we plan to move in such a drastic move, you would understand that communities are up in arms. Other stakeholders are up in arms. So, we have to make sure that we communicate and engage them in our strategy as extensively as possible…" – PAT5

"…We must encourage the manufacturing in communities to ensure self-sustainability in our country as well…" – PAT10

The protection of stakeholders against harm is also an important mechanism because it will increase the confidence of stakeholders in the business by making sure that the stakeholders do not suffer the consequences of the transition

> "…So, I think the, the way that it would be sustainable is to ensure that there is a just energy transition. So, you ensure that those affected parties in the transition are not exposed or harmed through their transition…" – PAT4

> "…So, as we transition towards a new energy mix as such, we don't leave those employees behind, especially the communities that have been established in and around those power stations to support the stations…" – PAT9

Furthermore, another mechanism that can be used within the business is the development of the integrated risk plan for climate change which includes the quantification of the emissions. Such quantification allows businesses to monitor it's emissions and take not of any improvement of regression.

5.3.6 Niche innovation hub supporting transition

The participants highlighted how the mining companies supporting niche innovation hubs that will support the transition to a low carbon economy. This is being done through the innovation of electrolyte for vanadium redox batteries, transition to alternative source (gas), Agri voltaic innovation, Asset development - green technology minerals, innovations that eliminate use of diesel – haulage trucks and Innovative in solar and electrical energy

Electrolyte for vanadium redox batteries

The electrolyte for vanadium redox batteries was one the innovations that was highlighted by the participants. This innovation helps with energy with generally good charge and discharge efficiency, due to their use of vanadium ions in their different oxidation states to store the chemical potential energy. The electrolytes have major advantage of high density and long shelf life which makes it suitable for mining industry businesses for energy storage options.

> "…I then realised that we do a lot, we are doing, um, we are supporting guys like Bushveld. Bushveld, Vametco, you know, we [are] supporting them to produce an electrolyte at that will go into those vanadium redox batteries…" – PAT1

Transition to alternative source (gas)

Businesses also see the potential of upgrading plant transportation network terminals with the aim of bringing in liquefied natural gas. By doing this, the terminal is going to be repurposed in due course, with modifications in different configurations to handle this sort of different technologies. Gas is seen as a cleaner option than coal and is one of the options to focus on innovation.

> "…but I think it's important to recognize that as we shift away from coal, of course, we are going to look at introducing gas and here the thinking is that we have to be smart about how we introduce gas…" – PAT7

Agri voltaic innovation

Mining companies own vast pieces of land which has been mined and rehabilitated. In some instances, this land has been repurposed and is used as agriculture land. Mining companies highlighted the use of Agri voltaic innovation as a niche innovation to transition to a low carbon economy. Not only are plants assisting with removing carbon dioxide from the atmosphere, but that electricity is generated from renewables. The Agri voltaic system is used by using both solar and agriculture on one piece of land, where the panels for solar and crops coexists.

> "…We also exploring the concept of agri-voltaics, which combines energy generation specifically solar with agricultural activities on the same plot of land..." – PAT9

Asset development - green technology minerals

Asset development to ensure green technology minerals was also one of the options of innovation that mining business should support to support the transitions to low carbon within the operations. To this extent, mining companies are allocating capital to mainly green metals such as manganese, cobalt, rare earths etc.

> "…Our asset development at this stage, except for our chrome and coal assets is in the green, technology minerals, you are looking at your, a nickel, you're looking at your copper, you look at your vanadium…So that is, that is how we are transitioning…" – PAT12

Innovation that eliminates use of diesel – haulage trucks

There is also an innovation-based strategy that participant five mentioned, where the business is looking at different technologies to reduce their emission of greenhouse gases. One of these identified innovations is using technology to eliminate the use of diesel in the haulage trucks within the mines. This will be done through splitting the hydrogen molecule from water or capturing it from the atmosphere and using it for energy production to propel haulage trucks and other mining vehicles.

> "…We will be, we are looking at how we can phase out the usage of diesel, for example, in our haulage trucks, because that's where most of our greenhouse gases are coming from..." – PAT5

Innovative in solar instead of electric energy

Innovation and investment in solar instead of electric energy as also an alternative to powering some of the systems on mines. This promotes the use of clean and green energy which is better than the electric energy generated from the fossil fuel.

> "…but for, for open cast machines, we are looking at powering our systems with solar panels instead of using electric energy from trucks…" – PAT11

The above-mentioned are all the different innovations that the mining companies are supporting in an effort to protect niche innovation hubs which will be fundamental in supporting the transition to a low carbon economy.

5.4 Answering the research questions and summary of the chapter

The study had four research question which were presented in chapter 3 of this report.

Research question 1: Climate risk is material to their business

Research Question 1: How do mining companies decide if climate risk is material to their business?

The first research question of the study investigated how the mining companies decided if climate risk is material to their business. This was first investigated by assessing the feasibility of the transition to low carbon economy with the findings revealing that there were mixed views of the feasibility of the transition to a low carbon economy. Some of the participants believe that it will be feasible with the advocacy for strong action. What was abundantly clear was that the face of mining as we know it today will change significantly in the next 20 to 30 years.

From figure 5, it can be seen that the feasibility is mainly being influenced by the adverse social impact – unemployment which is material to the business when it comes to mining communities, the lack of skills that are required for post the transition with most mining businesses not in possession of them. This is also material to their business as well as the enabling regulation where the self-generation threshold has been increased to 100 megawatts. In additional, the materiality is also talking about the influence on cost of production and pressure from funders and investors who are now less keen on investing to coal.

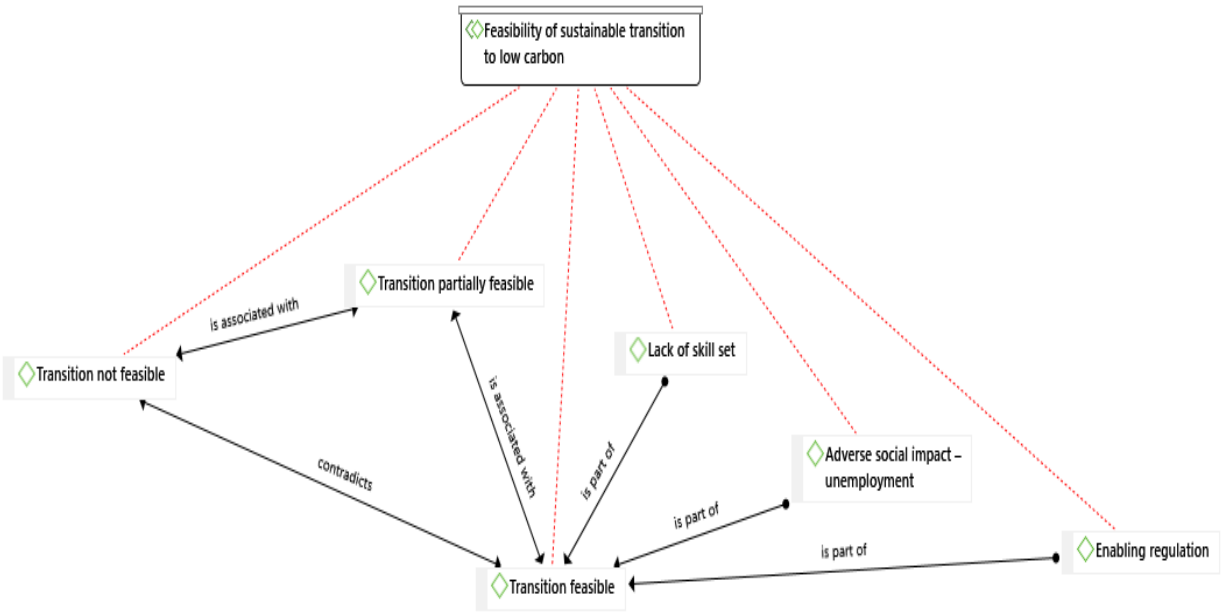

Figure 5: Thematic map for feasibility of sustainable transition to low caron economy.

Research question 2: climate strategies aligned to transition management framework

Research Question 2: How are mine companies climate strategies aligned to transition management framework?

The second research question focused on the need for climate change strategies to be align to the transition management framework. This alignment can be done by ensuring that there is adequate policy alignment from government and that ESG investment in developing countries is done in consideration of the transition management framework in its advocacy for multi-stakeholder engagement. Furthermore, the regulatory framework on renewable energy, the liquidity of the business, cost-effective alternative energy sources and related low carbon sources, implementation of a risk model to assess climate risk, alignment of climate risk to funding and extraction of synergies between project that are value adding are all fundamental in climate risk strategies of mining businesses and align with the strategic and operational aspects of the transition management framework.

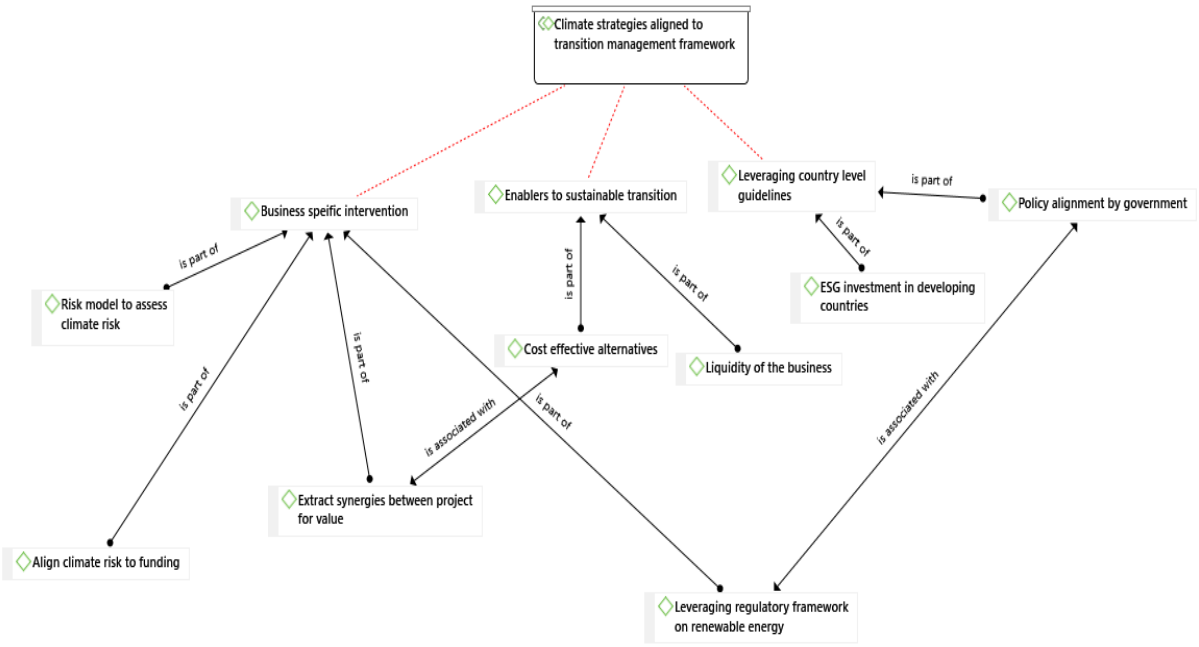

Figure 6: Thematic map for climate strategies aligned to transition management framework.

Research question 3: Mechanism for just transition to carbon economy

Research Question 3: What mechanisms are being put in place by mining companies to ensure a just transition to a low carbon economy?

The third research question attempted to understand what mechanisms are being put in place by mining companies to ensure a just transition to a low carbon economy. The findings revealed that there must be a commitment of the business as a responsible citizen. In doing so, this confirms the will of the business to participate toward the challenges of the climate change and transitioning towards a low carbon economy. A highlighted just transition was deemed to involve a hybrid of energy sources which will not completely eradicate coal as an energy source within the context of South Africa.

This just transition should ensure that it protects the stakeholders against harm especially the societal harm of the community and its people. Furthermore, since this is unchartered territory for most of the mining industry, it is important that there is a clear and purposeful drive towards skilling of the new workers as well as reskilling of the existing workers to ensure that they can be able to respond and have capacity to be effective in the low carbon economy.

To enable the just transition, mining businesses need to develop an integrated risk plan that which must be effectively managed. The integrated risk plan should allow for periodic monitoring and evaluation reviews where quantified carbon emissions are recorded. This should form the basis of improvement actions. Furthermore, small scale incremental actions such as energy saving initiatives should adequately be recorded in the integrated risk plan.

It can be seen from figure 7 that these mechanisms are related to each other e.g., commitment as a responsible citizen and strengthening of hybrid of energy source. Through these mechanisms, a balancing act between the climate change and well-being of the communities is necessary.

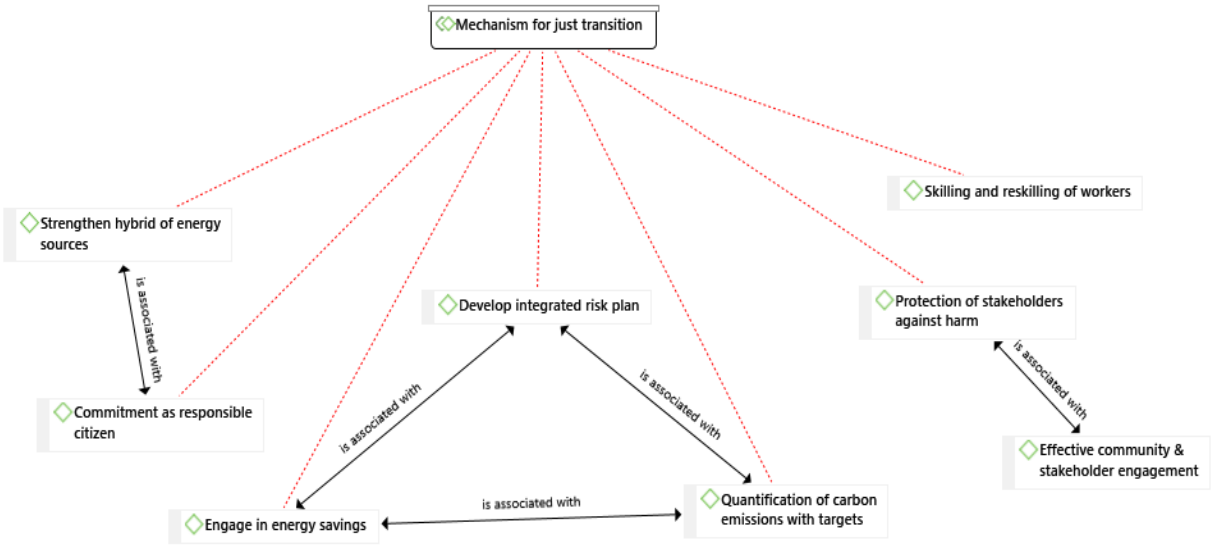

Figure 7: Thematic map of the mechanism for just transition to a low carbon economy

Research question 4: mining companies supporting niche innovation hubs that support the transition

Research Question 4: How are mining companies supporting niche innovation hubs that support the transition to a low carbon economy?

The last question aimed to understand how the mining companies were supporting niche innovation hubs that support the transition to a low carbon economy. Several niche innovations were mentioned in the study and the level of support that mining companies are providing included monetary support for research and development of such niche innovations. Some of the niche innovations that were mentioned included electrolyte for vanadium redox batteries, Agri voltaic innovation, Asset development of green technology minerals, elimination of the use of diesel in haulage trucks with the use of green hydrogen.

Figure 5 Thematic map of niche innovation hub supporting transition.

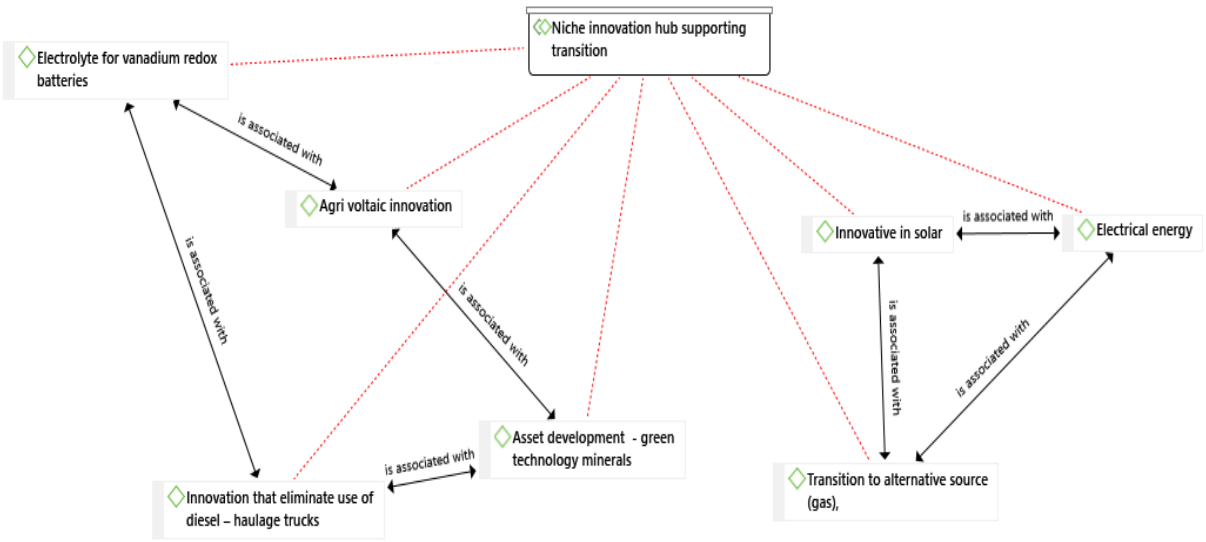

Figure 8: Thematic map of niche innovation hubs supporting the transition to a low carbon economy

5.5 Conclusion

This chapter presented the results of the study following the collection of empirical data using the measurement instrument. The empirical data was analysed for relationships and verbatim evidence was provided from the participants responses. What follows in the next chapter is an in-depth discussion of the results presenting in this chapter.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

This chapter discusses the results that were presented in chapter 5 with specific insights related to the findings presented. In order to facilitate the answering of the research questions, the theoretical framework on transition management is contrasted with the results obtained in an effort to provide insights of the study conducted. The research study that was undertaken was done so to establish the role of the South African mining industry in the sustainable transition to a low carbon economy. The transition management framework is one such framework that advocates for sustainable transitions through a four-step nonlinear process of vision setting (strategic), tactical, operationalisation, and reflection. The results of the study were grouped within six themes that emanated from the analysis of data. It was illustrated in Chapter 3 that the research questions that were developed for this study were anchored within the transition management theoretical framework. It therefore follows that the discussion of results in this chapter will anchor within the research questions and centre around how the results obtained provided insights in an effort to answer the theoretical questions. Furthermore, the literature review in Chapter 2 will provide the foundation for the discussion. The findings of this research study contribute to both the business and theoretical need. This chapter will follow a theory-application-conclusion approach which is also referred to as the should be-what it is(results)-so what approach as?

6.2 Discussion of results – RQ 1

Research Question 1*: How do mining companies decide if climate risk is material to their business?*

In order to understand whether climate risk was material to mining businesses, it was important to first establish whether the transition to low carbon was feasible. The understanding of whether it was feasible to transition to a low carbon economy would determine the material risks that were placed on mining businesses insofar as climate change is concerned. In this regard, the study highlighted that this view must be considered in a two-pronged approach. The first approach was to look at the feasibility of transitioning by 2030. The 2030 target is aligned with the governments integrated resource plan (Department of Minerals and Energy [DMRE], 2019). Viewed from the 2030 lens, the participants were in equal measure that lowering the carbon footprint of their businesses was indeed feasible. What was not clear was the extent to which these emissions would be lowered. This is so because there is no regulatory framework that currently exists in South Africa that compels businesses to cut emissions by a certain number. It is widely accepted that businesses cut their emissions only because it makes “business sense” to do so. It was evident from one of the participants that being a junior coal mine, there was no “business sense” in lowering their

carbon footprint through for example setting up of a self-generation facility to offset against scope 1 greenhouse gas (GHG) emissions from direct sources i.e., Eskom. The view from this participant was that their business needs to maximise value in the current and until the life of mine (LOM) is reached. Through such value maximisation, they would then invest in other projects were emissions would be investigated more seriously. Another view on what would constitute “business sense” was aired by a different participant through the acknowledgement of a different capital landscape. What made “business sense” to this participant was the re-injection of retained earnings into capital projects such as the extension of their LOMs. This would mean that their weighted average cost of capital would have a significant equity portion in comparison to debt as debt costs would significantly be higher when a business is viewed as a polluter. Both these participants were in coal mining.

Having established the objective of the aforementioned research question in Chapter 2, which objective was aligned with objective number 3 of the research study in Chapter 1, the following themes from the results aimed to answer the first research question.

6.2.1 Climate risk material to business

Climate risk was generally accepted by the majority of participants as being material to their businesses. Climate risk was generally viewed from the pressure that will be placed on businesses in the form of access to capital markets through high costs to capital and/or lack of funding for certain projects, increased costs of production due to costs relating to climate reporting on emissions (especially true for listed businesses) as well as costs that will be incurred to carbon boarder tax on high carbon content products, and the costs that may be incurred through self-generation projects which are mainly undertaken to offset scope 1 and GHG emissions. What follows now is a more detailed discussion on the climate risk materiality sub-themes with an analysis of literature from chapter 2 per sub-theme.

Pressure from funders

The results from the study showed that there was unison from participants when it came to their views on how funders will approach businesses that have high GHG emissions in their portfolios. They lamented the fact that many institutional investors have now become activist investors who are seeking commitments from businesses to limit their emissions before they are able to provide capital. A participant from a funding institution which provides capital to the mining industry highlighted the fact that the “emission KPIs” had become so important to funding institutions that financial metrics such as return on capital employed are not the ultimate measure of investment decisions. However, even though there was agreement that funders will put pressure on businesses in terms of the emission obligations, the results were not congruent insofar as the extent of this pressure. This lack of clarity was deemed a material

risk to mining businesses. This finding was consistent with Loorbach (2010) who stated that at a strategic level, certainly a level where the determination of material risk is critical, uncertainty that surrounds technological innovations of the future will generally be short term focussed as interests of leaders, policy makers, pressure from the public, institutions and individuals takes precedence. In this context, the study showed that each business will ascribe the materiality of risk from pressure from funding in the short term instead until there is more certainty as to the extent of this pressure from funders. A view from one participant highlighted the extent of this uncertainty by stating that while some funding institutions been clear that their capital allocating committees will not fund any green-field coal projects for example, others are still uncertain as to how to approach this aspect.

Energy self-reliance

The study found that mining companies have placed a high importance on energy security and energy justice. Energy security deals with the reliability and availability of energy while energy justice primarily deals with the cost of energy. The study found that having a centralised main actor in the form of Eskom posed a material risk to their business both from an energy justice and security point of view. As one participant put it, the climate change commitments from Eskom require it to decommission certain power stations in the next coming years and add more renewables onto the grid. The study showed that participants were in unison that a poorly managed Eskom will have increase mining businesses input costs and drive up the cost of production. Loorbach (2010) argues that to drive a societal transition, a group of societal participants and those from the dominant regime who have a common understanding of the societal problem must come together in order to provide a vision (goal) with objectives of how this goal will be achieved. It is evident from the results of the study that there is a disconnect between the incumbent regime and other actors. To compound this problem, energy-self regulation has been capped at 100 MW. The study results show that this self-generation threshold is material for businesses whose strategy is to offset emissions from direct sources i.e., scope 1 requirements such e.g., Eskom power. In a nutshell, the mining businesses are caught between a rock and a hard place. One the one hand, regulation to drive self-reliance is slow but welcome, while on the other hand they are not provided with adequate energy security and justice. The study found that interaction between the incumbent actor and policy developers is essential in determining whether climate risk is material to their businesses.

Increased cost of production

The study found that the proposed carbon tax will have an adverse effect on mining businesses retained earnings. The carbon tax will affect businesses who have high emission.

But like the uncertainty surrounding pressure from funders, the adoption of the carbon tax bill has been postponed numerous times for one reason or the other. The inability to have clarity on the carbon tax bill was highlighted as material to mining companies in ascribing climate risk. Another form of tax that was found to be material to climate risk was the carbon boarder tax that will be ascribed to high carbon content goods and materials. The study found the competitive position of mining companies will be called into question when countries that import South African goods and materials impose such a tax on goods and services in an effort to "force" mining companies to transition to cleaner forms of production.

6.2.2 Conclusion

The first research question was aimed at determining how mining companies determine if climate risk is material to their business. The results from the study showed that mining companies determine materiality of climate risk through consideration of a number of factors. These factors as highlighted from the results of the study include pressure from funders, energy self-reliance, and increased cost of production. These factors are critical in detailing the first step of the transition management framework positioned by Loorbach (2010) as shown in Figure 3.

6.3 Discussion of results – RQ 2

Research Question 2*: How are mine companies climate strategies aligned to transition management framework?*

Adequate community engagement

The aspect of the transition management framework that deals with the determination of strategies and vision setting is set out in the work of Loorbach (2010). The strategic element of the transition management framework particularly deals with the structuring of a problem, setting out the vision to address the problem and establishing the transition arena i.e., the transition playing field. Evidence from the study shows that there is agreement amongst mining businesses of the triple threat of poverty, inequality, and unemployment in the communities in which mining companies operate. The consideration of these three vices is particularly important when mining companies determine their climate change strategies. The study showed that mining companies are cognisant of this to the extent that it is part of the problem structure as stated by Loorbach (2010). The study has shown that in some instances, measures are being undertaken to address this problem. These measures, which emanate from the climate change strategies include the establishment of community-based business forums that will allow for community based small businesses to participate in renewable energy (RE) infrastructure projects pursued by the mining companies. Such participation will allow for the development of skills in not only the installation aspect but the operation and

maintenance point of view. Viewed from this angle, the study seems to have established evidence that contradicts the findings of Harrahill and Douglas (2019) in the assertion that the transition management framework is somewhat criticised for being non-democratic when considering the views of other stakeholders. This determination is purely based on the face value evidence of this study viz a viz mining companies and community-based SMEs working together to deliver RE projects in line with the climate change strategies of mining companies.

At this particular juncture, it is however important to pause and reflect on whether the findings do actually contract the findings of Harrahill and Douglas (2019) or perhaps a closer inspection of the findings would prove otherwise. To provide perspective, it is granted in the instance of community-based SMEs playing a role in infrastructure establishment that mining companies have indeed made strides to include this in their strategies of RE projects. However, the transition management framework calls for inclusivity of stakeholders at the inception of the process (Loorbach, 2010). Evidence from the study suggests that the inclusivity aspect of communities only comes after the determination of climate strategies by mining companies. This is indeed evidenced by the results of the study. It therefore holds that at face value, it seems as though the findings of this study contradict the findings of Harrahill and Douglas (2019), but on closer inspection of the transition management framework, it is indeed clear that the findings of this study agree with the findings of Harrahill and Douglas (2019) that the transition management framework suffers from its criticism of being non-democratic in allowing for stakeholder input at the inception of the strategic leg i.e., vision setting.

The next aspect to be addressed insofar as climate change strategy is concerned is analysed from the lens of the 8 disciplined steps as proposed by Silvestri et al. (2018) with particular emphasis on the step that deal with the assertion that steering away from the societal system is not effective. The study has provided evidence in the form that mining companies are driving a localisation agenda in the communities they operate. Among the many views expressed, a participant to the study attested to this localisation drive in the hydrogen economy by calling it the “hydrogen belt” where it is envisioned that a new hydrogen ecosystem will provide much needed growth opportunities to counter the effects of poverty, unemployment, and inequality. The first aspect to be addressed is that which deals with interaction with stakeholders in this localisation drive. The study did not provide adequate evidence that context-sensitive analysis of actors as argued by Silvestri et al. (2018) had taken place. It is one thing to talk about the fact that it must be done. It is indeed another thing to have it as a discussion point in mining boardrooms. However, that in itself does not translate to the fact that the members of the community have been taken into confidence in explaining what this new future will look like. It may be argued that well, it will bring about jobs and opportunities, so communities need not necessarily be required to be involved in such discussions. But that is exactly what the

transition management framework of Loorbach (2010) advocates for, it is also exactly what is defined as one of the eight fundamental steps by Silvestri et al. (2018). These considerations are so important that failure to adequately address them may result in failure of a niche innovation or led to a situation where the economic, social, and environment aspects of the transition are not fulfilled i.e., a situation that will indeed be defined as a non-sustainable transition.

6.4 Discussion of results – RQ 3

Research Question 3*: What mechanisms are being put in place by mining companies to ensure a just transition to a low carbon economy?*

Having established the objective of the aforementioned research question in Chapter 2, which objective was aligned with objective number 1 of the research study in Chapter 1, the following themes from the results aimed to answer the third research question.

Adverse social impact - unemployment

Galgóczi (2020) postulated that the just transition concept is two dimensional in its functionality with the first dimension dealing with outcomes of the transition i.e., how a new low carbon economy should look like from a new employment and social landscape point of view and the second dimension deals with the process i.e., how to get from the current economy to a new low carbon economy (Galgóczi, 2020). In describing the tactical arena of the transition management framework Loorbach (2010) was forthright in stating that the focus should be on the removal of barriers that would impede the setting of a new direction. Institutional, economic, and regulatory barriers were identified by Loorbach (2010) as key barriers to the implemention of a transition. South Africa's unemployment numbers are a cause for concern. The views from the participants were that a radical transformation of transitioning to a low carbon economy will only be possible if workers are protected. There was a view put forth that transitioning to a low carbon economy would create jobs for workers in new industries. However, this view has not been tested and is therefore looked at with suspicion. Furthermore, not only direct jobs were highlighted as being at risk. Indirect jobs that stem from small businesses supporting communities were mines are located were also highlighted as being at risk. This was also found to be true by Galgóczi (2020) who warned that the process leading to net zero will have a tremendous bearing on labour, the distribution of income, and small businesses. The results of the study show a mixed response to mechanisms being put in place by mining companies to combat the social impact of job losses. Two dominant views in particular were raised by the participants of the study. The first view is that while no leadership is provided at a national level, some mining companies will "do nothing," i.e., they will approach the transition on a business-as-usual basis until such a time that they have exhausted their

resource endowment. A second view was that some mining companies have established economic zones in areas such as agriculture to contain the effects of the transition in the communities they operate. It must however be noted that while such economic zones provide an employment buffer for community members, they do not address the workers that ply their trade for these mines.

The work Newell et al. (2013) also supports the views of this study's participants as they postulated that attaining climate justice did not adequately deal with the social justice of employees and communities. The transition management framework advocates for a multi-stakeholder dialogue to take place. When responding to questions on stakeholder engagement in relation to unions who represent workers' rights, the participants indicated that much of the work that has been conducted has been away from union engagement. These views again agree with what Stevis and Felli (2015) found that discussions on energy transitions have largely not involved unions and how workers jobs will be protected. The study's results therefore position that a huge gap exists between stakeholders from a dialogue perspective and not much is being done to address this issue in order to close the gap.

Lack of skills

The lack of skill was the second sub-theme that related to the sustainable transition to a low carbon economy. In the first instance, the majority of participants highlighted the fact that they have not begun with any re-skilling process related to the transition to a low carbon economy. A small percentage of participants indicated that they currently do have programs with universities for "knowledge workers" through the establishment of bursary schemes. Knowledge workers in this regard are typically engineers, data scientists, business improvement personnel etc. However, when it comes to artisans, operators, and low skilled employees, not much has been done in either starting with a re-skilling program or developing a re-skilling program. One participant commentary on this issue highlighted the significant importance of skills. They highlighted the fact that while many mining businesses are detailing their climate change plans, there exists very little discussion around how skills will be capacitated. This lack of discussion and bringing stakeholders together is contrary to the transition management framework that was postulated by Loorbach (2010) in the operationalisation of the strategic element that deals vision setting. The inability to capacitate skills that will drive the new low carbon economy becomes quite challenging when the two-dimensional approach proposed by Galgóczi (2020) is put to the test. In the first instance, Galgóczi (2020) postulated that the first dimension dealt with how a new economy that is transitioned should look like from a new employment point of view while the second dealt with how to get from the current to the new economy. It is quite clear that on both these counts,

the views of the participants of this study expressed their opinion in the negative based on the work of Galgóczi (2020).

Enabling regulation

An enabling regulatory environment allows for an even playing field when it comes to ensuring compliance. It the current state, participants highlighted the fact that the lack of succinct regulation dealing with the transition to a low carbon economy did not place any burden i.e., there was no motivation in some sectors to transition and thus they had no mechanisms in place from a regulatory standpoint to enable the transition. The findings of Jhagroe and Loorbach (2015) that using a top down approach to planning and market based tactics is not adequate is dealing with complex transformations of economies such as those that arise due to climate change paint a difficult picture in a non-regulated environment insofar as a sustainable transition is concerned. Indeed, the pictured painted was difficult in that due to the mixed views obtained from the study wherein some participants viewed the transition to a low carbon economy as a strategy that will offer them a competitive edge in the future while others indicated that they did not need to transition but rather optimise current business processes to drive value maximisation. The study also provided evidence that due to the differences in approach between the energy and public enterprises department on what regulation should constitute a transition, mining companies were left in limbo as to which direction the legislation will be driven.

While the pronouncement by the South African government to increase self-generation project capacity to 100 MW was welcome by most participants, there study found that there were mixed views on how this piece of legislation would aid mining companies with mechanisms to enable the transition. To this extent, some participants indicated that they are fully exploiting the newly announced self-generation legislation through the establishment of renewable energy projects while others argued that they do not currently have a large energy footprint and thus embarking on self-generation projects would be a destruction of value. In detailing the 8 principles that form the foundation of transition management, Silvestri et al. (2018) argued that while the objectives set forth should be flexible and adjustable, there is a view that long term thinking must guide short term policy. The lack of policy as is the situation with carbon tax which was highlighted by the participants to the study contradicts the findings of Silvestri et al. (2018). The study found that the current postponements in enacting the carbon tax bill meant that “business as usual” was the norm. This has made it difficult to place mechanisms that are legislatively driven in enabling the transition.

Leveraging partnerships

Silvestri et al. (2018) stated that the creation of protected spaces for change agents to build alternative regimes is a fundamental element of transition management. This view was supported by Holden et al. (2021) who argued that strong strategic partners are critical for the success of new technologies. The study found that the development of new technologies in the South African mining industry required that partnerships be formed with businesses who have a strong technological footprint. It was found that many mining houses do not have large research and development floors and will thus depend on businesses who can provide green solutions to enable them to develop and adopt technologies during the transition. There was congruence amongst the participants to the study that self-generation required energy companies that specialise in such fields. This was evident by the number of requests for information (RFI) that were sent out to the market by the majority of businesses from whom the participants belonged. In the green hydrogen space, the study found that participants had engaged the services of international partners as green hydrogen was a novel technology in South Africa.

Transition to alternatives

The results of the study showed that the transition to a low carbon economy should be viewed as a multi-stage journey which will involve different energy mixes at any given time. In highlighting this point, some participants indicated that the current prices of green technology would simply not support the business from a profit-making perspective and would require significant upfront capital to be set up. From this perspective, they study found that the participants are more comfortable to upscale green technologies that have past the acceleration phase and are moving towards stabilisation as shown by the work of Van der Brugge and Rotmans (2007) figure 2. As argued by Galgóczi (2020), an important aspect to consider during the transition is the recognition of how to bridge the gap between technologies in the current economy and the future economy. While there were mixed views on how to do this, the strong view from the study was to develop and operationalise lower emitting products than the current products in the short term while prices for green technologies fall. That would then allow the development and adoption of green technologies in the long term. This strategy, agrees with both Van der Brugge and Rotmans (2007) and Shum (2017) insofar as preventing locking in and the protection of niches respectively. An example that strongly emanated from the study was that as a transition away from coal ensues, gas technology for production of materials should be developed in the short term which will eventually be replaced by hydrogen in the long term. This allows for continuous research and development in hydrogen

technology, protecting it from dominant actors i.e., coal while developing gas technology to bridge the gap.

In transitioning to alternatives, it is important to think clearly about the short term and long-term decisions that will affect the transition. The transition management framework postulated by Loorbach (2010) calls for long term policy to dictate short term actions as one of the fundamental elements of the strategic actions that need to be taken. To this extent, the study strongly found that infrastructure in use currently should configured well enough to cater for the technologies in the short term while managing the phase out of current technologies but should also not require drastic changes when niche technologies have finally stabilised. This was found to be a critical point of the study were participants urged that it is important to think "clearly" about the infrastructural architecture that allows for minimal changes as technologies transition from high through to low carbon.

6.5 Discussion of results – RQ 4

What niche innovations are mining companies supporting to enable the transition to a low carbon economy?

Having established the objective of the aforementioned research question in Chapter 2, which objective was aligned with objective number 2 of the research study in Chapter 1, the following themes from the results aimed to answer the fourth research question.

Agri-voltaic innovation

Owing to the amount of arable land available to mining companies, the study has shown that mining companies are embarking on a niche innovation of renewable energy projects coupled to agriculture. This ecosystem allows for power generated from RE sources such as solar and wind as an input to the agriculture process. The crops grown on such arable land are further able to remove carbon dioxide from the atmosphere. The results of the study show that the Agri-voltaic innovation allows for the creation of employment for local persons in both agriculture and renewable energy.

Green hydrogen

The production of green hydrogen was one of the niche innovations that was found to be strongly driven by the South African mining industry. When analysed against the niche innovation pathway described in figure 2 by Van der Brugge and Rotmans (2007), green hydrogen is plotted in the take-off phase. In this phase, it is argued by Van der Brugge and Rotmans (2007) that there exists a number of sustainability initiatives with very little movement in the general market, which market is characterised by technological innovations in their infancy. The study found this to be true for green hydrogen where the technology being

investigated for the production of green hydrogen is either from electrolytic technology or from hydrogen capture from the atmosphere. Both these technologies provide an exciting foundation for the transition but there is no general consensus in the market i.e., mining industry, as to which technology will emerge as the forerunner to green hydrogen production. It was evident from the study through the views of some participants that preference was given to one technology over the other because this technology has not reached a stage where prices and other micro economic factors have emerged stronger for one technology in comparison to the other.

Solar and wind

Solar and wind are classified as niche innovations owing to the fact that they are not mainstream technologies as they are still dominated by energy from fossil fuels. Furthermore, technology around the storage of energy from solar is further being refined through the optimisation of battery storage units. When analysed against the niche innovation pathway described in figure 2 by Van der Brugge and Rotmans (2007), solar and wind are plotted along the acceleration pathway. To substantiate this, the study found that a great deal of momentum has begun to build behind the use of solar and wind as alternatives with a general consensus that they are widely accepted technologies which will be able to provide adequate competition against the incumbent regime of energy production from fossil fuels. However, the study found that owing to reasons mentioned earlier with respect to battery storage technology, a new equilibrium has not be reached with solar and wind in agreement with the argument put forth by Chang et al. (2017) that equilibrium is reached at a systems level when the energy system works in unison to the extent that only improvements at a system level are undertaken.

Electrolysis of vanadium redox batteries

The study found that vanadium redox batteries was a niche innovation that was being driven in the mining industry in particular it's symbiotic relationship with solar and wind power production. However, it was evident that this niche innovation lags the solar and wind technologies on the innovation pathway proposed by Van der Brugge and Rotmans (2007) in figure 2. The vanadium redox batteries are plotted at the beginning of the take-off phase due to the fact that refinements to the technology are still being undertaken in order to provide better efficiency in the energy storage capacity of the batteries. The inability of RE to provide consistent power for mining operations was raised as a major concern for mining companies.

Clean carbon

The transition to a low carbon economy is essentially a transition pathway that minimizes the atmospheric emissions of carbon to prevent the warming of the Earth's crust. Perhaps the

most exciting niche innovation that was found in the study was the use carbon in a clean form and that which involved the capture of carbon from the chemical reaction to prevent it from being emitted into the atmosphere. When plotted on the technology transition pathway proposed by Van der Brugge and Rotmans (2007), these technologies are at the inception of the take-off phase and in the predevelopment phase respectively. The study found that some mining businesses had developed a way of obtaining clean carbon from any source. This would essentially mean that they could be able to continue using fossil fuels as a feedstock to their operations. One needs to understand the social economic landscape of coal mines to explain the excitement around carbon capture that some of the participants to the study highlighted. Caution must however be borne in mind with respect to this technology as its current costs are extremely high and it has not been proven.

6.6 Conclusion

The results of the study show that the South African mining industry has embarked on working through various niche innovations that will aid the transition to a low carbon economy. The study further showed that while there were commonalities in some of the niche innovations i.e., solar and wind, some mining businesses are adopting niche innovations that will offer them a competitive edge in a new transitioned economy i.e., hydrogen and clean carbon. The study further showed that these niche innovations are at different transition pathways in the maturity to the stabilisation proposed by (Van der Brugge & Rotmans, 2007). The effect of this being that the incumbent regime will still enjoy some time as the dominant actor insofar as energy production is concerned until such time that these technologies reach maturity and the costs involved in commercialising them become considerably bearable.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

It is no secret that the planet earth has been warming over a number of years. It is further not a secret that such warming has been brought about by human actions as found in the IPCC 6th assessment report (Masson-Delmotte et al., 2021). Some of the human actions which have facilitated the warming of the planet earth has been the extreme use of fossil fuel-based energy production which has driven the industrialisation of many economies. After recognising that the planet earth was warming at an alarming rate, with science providing evidence of the ramifications of climate change, world leaders came together and ratified the Kyoto protocol at the congress of parties held in Kyoto, Japan in 1997 (United Nations, n.d.). To date, the Kyoto protocol has 192 parties signed to it of which South Africa is also a signatory (United Nations, n.d.).

Being a signatory to the Kyoto protocol and having its own agenda in so far as lowering its emissions, South Africa developed the integrated resource plan with the aim of transitioning to a lower fossil fuel production of energy using the appropriate energy mix (Department of Minerals and Energy [DMRE], 2019). Transition management is a theoretical framework that deals with social-technical transitions and is succinctly defined by Silvestri et al. (2018) as a reflective process of governance that aims to influence the dynamics in society by encouraging multiple experimenting amongst actor, searching, and the creation of a knowledge process aimed towards the creation of a sustainable future. It is against this backdrop that this research study was formulated. The study aimed to understand what the role of the South African mining industry is in the sustainable transition to a low carbon economy. Given South Africa's unique setting i.e., a heavily concentrated energy production from coal, a mining industry whose fabric is intertwined with mining communities, and a mining industry that is heavily pressured by costs, the study postulated four research questions that would enable the understanding on whether the mining industries transition will be sustainable.

This chapter presents a summary of findings in Chapters 5 and 6 which were used in answering the research questions. The research study will be useful for mining companies in developing their climate change strategies to ensure a sustainable transition to a low carbon economy though the understanding of the key foundations of the transition management framework. The chapter will further highlight the limitations of the research and end with suggestions on possible future research which will contribute to the existing body of knowledge on transition management and transition to a low carbon economy in the mining industry.

7.2 Principal findings and consolidation

7.2.1 RQ1 – Climate risk material to business

In determining whether climate risk was material to the business, the study found that there was universal agreement that climate risk was indeed material. However, it was quite evident from the study that differences came in when this risk was "defined" differently between the mining businesses which subsequently determined the transition pathway they would follow. The definition of climate risks materiality on the business was driven by three key elements. The first of these elements was the pressure that would emanate from funders to reduce emissions through the limiting of capital altogether or through the provision of "expensive" capital. The second key element which drove materiality of climate risk to the business was the envisaged high costs of production which would emanate from not reducing emissions. The high costs of production considered from the imposition of emission related taxes such as carbon boarder tax and carbon tax. The third element that was considered as a driver for materiality was the costs that would be borne through the development of energy self-reliance through the implementation of self-generation of energy using renewable energy technologies. The study found that different mining businesses weighed the three elements differently. The fact that these were viewed differently then had an effect on how the mining businesses approached how to drive the transition to a low carbon economy for their business.

From a materiality point of view, the study found that there should be a radical transition from fossil fuel energy production and consumption coupled to a rapid uptake of renewable energy technologies in the extreme case. On the other hand, the study found that there was a view by many participants that fossil fuel energy production should continue to play a significant industrialisation role in South Africa by producing energy security in the form of baseload for current growth demands and that future growth should be facilitated through the onboarding of renewable energy technologies. This wide gap in "defining" climate risk by different mining businesses signifies that, from a transition management framework formulated by Loorbach (2010) point of view, there exists no consensus on the strategic arm of the framework. Loorbach (2010) contends that differences amongst actors in setting the vision in the strategic arena are normal in any transition. However, it is important that these differences are first ironed out amongst the actors before the transition begins to gain momentum.

A critical finding of the study insofar as materiality was concerned was that the consensus might not be reached amongst actors in setting the vision of the strategic arm of the transition management framework. This is because, at the core of their existence, mining businesses are competing with each other, and any source of competitive advantage will be used by different businesses. Therefore, depending on how a mining business views its competitive position, they will define their transition pathway based on this. This will however be contrary

to the eight fundamentals of transition management postulated by Silvestri et al. (2018) and consequently result in a transition that is not sustainable. To counter this, the study found that the overarching leadership role should be played by policy makers, in the case of South Africa the national government. Policy makers are required to bring the actors together with a policy framework that levels the playing field for all actors involved and then encourage the actors to define the vision based on a common policy. The study found that while work is being undertaken by the Presidential Climate Commission, a commission set up by the President Cyril Ramaphosa, to develop policy that will be the anchor for a level playing field, such policy has yet to be developed. Further, the study found that until such policy is developed, momentum can begin to develop towards energy transitioning, but this momentum will not lead to a sustainable transition to a low carbon economy.

7.2.2 RQ2 – Climate strategies alignment to the transition management framework

One of the key cornerstones of the transition management framework is that adequate stakeholder engagement is essential to any transition. Harrahill and Douglas (2019) assert that the transition management framework is sometimes criticised for being non-democratic in its approach. To this extent, Harrahill and Douglas (2019) assert that the views of none technical actors such as communities are not adequately considered when defining the vision as well as when operationalising the transition management framework. The ramifications of not adequately engaging stakeholders are that the outcomes of any such transition will not be sustainable. The study found that mining businesses are cognisant of the importance of community engagement in developing their climate change strategies. The inclusion of communities in climate change strategy development comes in the form of mining businesses and community-based SMEs working together to deliver RE projects. In other instances, mining companies have established alternative economies such as agro-businesses that use the vast land that is at the disposal of mining companies. However, on closer inspection of this community engagement, the study agreed with the findings of Harrahill and Douglas (2019) by noting that while mining companies were cognisant of the importance of community engagement, they did not do so at the inception of vision setting as called for by Loorbach (2010) in the formulation of the transition management framework. They decided on the vision and only engaged with the communities on what they had decided would be the vision of the transition. The community therefore had very little input in these decisions and were merely a passenger that was “forced” to aid the implementation process.

When analysed against the eight disciplined steps of social-technical transitions as proposed by Silvestri et al. (2018), the study found that while mining companies are driving a localisation agenda as part of their climate change strategies i.e., the development of niche technologies in the areas that mining companies operate such as the development of the hydrogen

ecosystem, communities were not adequately engaged on this localisation agenda. Evidence of this contends with the argument put forth by Silvestri et al. (2018) that any transition that steers away from the societal system will not be effective. In this context, such a transition will not result in a sustainable transition to a low carbon economy. To this extent, no adequate evidence was provided by the study that the context-sensitive analysis called for by Silvestri et al. (2018) had taken place. Evidence from the study showed that mining businesses argued that the opportunities that they were to embark on in the transition to a low carbon economy would bring about employment which would positively influence poverty, unemployment, and inequality in those communities and therefore, it was not a necessity to engage the communities. However, to give a social-technical transition any chance of being sustainable, the transition management framework postulated by Loorbach (2010) calls for exactly this type of engagement.

7.2.3 RQ3 – Mechanisms to enable a just transition

In determining the mechanisms that will enable a just transition, the study aimed to determine whether evidence existed wherein five mechanisms for a transition to a low carbon economy were investigated. In analysing the five mechanisms, the two dimensional approach called for by (Galgóczi, 2020) of how a new low carbon economy should look like from an employment point of view and how to get from the current economy to the new economy were considered.

From an employment perspective, the study found mixed evidence of the mechanisms being put in place by mining businesses to counter the social impacts of unemployment which may result from a transition to a low carbon economy. In this instance, two dominant views emerged from the study with the first being that without a nationally coordinated response, some mining businesses will “do nothing” with regards to the development of plans to address the social impacts of unemployment in communities. This evidence is akin to that which was found and described on the determination of materiality of climate risk to the business in that without a nationally coordinated response, such measures will be futile. The second view, a view which is more progressive that the first was one in which some mining businesses had begun to establish alternative economies in agriculture for example, to counter the effects of a transition led unemployment trajectory. More concerning however, was the evidence from the study that suggests that as far as workers are concerned, very little dialogue has taken place with workers representatives on adequate ways to protect workers from job losses. This is exactly in line with the finding put forth by Stevis and Felli (2015) which found that discussions in energy transitions did not involve unions and how workers were to be protected.

The second aspect of the mechanisms being put in place to enable a just transition was an investigation in building capacity from a skills point of view. In this instance, skills are viewed

from both a re-skilling of current employees and also building programs for future employees. The study found very little evidence that capacity building of skills has been developed to an extent that it can be operationalised. In actual fact, what the study found to be true was that the mining industry had indeed given this some thought, but very little work has gone into what this really entails to aid in the formulation of a vision that is called for by Loorbach (2010).

The third mechanism investigated to enable a just transition was the existence of an enabling regulatory environment. Evidence from the study was unanimous in the assertion that the current regulatory landscape in South Africa did not encourage an even playing field in driving a transition to a low carbon economy. The study further agreed with Jhagroe and Loorbach (2015) that a non-regulated environment poses a difficult path for any social-technical transition. The study further provided evidence that the mumblings from the Department of public enterprises and the Department of minerals and energy from their ministerial deployments on what should constitute a just energy transition have caused much frustration and points to the fact that no concise regulation is currently existing for the sustainable transition to a low carbon economy.

The fourth mechanism investigated to enable a just transition was the leveraging of partnerships. The study provided strong evidence that mining businesses appreciated the need to form strategic partnerships as a mechanism to drive the transition to a low carbon economy. There was congruency with Holden et al. (2021) on the argument that the success of new technologies to drive the transition required strong strategic alliances with partners who possessed a large research and development pool in such new technologies.

In explaining the fifth mechanism to enable the transition to a low carbon economy, the results of the study showed that the transition to a low carbon economy should be viewed as a multi-stage journey which will involve different energy mixes at any given time. From this perspective, they study provided strong evidence that to upscale green technologies, there was a need to have an appropriate mix of technologies at any given point to support the transition, as long as those technologies had passed the acceleration phase and were moving towards stabilisation as shown by the work of Van der Brugge and Rotmans (2007) in figure 2. Galgóczi (2020) argued that an important aspect to consider during the transition was the recognition of how to bridge the gap between technologies in the current economy and the future economy. While there were mixed views on how to do this, the strong view from the study was to develop and operationalise lower emitting products than the current products in the short term while prices for green technologies fall which would then allow the development and adoption of green technologies in the long term. The transition management framework postulated by Loorbach (2010) calls for long term policy to dictate short term actions as one

of the fundamental elements of the strategic actions that need to be taken. To this extent, the study found strongly that infrastructure in use currently should be configured well enough to cater for the technologies in the short term while managing the phase out of current technologies but should also not require drastic changes when niche technologies have finally stabilised. This was found to be a critical point of the study were participants urged that it is important to think “clearly” about the infrastructural architecture that allows for minimal changes as technologies transition from high through to low carbon.

7.2.4 RQ4 – Niche innovations being supporting to enable transition

Evidence from the study shows that the mining industry is supporting a number of niche innovations to drive the transition to a low carbon economy. These niche innovations range from agri-voltaic, production of green hydrogen, the use of solar and wind, electrolysis of vanadium redox batteries, and clean carbon. The study further showed that these niche innovations are at different transition pathways when plotted against Van der Brugge and Rotmans (2007) transitional pathway map. This important consideration supports the evidence on the transition to alternatives investigated in the third research question that a need to have an appropriate mix of technologies is important in supporting a transition to a low carbon economy.

7.3 Theoretical contribution

The anchor theoretical framework upon which this study was based was the transition management framework. The transition management framework has been described as a four-stage non-linear process by Loorbach (2010). Furthermore, its foundational elements are elaborated on by Silvestri et al. (2018). Evidence from this study has shown that the transition management framework incorporates elements of other sustainability frameworks such as SNM, MPC, and MPL. Furthermore, the study has shown that the transition management framework is a participatory framework with a key undertaking of involving stakeholders during the inception of setting the vision as set out by Loorbach (2010) and carrying through the tactical, operationalisation, and reflective processes

South Africa is uniquely positioned in that it has a high concentration of fossil-fuel based energy production and consumption and mining in particular is a high consumer of energy. The mining industry is therefore posed to play an instrumental role in the transition to a low carbon economy. This instrumental role that mining will play is further supported by the positioning of mines in communities were jobs are instrumental to the fabric of those communities. As such, this study contributes to theory by recognising that while it is accepted that the transition management framework is essential in ensuring sustainable transitions, its application in the South African sense should recognise the unique challenges that South

Africa faces as a developing nation and in particular, the unique circumstances that the South African mining industry grapples with insofar as poverty, unemployment, and inequality in mining communities is concerned. Only through such recognition, will the development of the appropriate policies amongst actors lead to the vision setting that will result in the sustainable transition to a low carbon economy, and only then will such a transition be deemed as being just.

7.4 Implications for management and other relevant stakeholders

Climate change has been deemed as one of the foremost threats to the existence of mankind. It is therefore crucial that actions be developed to mitigate the effects of climate change, which actions will be driven by the transition to a low carbon economy. However, it must be recognised that much as the transition pathways will be similar in approach at a contextual level, countries will transition differently based on the social economic circumstances. As countries transition, the industries that drive the economies of those countries will transition differently. Evidence from this study has shown that there exist key areas for management of businesses and other relevant stakeholders to concern themselves with when it comes to developing transition plans. First and foremost, the importance of stakeholder engagement at the beginning of the process is crucial. The absence of stakeholder engagement is futile as it builds a sense of mistrust amongst social actors and may lead to a situation where there is no buy in from the said stakeholders. Management also needs to understand that transition management advocates for the protection of niche innovations. An important consideration to make with regards to niche innovations is the appreciation that they exist at different stages in the transition pathway. The lack of making this very important consideration will result in management teams not knowing which niche innovations will drive their transition to a low carbon economy.

7.5 Limitations of the research

Given the fact that information relating to sustainability may at times be confidential, the lack of forthcoming information from the respondents was a limitation to gaining a broad insight into study. A typical example of this was when some of the participants indicated that they could not disclose certain information that might affect their competitive edge. Organisations that were far along the transition to low carbon spectrum typically highlighted that some of the information surrounding niche innovations could not be disclosed and only what was reported in their climate change strategies could be reported on.

The covid-19 pandemic created both a positive and negative situation insofar as access to senior management is concerned. In the positive, it allowed for ease of access to senior management as an online interview link could easily be sent to such executives after

consulting with their personnel assistants. This however resulted in a negative situation in that this access limited the amount of time that these executives could give to any one person and still continue with running of their organisations. As such, time of the interviews became a limitation as most executives could not allow more that 40 minutes of their time to answer the interview questions. This resulted in a situation wherein the full depth of answers to some questions was not obtained.

Interviews conducted with executives require seasoned interviewers who understand the interviewing process and how to pose questions. To this effect, in as much as the researcher practiced, read about, and watched interviewing videos, they were not a seasoned interviewer to the extent that they have done interviews before and thus this became a limitation to the study.

An important aspect of the transition management framework is the participation of stakeholders. While the researcher made efforts to have a sample that could provide enough information to make inferences for the study, representatives of employees in the form of organised labour did not form part of the sample. Furthermore, community-based forums and SMEs dealing with mining businesses were not part of the sample. It is the researcher's belief that this was a limitation of the study as the study could be deemed "one-sided."

7.6 Suggestions for future research

The study identified a limitation in the form of inadequate stakeholder consultation i.e., the lack of participants from organised labour and communities. It is argued by the researcher that this limitation be a suggestion for future research in order to determine the full range of evidence from both business, unions, and communities.

The study that was undertaken by the researcher was qualitative in nature. A suggestion for future research is to undertake a quantitative assessment of the transition management framework postulate by Loorbach (2010).

The third suggestion for future research is in the realm of grounded theory. Given the unique setting of South Africa in as far as poverty, unemployment, and inequality is concerned, a suggestion is made to develop grounded theory on what will result in a sustainable transition to a low carbon economy in South Africa.

APPENDICES

APPENDIX I: Semi-structured interview guide – Consent form

I am Ndashe Ndyamba, a final year student at the Gordon Institute of Business Science. I am conducting research on the role of the South African mining industry in the transition to a low carbon economy for the purpose of establishing whether the climate strategies of mining companies confirm the theory of transition management with a view of providing a view on whether these strategies will lead to a sustainable transition to a low carbon economy. This interview guide is designed to obtain insights from you the participant on the role that role that your organisation will play in the transition to a low carbon economy. The interview is semi-structured with a list of 10 questions.

Your input is absolutely valuable and welcome. The information obtained from this interview will be treated with the utmost discretion and your anonymity is guaranteed with all data obtained reported without any identifiers. The researcher has given permission for the findings of this research to be disseminated in academic and popular media. Your taking part in this interview is absolutely voluntary and you can opt to withdraw from this interview at any given time without penalty.

The interview consists of 10 questions and will require 45 minutes of your time. During the interview, you are required to provide your own perspective of the questions being asked. If there are any concerns or queries regarding this interview, please contact myself or my supervisor on the contact details below.

Researcher: Ndashe Ndyamba	Tel: +27 76 557 7884 Email: 27392432@mygibs.co.za
Supervisor: Prof. Johan Olivier	Tel: +27 11 771 4000 Email: olivierjo@gibs.co.za

Participant Signature **Researcher Signature**

_____ _____

Date of interview_____ **Date of interview**_____

APPENDIX II: Semi-structured Interview questions

1) In your view, is the sustainable transition to a low carbon economy in South Africa's mining industry feasible within the next 30 years?

2) What in your view are the top 3 enablers to a sustainable transition to a low carbon economy in South Africa's mining industry?

3) Transition management has been used as a framework to study complex societal transitions. It is however criticised for being non-democratic. What mechanisms have you used to ensure adequate participation of all stakeholders in the establishment of your climate change strategy?

4) Just transition has been touted as a way of ensuring a sustainable transition to a low carbon economy. One of the ways proposed of achieving a just transition is through the re-skilling of employees. How is your climate change strategy addressing the re-skilling aspect?

5) Apart from the re-skilling of workers, what other mechanisms are being employed in relation to the communities in which you are present to ensure a sustainable transition is made possible?

6) Transition management advocates for the protection of niche innovations before complete system uptake. Does your organisation have any niche innovations or participate in any niche innovations that will form the foundation of a transition to a low carbon economy? If so, how is your organisation supporting these niche innovations to protect them from dominant actors such as Eskom so that they can survive and become mainstream.

7) Would you say that your organisation is maximising the use of renewable energy within the current national legislative framework?

8) What processes are used by your organisation in assessing the risks of climate change to your organisation?

9) Do you think vision 2050, zero-carbon economy is possible in the mining industry in South Africa? Is your organisation transitioning quick enough to achieve this vision?

10) How are the climate change plans developed by your organisation taking the huge income disparity in the communities you operate into consideration?

APPENDIX III: Permission to conduct research

Name of participant

Position

Company details

Company address

Ref: Request for permission to conduct research at (Name of company)

Dear Sir/Madam,

My name is Ndashe Ndyamba, I am a Master's in Business Administration (MBA) student at the Graduate Institute of Business Science (GIBS). I am currently conducting research for my master's dissertation on "The role of the South African mining industry in the sustainable transition to a low carbon economy." This research will be conducted under the supervision of Prof. Johan L. Olivier, Acting Director at GIBS.

I am hereby seeking your consent to conduct this research within your organisation by interviewing personnel within your organisation within the context of the said topic.

With this signed form, you can confirm that you have given me the permission to conduct this research in your organisation through conducting interviews with the appropriate employees within your organisation.

Yours sincerely,

_____ _____

Ndashe Ndyamba (Researcher) **Interviewee**

APPENDIX IV: List of codes used

Number	Codes
1	3-step process of plan
2	adverse social impact
3	agri voltaic innovation,
4	assessments of cash flows,
5	availability of capital
6	carbon border tax
7	climate risk assessment model
8	climate risk material to business
9	coal efficient energy
10	coal yield cheap electricity
11	collision with stakeholders
12	commitment as responsible citizen
13	comprehensive risk management framework
14	confidence of stakeholders
15	cornerstone of decision-making
16	cost effective energy alternatives
17	de-carbonization not feasible
18	development of green technology minerals
19	disconnect between government departments
20	electrolyte for vanadium redox batteries
21	eliminate greenhouse gasses
22	eliminate use of diesel
23	enabling Regulation
24	energy self-reliance
25	ESG investment
26	funding / investment framework
27	funding based on renewals
28	high cost of production
29	high unemployment rates
30	hindrance to the transition
31	IDC as investors
32	impact of struggling economy

Number	Codes
33	inconsistency of first world countries
34	increased cost of production
35	industrialised with coal
36	industrialised with steel
37	initial threshold not leveraged
38	interest rate on debt
39	investment in developing countries.
40	Investor's pressure
41	lack of affordable energy
42	lack of investment in South Africa
43	lack of reliable energy supply
44	lack of skill set
45	liquidity of business
46	low carbon economy
47	management of secular economy project
48	manufacturing of biofuel
49	misnomer of clean coal
50	new energy mix
51	optimise synergies from projects
52	participation of manufacturing communities
53	people losing jobs
54	PIC as investors
55	political alignments
56	power station support
57	pressure from funders
58	pricing of the risk
59	process solid waste into fertilizer
60	protection of stakeholders
61	quantification of carbon emissions
62	reach 2030 milestone
63	reach 2050 milestone
64	redeploy people into new sectors
65	renewals incorporate in schooling
66	require 200 megawatts

Number	Codes
67	re-skilling of the employees
68	self-sustainability business
69	skilling of new entrants
70	stakeholder engagement
71	strategic risk register
72	supportive energy innovation
73	threshold 100 megawatts
74	total de-carbonization
75	transition from electrical to solar energy
76	transition not feasible
77	transition partially feasible
78	transition to gas
79	transition to low carbon
80	transition to low carbon economy
81	turn away from coal fired power station,

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